ACA 2018

Inspiration in Color

The 4th Asia Color Association Conference

The 4th Asia Color Association Conference

5th - 8th December 2018, Khum Phucome Hotel, Chiang Mai, Thailand

Hosted by:

Faculty of Mass Communication Technology
Rajamangala University of Technology Thanyaburi
Asia Color Association
Thailand Convention & Exhibition Bureau

Proceeding book

ACA2018 PROCEEDING BOOK

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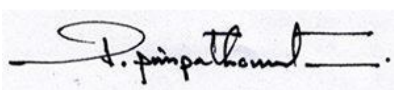
Message from ACA2018 Conference Chair

Dear colleagues in the field of color science and design.

It is our great pleasure to host the 4th conference of the Asia Color Association (ACA). It will take place at the Khum Phucome Hotel in Chiang Mai, Kingdom of Thailand on 6 to 8 December 2018 with the conference theme "Inspiration in Color". In 2013 we invited you to our main campus at Thanyaburi but this time we hold the conference at the city of Chiang Mai, an ancient city locating in the north of Thailand with abundant culture and history. The month of December is the best season in Thailand, nice and cool. The Khum Phucome Hotel has a beautiful Thai Traditional facade and I am sure that you can enjoy to stay there. I understand that the motto of the ACA is an economical conference so that young scientists and designers can easily attend. We will try our best to meet the motto.

I sincerely hope that you will attend at the conference and exchange your views with people from all ASEAN countries to make the conference successful.



Assoc. Prof. Prasert Pinpathomrat, Ph.D.

The President of Rajamangala University of Technology Thanyaburi

Message from the coordinator of Asia Color Association

Dear colleagues of ACA

I am happy to announce that the 4th conference of the Asia Color Association ACA takes place in Chiang Mai, Thailand and thank Rajamangala University of Technology Thanyaburi for organizing the conference. The ACA was established in 2013 to encourage and give opportunities to young color scientists and designers to exchange their views with colleagues from other countries in Asia by presenting papers. It was held in Taiwan, in China after Thanyaburi. The ACA is not to compete with the International Color Association AIC but to cooperate and supplement with each other, so the conference is not held in the year when the AIC conference is held in a country or a district in Asia.

The mottos of ACA are (1) to hold economical conferences so that young researchers can attend, (2) conference language is English and poor English is accepted, and (3) no membership so that anyone can join. In the board meeting held in Changshu, China at the 3rd ACA conference many delegates suggested Chiang Mai for the next conference and Thai delegates kindly accepted the suggestion.

I understand that colleagues at Rajamangala University of Technology Thanyaburi are organizing the 4th conference to meet all these mottos. I am sure that you can enjoy and get much profit by joining the conference in Chiang Mai. See you at the Khum Phucome Hotel in Chiang Mai, December 2018.

Prof. Mitsuo Ikeda, Ph.D.

Coordinator of ACA, Professor at Color Research Center,

Rajamangala University of Technology Thanyaburi.

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INVITED SPEAKER

Prof. Dr. Lee, Tien-Rein (Taiwan)

"Color orders and orders of life"

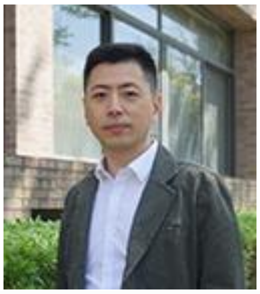
Colors can be differentiated in their various characteristics and appearances until today, many color order systems exist for people to apply in their daily life matters. Organizing colors into orders and making use of these systems in human orders of life have been age-old traditions in many places all over the world, and modern science has significantly contributed to conserving, improving and innovating knowledge about color characteristics and color order systems. Which are the examples of such orders of life specifically depending on colors? And, is there a color system that can indeed trustfully be used to manage our daily life issues? This talk is going to explore color order systems and their possible methods and means for effective color management in human orders of life. Prof. Dr. Tien-Rein Lee's professional expertise comprises practical interest and experience in Visual Communications and New Media, and an academic focus in Color Communication, Color and Culture, and Media Technology. As the Founding President of the Color Association of Taiwan (CAT), Prof. Lee is a color research pioneer establishing color studies and color application networks in Taiwan, with China, Asia, and worldwide. He has taken position of AIC President in 2018. Prof. Lee was President of the Chinese Culture University from 2003 to 2009, and has acquired this position again from August 2013 to January 2018. Prof. Lee originally graduated with a B.S. in Print Media Communications and a M.A. in Journalism from Chinese Culture University. He also received a M.A. in Visual Communication from University of California, Los Angeles (UCLA), and a Ph.D. in Culture and Communication from New York University (NYU). His experience covers a vast range of international collaboration on academic, cultural and administrative levels.

Asst. Prof. Apisak Sindhuphak, M.ID., Ph.D. (Thailand)

"Intuitive Color through Cultural Perceptive Assessment"

In a creative process, do we recognized or remembered the vividness of our design decision through a personal color preferences? When under pressure, has the color solution yielded from our deep consciousness–the experiences recalled from previous learned or adopted signifiers. Are we living in the realm of reflective consciousness when thinking of color selection that our responses spontaneously imply through recognizable color tonality? Interpreting such signified color, related to situation or memory conducive to design of Thai textile, pottery, architecture ornaments, or product design, has been a personal journey–never to draw a definite conclusion or to seclude from academic discussion. This exploration became a treasure not for such a cultural collective color matters but also a gift of assimilated knowledge gained through time and exposure. In amalgamation of this process, such data and research allowed the design to defy the subdue color selection and challenge the traditional idea within the creative process. Through a system coined as **"Chromaticon"** (a set of Thai collective color exploration), the intuitive colors were arranged in order, paralleled to that of the physical design solution. Thus allows for an alternative way of how new color arrangement can challenge the status of the traditional color originated to discipline design consciousness. This also served as an assessment network that opened to various format to interplay the color of contemporary Thai design.

KEYNOTE SPEAKER



Assoc. Prof. Dr. Changyu Diao (China)

"Color Correction and Reproduction Assessment of Cultural Heritage Images"

Dr. Changyu Diao, an associated professor of Cultural Heritage Institute of Zhejiang University, China. A highly motivated researcher with broad-based experience and hands-on skill in research and analysis. A competent team leader of a computer aided archaeological technology and application group with proven organizational and interpersonal communication skills and experience. Engaged in cultural heritage digitization research for over ten years, including 3D digitization, information management, information processing and analysis, virtual exhibition, digital museum, etc. Some of research achievements represent the highest level of the related areas in China, which have been successfully applied to many sites and museums. Close and sustaining relationships with many archaeological research organizations, such as Dunhuang Academy, Yungang Academy, Chinese Academy of Cultural Heritage, and Institute of Archaeology of Zhejiang, Shanxi, Ningxia, Xinjiang, etc.

Prof. Dr. Adi Djoko Guritno (Indonesia)

"The importance of color in the field of agroindustry"

Dr. Adi graduated from Gadjah Mada University, Jogjakarta, Indonesia with bachelor of agricultural technology, (Ir), got master of industrial engineering (MSIE) from Bandung Institute of Technology, Indonesia, and Ph.D. at United Graduate School of Agricultural Sciences Ehime University, Japan. He is currently a permanent lecturer at Faculty of Agricultural Technology, Gadjah Mada University, Indonesia. He serves a chairman of IAAI (International Association on Agro Industry) and a chairman of APTA (Association of Agro Industry in Indonesia). He was honored research fellowship from Japan Alumni Society and Science Organization (JASSO) and research fellowship from Japan Society for Promotion Sciences (JSPS). He will talk on "The importance of color in the field of agroindustry" Color is a natural gift given to humans through various ways among them as an indicator of whether vegetables and fruits ready for consumption or not. The development of color is now very much developed where colors also have an effect that can affect consumers to buy agricultural products or not, and in the field of agro-industry now have to take into account the influence of colors and combinations that will provide additional value for the product itself. Agroindustry products come in two forms: fresh and processed (preserved). For fresh products a lot of effort is emphasized on the effort to keep the color from fading, wilt, dull, etc. As for the color processed products are more emphasized in the combination of the product itself and the accompanying packaging.

Prof. Dr. Ichiro Kuriki (Japan)

"Study on color category in Japanese by using a clustering analysis"

Dr. Kuriki received his Ph.D. from Tokyo Institute of Technology (1996), worked at Tokyo Institute of Technology (1996-99), University of Tokyo (1999-2001), and NTT Communication Science Laboratory (2001-05), before joining Tohoku University as an Associate Professor (2006-present). He investigates the mechanisms of human color vision by using psychophysics and functional brain imaging techniques. Recent works also revealed the presence of hue selective mechanisms in human visual cortex by fMRI (Cerebral Cortex, 2015), cortical responses to color category in prelingual infants by brain activity measured with NIRS (PNAS, 2016). He led a research group composed ot USA, Taiwan, Thailand and Japan to compare color categories among different countries.

Prof. Dr. Takahiko Horiuchi (Japan)

"Challenges in Shitsukan imaging"

Prof. Takahiko Horiuchi has been a Professor at the Graduate School of Engineering, Chiba University since 2013. He is a chair of Department of Imaging Sciences. He has made several important contributions to color image science and technology. His contributions, spanning more than two decades years, range from the fundamentals of color imaging to its computer image applications. He has contributed in particular, to advancements in color image processing, spectral imaging, and color perception. He has published about 250 scientific papers on international journals or conferences in the field of color sciences and engineering. He served as the auditor and the director of the Color Science Association of Japan (CSAJ). He presently member of the editorial board of Color Research and Application. Since 2018, he is an executive committee member of the International Colour Association (AIC).

Prof. Dr. I-Ping Chen (Taiwan)

"Color Analysis in Art and Design Studies"

Prof. I-Ping Chen received his BS degree in Psychology from National Taiwan University in 1986, and the Ph.D. degree in Biological Psychology from the University of California, Berkeley, USA, in 1994, under the supervision of late Prof. Russel De Valois, the director of the world famous primate color vision lab. He was an associate professor at National Chung-Cheng University and National Yang-Ming University for several years, associated with the Department of Psychology, and the Institute of Neuroscience, respectively. He made a turn in his academic career in 2001, shifting from vision neuroscience to art and design related interdisciplinary studies. He is currently a full professor of the Institute of Applied Arts at the National Chiao Tung University. His research interests include visual perception, psychology of the Arts, and psychology for design.

Asst. Prof. Dr. Chanprapha Phuangsuwan (Thailand)

"Color constancy on 2D photographic images"

It is said that the color constancy does not take place on a 2D photograph. The concept of the recognized visual space of illumination RVSI developped by Ikeda asserts the color constancy occurs for a space for which the illumination can be recognized by the observer. Dr. Phuangsuwan confirmed the concept by demonstrating the color constancy on a 2D photographs. She received a Ph.D. at the Faculty of Science, Chulalongkorn University, Thailand in 2012 and returned to Rajamangala University of Technology Thanyaburi (RMUTT) as a lecturer, presently an assistant professor. Her research interest is to investigate the color appearance of objects in relation to the space recognition. She serves the director of Color Research Center CRC of RMUTT.

Dr. Jeeranuch Buddeejeen (Thailand)

"Color Application in Functional Packaging Design and Smart Service"

Dr. Buddeejeen received her Master's degree from Thammasat Univeristy and PhD ((Industrial Engineering) from King Mongkut's University of Technology North Bangkok. She has beeen a lecturer at Sukhothai Thammathirat Open University (STOU) since 2012, teaching printing and Packaging Technology. She was a visiting researcher at Department of Management and Engineering, Linköpings Universitet, Sweden, Life Cycle Engineering Laboratory, Osaka University, Japan, and Universal Design Laboratory of Dr. T. Obama at Shizuoka University of Art and Culture, Japan.

Dr. Buddeejeen focuses her research on the functional Printing /Packaging for Smart Application. Color is the high priority to connect with agricultural/food products and smart packaging. We developed the area scale of color changing and design packaging to keep banana for long life time. The idea is accepted by the agricultural farmers in Thailand with interest in designing functional packaging. Thailand is a land producing the best food and fruit in the world.

Time	December 5, 2018	December 6, 2018			
	Sri Satchanalai room	Sri Satchanalai room		Sri Nakorn room	
8.30		Registration (In front of Sawankalok room)			
8.45					
9.00		Open ceremony (Sawankalok room)			
9.15					
9.30		Color orders and orders of life *T.R. Lee* (Sawankalok room)			
9.45					
10.00		Group photo (Sawankalok room)			
10.15		Break			
10.30		Challenges in shitsukan imaging *T. Horiuchi*		Color correction and reproduction assessment of cultural heritage image *C. Diao*	
10.45					
11.00		Color imaging	OA1-01	Color technology	OB1-01
11.15			OA1-02		OB1-03
11.30			OA1-03		OB1-04
11.45			OA1-04		OB1-05
12.00					OB1-06
12.15		Lunch			
13.30		Short poster persentation (PA)		Short poster persentation (PB)	
13.45					
14.00					
14.15		Poster session (In front of Sri Satchanalai room)			
14.30					
14.45					
15.00	Registration (In front of Sri Satchanalai room)				
15.15		Break			
15.30		Color analysis in art and design studies *I. P. Chen*		Color constancy on 2D photographic images *C. Phuangsuwan*	
15.45					
16.00		Color design	OA1-07	Color vision	OB1-07
16.15			OA1-08		OB1-08
16.30			OA1-09		OB1-09
16.45			OA1-11		OB1-10

Evening Session	Welcome reception (In front of Sri Satchanalai room (18.00 - 20.00)	Exchange meeting (Banquet) (Sawankalok room) (18.30 - 22.00)

Time	December 7, 2018				December 8, 2018
	Sri Satchanalai room		Sri Nakorn room		
8.30					
8.45	**Invited lecture:** **(Sawankalok room)**				
9.00					
9.15	Move to meeting room				
9.30	**Color application in functional packaging design and smart service** ***J. Buddeejeen***		Color vision	OB2-01	
9.45				OB2-02	
10.00	Color design	OA2-03		OB2-04	
10.15		OA2-05		OB2-06	
10.30	**Break**				
10.45	Color psychology	OA2-06	**Study on color category in japanese by using a clustering analysis** ***I. Kuriki***		
11.00		OA2-07			
11.15		OA2-08	Color vision	OB2-07	
11.30		OA2-09		OB2-08	
11.45		OA2-10		OB2-10	**Thai cultural study**
12.00		OA2-01		OB2-11	
12.15	**Lunch**				
13.30	**Exhibition and poster session II** **(In front of Sri Satchanalai room)**				
13.45					
14.00					
14.15					
14.30	**The importance of color in the field of agroindustry** ***A. D. Guritno***		Quality of life Color in health and cosmetics	OB2-12	
14.45				OB2-13	
15.00	Color application	OA2-11		OB2-16	
15.15		OA2-12		OB2-14	
15.30		OA2-14		OB2-15	
15.45	Break				
16.00	**Closing ceremony** **(Sawankalok room)**				
16.15					
16.30					
16.45					

Evening Session	

CONFERENCE PROGRAM

Date Thursday, December 06, 2018

Room Sawankalok

Start		End		Title
8:30	-	9:00		Registration
9:00	-	9:30		Open Ceremony
9:30	-	10:00		**Invited Lecture:** Color Orders and Orders of Life *T.R. Lee*
10:00	-	10:15		Group Photo
10:15	-	10:30		Break

Room Sri Satchanalai

Session I

Start		End		
10:30	-	11:00		**Keynote speech:** Challenges in Shitsukan Imaging *T. Horiuchi*
11:00	-	11:15	OA1-01	Robust Color Correction Strategy Based on Chromatic Adaptation Model *J. Qiu, H. Xu and Z. Ye*
11:15	-	11:30	OA1-02	Study of Color Volume Metrics Reflecting Image Quality of HDR Displays *Z. Ye, H. Xu, W. Lv, J. Qiu and W. Ye*
11:30	-	11:45	OA1-03	Investigation of Multispectral Demosaicking Algorithms for Spectral Image Reconstruction *P. Xu and H. Xu, Z.Ye and J. Qiu*
11:45	-	12:00	OA1-04	Visual Ethnography: Photography and Color *T. M. R. Groves*
12:15	-	13:30		Lunch
13:30	-	14:15		Short Poster Presentation (A)
14:15	-	15:15		Poster Session (In front of Sri Satchanalai room)
15:15	-	15:30		Break

Room **Sri Satchanalai**

Session II

Start		End		
15:30	-	16:00		**Keynote Speech:** Color Analysis in Art and Design Studies *I. P. Chen*
16:00	-	16:15	OA1-07	Better Color, Better City: Shanghai Urban Color Survey and Analyzing *A. Gou and J. Wang*
16:15	-	16:30	OA1-08	Influence of the Difference between Planer Illustration Expression and VR Expression on the Preference of Interior Color Design *M. Sakamoto and H. Suto*
16:30	-	16:45	OA1-09	Influence of Structural and Color Packaging Design for Customer Perceptions in the Case Study of Organic Products *J. Buddeejeen*
16:45	-	17:00	OA1-11	The Influence of HDR Image to Satisfaction of Virtual Reality (VR.) to Promote Tourism in Nakhon Nayok Province *T. Lailang*

Room **Sawankalok**

Start		End	
18:30	-	20:30	Exchange Meeting (Banquet)

CONFERENCE PROGRAM

Date **Thursday, December 06, 2018**
Room **Sri Nakorn**
Session I

Start		End		
10:30	-	11:00		**Keynote speech:** Color Correction and Reproduction Assessment of Cultural Heritage Images *C. Diao*
11:00	-	11:15	OB1-01	Gloss Distribution Measurement of Foods and their Visual Palatability Evaluation *M. Isomi, H. Sakai and H. Iyota*
11:15	-	11:30	OB1-03	Evaluation of Surface Color of Steam-Cooked Manju through Non-Contact Colorimetric Measurement Using Dome Illumination: Effect of Processing Conditions *H. Yamamoto, H. Sakai, S. Kitamura, M. Takayama and H. Iyota*
11:30	-	11:45	OB1-04	Standard Measurement Apparatus of Cotton Color with Xenon Lamp *Y. Ma and L. Lv*
11:45	-	12:00	OB1-05	Non-Contact Colorimetric Measurement Using Dome Illumination for Complex Shape Objects *H. Sakai, M. Isomi and H. Iyota*
12:00	-	12:15	OB1-06	Application of AI Technology on the Color Trend Research in Textile and Apparel Industry *X. Li, D. Huang, M. Qi and J. Wang*
12:15	-	13:30		Lunch
13:30	-	14:15		Short Poster Presentation (B)
14:15	-	15:15		Poster Session (In front of Sri Satchanalai room)
15:15	-	15:30		Break

Room **Sri Nakorn**

Session II

Start		End		
15:30	-	16:00		**Keynote Speech:** Color constancy on 2D Photographic Images *C. Phuangsuwan*
16:00	-	16:15	OB1-07	Variations in Human Color Vision beyond Perceptual Differences *C. Hiramatsu*
16:15	-	16:30	OB1-08	Chromatic Adaptation Transform and Properties for Symmetry and Transitivity *C. Li*
16:30	-	16:45	OB1-09	Color Appearance of Objects under Vivid Colored LED Light *N. Panitanang, M. Ikeda and C. Phuangsuwan*
16:45	-	17:00	OB1-10	Aging Effect of Observer Metamerism for Wide Color Gamut Displays *H. Yaguchi, R. Suto, S. Katsura and S. Sunaga*

Room **Sawankalok**

Start		End	
18:30	-	20:30	Exchange Meeting (Banquet)

CONFERENCE PROGRAM

Date Friday, December 07, 2018

Room **Sawankalok**

Start		End		Title
8:45	-	9:15		**Invited Lecture:** Intuitive Color through Cultural Perceptive Assessment *A. Sindhuphak*

Room **Sri Satchanalai**

Session I

Start		End		Title
9:30	-	10:00		**Keynote Speech:** Color Application in Functional Packaging Design and Smart Service *J. Buddeejeen*
10:00	-	10:15	OA2-03	The Color of Manorah Thai Performance's Costumes in South of Thailand *W. Khwansuwan and E. Phetkeaw*
10:15	-	10:30	OA2-05	Neural Correlates of Color Harmony *N. Osaka, T. Ikeda and M. Osaka*
10:30	-	10:45		Break

Room **Sri Satchanalai**

Session II

Start		End		Title
10:45	-	11:00	OA2-06	Developing Creative Contemporary Painting under The Flowers-Happiness Theme *S. Inthaniwet*
11:00	-	11:15	OA2-07	Traditional Thai Style Colors: Studying on Color Tolerence and Acceptance by Thai Artists *N. Kaew-on, P. Katemake and A. Radsamrong*
11:15	-	11:30	OA2-08	Personality Characteristics and Stability of Color Preference *S. Nakamura*
11:30	-	11:45	OA2-09	Color Preference by Elderlies for Colored Rice *S. Yongsue and C. Phuangsuwan*
11:45	-	12:00	OA2-10	Color Boundary Determined by Comparison with 12 Colors on Young and Elderly *B. Waleetorncheepsawat, S. Theerathammakorn and T. Obama*

12:00	-	12:15	OA2-01	The Study of the Visual Elements in Wat Phumin Mural Painting *P. Pittayawattanachai*
12:15	-	13:30		Lunch
13:30	-	14:30		Exhibition and Poster Session II (In front of Sri Satchanalai room)

Room **Sri Satchanalai**

Session III

Start		End		
14:30	-	15:00		**Keynote Speech:** The Importance of Color in the Field of Agroindustry *A. D. Guritno*
15:00	-	15:15	OA2-11	Color Measurement and Characteristics Analysis for Porcelain *D. Chen, Q. Huang, W. Li, B. Kang, J. Hou and C. Jia*
15:15	-	15:30	OA2-12	Hom Thong Banana Ripening Color Scale for Individual Packaging Selection in the Retail Market *M. Wipaweeponkun and J. Buddeejeen*
15:30	-	15:45	OA2-14	The Color and Appearance in Fungal Inhibition Effect of Natural Packaging Material by Using Thai Herb Powder Extraction *P. Booncharoen and J. Buddeejeen*
15:45	-	16:00		Break

Room **Sawankalok**

16:00	-	16:30		Closing Ceremony

CONFERENCE PROGRAM

Date **Friday, December 07, 2018**
Room **Sri Nakorn**
Session I

Start		End		
9:30	-	9:45	OB2-01	Individual Differences of IPRGC's Contribution in Brightness Perception *M. Yamakawa, S. Tsujimura and K. Okajima*
9:45	-	10:00	OB2-02	Comparison of the Simultaneous Color Contrast Stimulated by Colored Paper and Colored Illumination *P.Chitapanya, M.Ikeda and C.Phuangsuwan*
10:00	-	10:15	OB2-04	Difference in Color Area of Elderly and Young People in the Difference of Color Temperature of Lighting *T. Obama, B. Waleetorncheepsawat and S. Theerathammakorn²*
10:15	-	10:30	OB2-06	Influence of Difference in S-Cone Stimulus Value between Target and Distractors on Visual Search Task *Y. Hishikawa, S. Katsura and S. Sunaga*
10:30	-	10:45		Break

Room **Sri Nakorn**
Session II

Start		End		
10:45	-	11:15		**Keynote Speech:** Study on Color Category in Japanese by Using a Clustering Analysis *I. Kuriki*
11:15	-	11:30	OB2-07	Strong Effect of Simultaneous Color Contrast Perceived in the Afterimage *M. Ikeda and C. Phuangsuwan*
11:30	-	11:45	OB2-08	Observer Metamerism in Wide Color Gamut Display for Anomalous Trichromats *S. Sunaga, R. Suto, S. Katsura and H. Yaguchi*
11:45	-	12:00	OB2-10	Effect of Macular Pigment Density on Brightness Perception of Colored Light *T. Tashiro, E. Takahashi, T. Nagai and Y. Yamauchi*

12:00	-	12:15	OB2-11	Creative Contemporary Mural Painting of Northeast Thailand to Participate in the Local Province *O. Nandawan*
12:15	-	13:30		Lunch
12:15	-	13:30		Exhibition and Poster Session II (In front of Sri Satchanalai room)

Room **Sri Nakorn**

Session III

Start		End		
14:30	-	14:45	OB2-12	Improvement of the Color Discrimination Ability with a Spot Lighting *N. Wisestoom, M. Ikeda and C. Phuangsuwan*
14:45	-	15:00	OB2-13	Development of Heating Test Equipment for Improved Utilization of Superheated Steam: Monitoring Color Change of Food at High Temperature *Y. Tanada, H. Iyota, H. Sakai and K. Fukuchi*
15:00	-	15:15	OB2-16	The Effect of Processing Conditions on Color, Total Phenolic Content and Antioxidative Activities of Cassava Leaf Extracts *N. Tangsuphoom, U. Suttisansanee, T. Winuprasith, and V. Kemsawasd*
15:15	-	15:30	OB2-14	Study of Student Perception on Colored Some Traditional Foods in Yogyakarta *W. Supartono, M.P. Kurniawan and D.F. Nikasari*
15:30	-	15:45	OB2-15	Preliminary Study on Spectral Characteristics for Identification of ESKD Skin Color under Hemodialysis Treatment *Y. Akizuki, T. Kutsuzawa, T. Iizuka and F. Ohyama*
15:45	-	16:00		Break

Room **Sawankalok**

16:00	-	16:30		Closing Ceremony

POSTER SESSION

Date Thursday, December 06, 2018

Start		End	
13.30	-	14.45	Short Poster Presentation Session PA (Sri Satchanalai room) Session PB (Sri Nakorn room)
14.15	-	15.15	Poster Session (In front of Sri Satchanalai room)

Date Friday, December 07, 2018

Start		End	
13.30	-	14.30	Exhibition and Poster Session II (In front of Sri Satchanalai room)

Poster Session PA (In front of Sri Satchanalai room)

PA-01 Effect of Natural Combination of Saturation and Lightness Contrast on Colorfulness Adaptation
T. Masumitsu and Y. Mizokami

PA-02 Effect of Gloss on Color Constancy for Familiar Objects
T. Wakamatsu and Y. Mizokami

PA-03 Comparison of Trichromatic and Multispectral Simulation Models for Anomalous Trichromats
M. Kato, Y. Mizokami, H. Yaguchi

PA-05 Visibility as a Function of Spatial Frequency of a Gabor Patch and the Surround Light's Intensity for Haze Estimation oef Cataract Crystalline Lens
W. Isoi and H. Shinoda

PA-06 The Color Blind Perception: a Case Study on Thai Banknotes Series 16
P. Kajondecha

PA-07 Effects from Spatial Frequency of Glare Image on Display Visibility
Y. Nozoe and H. Shinoda

PA-08 The Perceived Color Constancy Demonstrated in an Unclear Photographic Image
T. Mikiat, P. Chitapanya, N. Panitanang, X. Du, Y. Mizokami, M. Ikeda and C. Phuangsuwan

PA-09 Whiteness Enhancement Using the Watercolor Effect
S. Isawa, T. Tashiro, T. Nagai and Y. Yamauchi

PA-10 Effect of Illuminance Levels, Stimulus Size and Observation Period on Color Identification
A. Hashimoto and H. Shinoda

PA-11 Investigating Interaction between Sounds and Graphics on Perceptual Transparency
T. Nakamura, K. Hirai and T. Horiuchi

PA-13 The Study of Background Color Suitable for Thai Sign Language on TV Screen
W. Wuthiastasarn

PA-15 KANSEI Evaluation of Color Images Presented in Color Gamuts with Different Red Primaries
S. Kageyama, Y. Inuzuka, T. Ishikawa and M. Ayama

PA-16 The Characteristics of the Happy Family on Thai Culture Context
K. Homtrakul, R. Piriyakul and N. Khantanapha

PA-17 Chromatic Threshold for Total Color-Image Impression
T. Fujiwara, S.Nakada, T. Ishikawa, M. Ayama

PA-18 Automotive Exterior and Color Matching Method Based on Kansei Engineering
A. Yan Haiwei and B. Sun Yuanbo C. Gao Ruolin

PA-19 Cultural Competenc of Hospitality Industry Employees
S. Tadawattanawit

PA-20 Regional Characteristics on Preferences of Ceremonial Red Color in Japan -
Comparison between the West and the East-
C. M. Asano, A. Asano, K. Okajima, and K. Matsumura

PA-21 Color Names Not Expressible by 11 Basic Colors for Thai People
S. Sonkaew, N. Panitanang, C. Phuangsuwan, M. Ikeda

PA-23 Studies on Effects of Temporal Color Transition on Harmony of Three Color Combinations
T. Nonoyama, M. Kawasumi, A. Asano, C. M. Asano, and K. Okajima

PA-24 Unattractive colors by Color memory of Thai Teenagers
K. Rattanakasamsuk

PA-25 Influence of Chromaticity of Illumination on Impression of a Living Room
N. Watanabe, T. Tashiro, T. Nagai and Y. Yamauchi

PA-26 Creative Color Designs for 3D Projection Mapping
C. Tongsab, W. Sunthon and W. Kaewdee

PA-28 Web Design for Student Affair of Faculty of Mass Communication Technology Rajamangala University of Technology Thanyaburi
A. Wonglert

PA-29 Web Color Design for Present Rajabongkod Hotel Training Center
P. Pitichokdetudom, P. Cheypirom and S. Yongseu

PA-30 An Empirical Study on Association of Colors with Adjectives
C.M. Tsai, T.R. Lee, W.C. Tsai

PA-31 Determining the Color in Infographic Design to Suitable for Content.
W. Chanphen, *P. Srisuro and S. Panya*

PA-32 Preferred Color of Top Banner Backgournd of The ACA2018 Website.
T. Songthanapitak

PA-33 Comparative Analysis on the Effects of Car Front Grill Design Types on Visual Impression between Japanese and Thai Consumers
S. Kou and M. Kawasumi

PA-34 Identification of Hoppatamb Mural Painting Color Used for Packaging Design
S. Kuntaros

PA-37 Image and Identity to Promote Brand Image on Rajamangala University of Technology Thanyaburi
N. Meeusah

PA-38 The Influence of Packaging Colour on The Consumers Expectation of Healthy Food
S.Nilmanee

PA-39 Color Correction for Milky Way Photography
S. Puenpa, T. Suriwong and W. Boonkong

PA-40 Comparison of Color Different between .PSD and .AI File Format in Digital Printing
S. Chottakun

PA-41 Production of Motion Graphics Media for Public Relations Rajamangala University of Technology Thanyaburi Transportation
R. Tananimit

PA-42 A Study on the Influence of Surround Luminance on the Color Perception in Display
W. Ray-Chin

PA-43 Determination of red floor for fake blood realistic enough viewers feel scary in make-up effect of horror film
K. Jaemin

PA-44 Image Scrambling on Packaging Label for Anti-Counterfeiting
P. Kajondecha and A. Tanwilaisiri

Poster Session PB (In front of Sri Satchanalai room)

PB-01 Detection of Oil Palm's Color Using Digital Image Processing and Artificial Neural Network
M. P. Kurniawan, A. D. Guritno, S. Dongoran and K. Retnoningsih

PB-02 Experimental Consideration of Factors Affecting the Shitsukan Contrast Effect
D. Nakayama, M. Tanaka and T. Horiuchi

PB-03 The Customers Perception Evaluation for Packaging Design Selection by Using Multi-Attribute Utility Theory (MAUT) Method
J. Buddeejeen

PB-04 Investigating Perceptual Qualities of Surface Appearance under Ceiling Light Using Real Materials and Displayed Images
Y. Sakuma, M. Tanaka and T. Horiuchi

PB-06 Brightness Property Adjustment of Handicraft Paper of Natural Latex
K. Suwannawatanamatee

PB-07 Optical Analysis of Rainbow Color Mixing Cube
K. Miyazaki, K. Tsuchiya, Y. Azuma and T. Uchida

PB-09 Optimal Color Temperature of Bakery Photography for Advertising
C. Saksirikosol

PB-10 Analysis of Metallic and Transparency Perception of Glass Object
Y. Nakamura, M. Tanaka and T. Horiuchi

PB-11 The Background Color for Silver Accessories Advertising Photography
J. Jarernros

PB-12 Yellowness and Related Structural Changes of UV Curable Overprint Varnish
A. Kempanichkul, P. Katemake, T. Piroonpan and W. Pasanphan

PB-13 Influence of Led Light on Resistance to Color Change of Textiles Used for Japanese Kimono Accessories
K. Fumoto, M. Fukuda, K. Morimoto, T. Sato and S. Kitaguchi

PB-14 Effect of the Presentation of Colors on the Recovery from Eye Fatigue
H. Takahashi and R. Kato

PB-16 Effects of the Wavelength of the Primary for the Metameric Color Matching
A. Konno, T. Tashiro, T. Nagai, and Y. Yamauchi

PB-17 Relationship between Facial Pigmentation Distribution and Conspicuousness
C. Otsuka, Y. Mizokami, and H. Yaguchi

PB-19 Subjective Assessment of Image Quality Degraded by Uniform Color Shift
Y. Kosaka and H. Shinoda

PB-21 Structure and Appearance of All-Organic Gold Metallic Lustrous Films
M. Kubo, K. Horikoshi, H.Doi and K. Hoshino

PB-22 The Design of Interactive Virtual Boards for Drawing and Painting Used LED Light and Infrared Pen: A case Study of Grade-1 Student of Sirinusonvitaya School
S. Yongsue, K. Yongsue, C. Phuangsuwan

PB-23 A Novel Colorimetric Bio-Based Indicator Film Using Naturally Extracted Dye from Red Dragon Fruit Skin
S. Khankaew and S. Chinarunmangkorn

PB-24 Estimation of Spectral Reflectance Using a Projector-Camera System
H. Maruyama, H. Shinoda

PB-26 Creation Digital Video to Give a Characteristic Visual Look by Color Grading Process
S. Wangkaew

PB-27 Acquisition of Spectral Power Distributions of Display Using a Digital Camera
R. Tetsuo and H. Shinoda

PB-29 Understanding of Body Language in 3D Animation with Motion Capture Technology
B.Chartchuea, T.Mikiat, C.Nakprasoet and C.Narueang

PB-31 Instruction Media Designs and Development the 2D Animation “Character Designs and Development”
V. Piankarnka

PB-32 Effect of Window View on Perceived Brightness of Inside the Room Evaluated on a Display
S. Ito and H. Shinoda

PB-33 A Basic Research on Realistic Texture Reproduction of Photographic Print by Display Monitor
Y. Azuma, T. Tamura, M. Inui and K. Uchikawa

PB-35 Studying Landscape Photography Using the Tone Control with Zone System
P. Lewpaibool

PB-36 Product Development of Tea Drink from Telang (Clitoria Ternatea) Flower by Using Value Engineering
W. Supartono and S. Ardhyan

PB-37 The Factors for Determining the Sharpness of the Image Obtained from PVC Multi-Rotor (Drone)
K. Kanjanaparangkul, K. Jaimeewong, N. Baisri and C. Singkumpong

ORAL SESSION

INVITED SPEAKER

COLOR ORDERS AND ORDERS OF LIFE

Prof. Dr. Lee, Tien-Rein (Taiwan)

Colors can be distinguished from its various characteristics and there are many color order systems existing for people to use to organize the colors in order nowadays. Is there any orders of living which depends on the colors? Is there a system to use to managing our life with colors? This talk is going to explorer the effective color management for our living.

INVITED SPEAKER

INTUITIVE COLOR THROUGH CULTURAL PERCEPTIVE ASSESSMENT

Asst. Prof. Apisak Sindhuphak, M.ID., Ph.D. (Thailand)

In a creative process, do we recognized or remembered the vividness of our design decision through a personal color preferences? When under pressure, has the color solution yielded from our deep consciousness–the experiences recalled from previous learned or adopted signifiers. Are we living in the realm of reflective consciousness when thinking of color selection that our responses spontaneously imply through recognizable color tonality? Interpreting such signified color, related to situation or memory conducive to design of Thai textile, pottery, architecture ornaments, or product design, has been a personal journey–never to draw a definite conclusion or to seclude from academic discussion. This exploration became a treasure not for such a cultural collective color matters but also a gift of assimilated knowledge gained through time and exposure. In amalgamation of this process, such data and research allowed the design to defy the subdue color selection and challenge the traditional idea within the creative process. Through a system coined as "**Chromaticon"** (a set of Thai collective color exploration), the intuitive colors were arranged in order, paralleled to that of the physical design solution. Thus allows for an alternative way of how new color arrangement can challenge the status of the traditional color originated to discipline design consciousness. This also served as an assessment network that opened to various format to interplay the color of contemporary Thai design.

ORAL SESSION

CHALLENGES IN SHITSUKAN IMAGING

Takahiko Horiuchi*

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Keywords: Shitsukan, materials, perception, appearance, management

INTRODUCTION

The ability to distinguish colorful fruits against green leaves was important for the survival of our ancestors, who resided in forested regions replete with greenery. We developed a sophisticated visual ability to assess the color change in fruits and vegetables in everyday life to judge the optimal harvest time. In this manner, colors contain a great deal of information essential to our lives, and we unconsciously use them to live.

In addition to color recognition, evolution has given us various other abilities to instantly recognize object features through sight. Through vision, we can identify if an object might be fragile and thus must be handled carefully. If we judge that an object is heavy, we can lift it slowly and carefully after adopting a suitable stance. If we can observe that a road is slippery by looking at its surface features, we can walk slowly and carefully. This assessment of an object obtained from perceptual information is called *shitsukan* in Japanese. Despite *shitsukan* being a key element of our behavior, academic efforts to answer questions such as how to perceive, measure, calculate, or reproduce *shitsukan* have proven elusive. Obviously, color information strongly contributes to *shitsukan*, but *shitsukan* uses not only RGB three-channel signals but also higher-order color features based on spatial and temporal distributions.

To better elucidate *shitsukan*, Japan created a national project called "Brain and Information Science on SHITSUKAN (material perception)"[1] in FY2010, bringing together brain scientists, engineering researchers, and psychological researchers to investigate *shitsukan* from an academic perspective. In FY2015, a new project called "Innovative SHITSUKAN Science and Technology"[2] continued research on *shitsukan*, expanding its scope to include senses other than vision. In Europe, the PRISM (Perceptual Representation of Illumination, Shape & Material) project [3] was launched in 2012, mainly to clarify *shitsukan* from a visual psychology viewpoint, and the DyViTo (Dynamics in Vision and Touch) project [4] approaches the elucidation of *shitsukan* in terms of merging the visual and tactile senses. In the United States, IS&T Electronic Imaging started the meeting of Material Appearance [5] in 2014, and research on the measurement and perception of *shitsukan* has been accelerating globally. In addition, in the CIE, which is an international standardization organization, the JTC 12 technical committee has begun examining methods for measuring the gloss and graininess of an object's surface.

In this keynote, I introduce research trends to understand *shitsukan* and explain our approach to "shitsukan management," which is an extension technology of color management.

PROGRESS OF SHITSUKAN STUDIES

"Shitsukan" is a Japanese word that literarily means "the sense of quality." In the project [2], this term has been used to refer to the following four characteristics:

(1) Material category (metal, ceramic)
(2) Physical property (gloss, translucent)
(3) Physical state (wet, dusty),
(4) Subjective value (beautiful, yummy).

There have been many studies on (1) *material category*. For example, in the fields of computer vision and image processing, research on material classification and material recognition has been actively carried out along with developments in deep learning. With regard to (2) *physical property*, studies on the acquisition methods of physical properties and perceptual mechanisms have progressed significantly. Motoyoshi et al.'s discovery [6] that low-order statistics contribute to the recognition of physical properties has had a great influence on subsequent research. In Europe and the United States, "material appearance" or "material perception" is often used as a term corresponding to *shitsukan*, but many of them often point to (1) and (2). However, terms of *shitsukan* include higher concepts of (3) and (4) that can be perceived from objects. (3) *Physical state* is the characteristic that most influences our behavior choice. Although research has just begun in the area, physical state becomes crucial in the field of humanoid robots and automatic driving technology in the future. (4) *Subjective value* is the highest *shitsukan* level that describes human value judgment from visual information. Research in this field has only just begun and is focused mostly on large industrial applications.

SHITSUKAN MANAGEMENT

Below are examples of our approach to *shitsukan* research. Color management is a standard technique for handling the correct color, and color management giving equivalent color perception between different devices such as a display and a printer depending on the color profile is realized. By extending this technology, we have constructed a *shitsukan* management system for managing *shitsukan* of (2) Physical state among different devices. Figure 1 shows an overall view of a *shitsukan* management system capable of perceiving equivalent physical state in all devices.

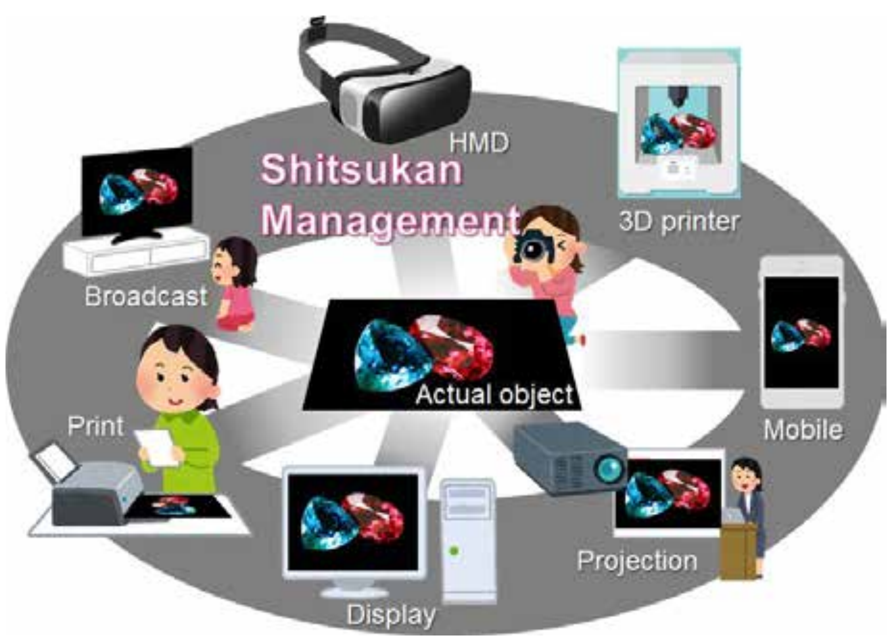

Figure 1. Shitsukan management.

In Ref. [7], an experiment was conducted to investigate if the *shitsukan* was perceived correctly when colorimetrically correct color reproduction was performed by color management. As a result, we observed that many *shitsukan* properties could be accomplished via color management, but it became clear there were physical states that could not be accomplished via color management, such as glossiness and transparency. Some physical states have also been able to manage *shitsukan* by modulating the luminance of an object [8]. In addition, research results that ipRGC influences the physical state of *shitsukan* have also been obtained [9]. Further research should be carried out for management methods for devices with different color gamut and dynamic ranges.

Furthermore, along with the recent development of devices, device management beyond conventional color management is also important. In *shitsukan* management in 3D printers, it is necessary to study ways to give equivalent perceptions with different materials, and we have already successfully created an apparent metallic luster in cloth materials [10]. In addition, texture control in new devices such as head-mounted displays (HMDs) is also important. In our research, the color perceived by the HMD is different from the color on the display device, even when colorimetric color reproduction is performed [11]. This is also an important issue in this field.

ACKNOWLEDGEMENT

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COLOR ANALYSIS IN ART AND DESIGN STUDIES

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Keywords: Color Analysis, Visual Art, Color in Films, Color in Paintings

ORAL SESSION

ABSTRACT

Perhaps due to our limited vocabulary and poor memory of colors, the classic art history, film criticism literature, and design study has been shying away from discussing colors. Most art history texts introduced all those great paintings in a manner as if the writer and the reader alike are color blind. It is the author's belief that humanists are in great need of a sensible and meaningful way of communication about colors. Colors need to be described in an intuitive, less intimidating, and yet scientifically sound terms. In this talk I will briefly review the studies we have done over the past ten years on taking up the challenge. A color analysis protocol will be induced, and examples of: (1) Color style analysis of individual artists; (2) Color style analysis of different countries and across different times; (3) Comparison of color palettes of impressionists with that of their contemporaries; (4) Studies on film colors will be given and discussed.

INTRODUCTION:

Color, as a scholarly topic, is much too underrepresented in current art and design studies. We sampled three popular art history textbooks on the market, including Adams (2011), Stokstad & Cothern (2011a, 2011b), and Kleiner (2009), and did a word frequency analysis. We found that out of the total 1,293,878 words in these volumes, the word 'color' only appeared 749 times. It is unthinkable that an art historian would lack interest in color when discussing the evolution of painting styles across ages. The omission of color is most likely due to the difficulty of verbalizing our color experiences. The situation will not improve unless a useful color analysis tool is made available to art and design researchers.

COLOR CONTENT EXTRACTION

We have shown elsewhere that the color content of an image can be summarized by computing brightness, contrast, saturation, redness, yellowness, greenness and blueness parameters (Feng & Chen, 2006; Lin, Feng & Chen, 2007). For a given image, RGB values of each pixel were converted into HSB (Hue, Saturation and Brightness) format (Joblove & Greenberg, 1978). Along each of H, S and B dimensions a frequency count histogram can be established. Computation of brightness and saturation values was straightforward. One only needs to integrate the area of B and S histogram, and divide the result with the total pixel count. The contrast value, however, cannot be obtained by any pixelwise method. We defined the overall contrast of an image as follows:

(BMax – BMin) x (1 – ABS(AreaBmax – AreaBmin)) …....(1)

where BMax is the maximum value of brightness in the processed image, BMin is the minimum value of brightness in the processed image, AreaBmax is the area occupied by the maximum brightness values, and AreaBmin is the area occupied by the minimum brightness values.

It is pointless to integrate hues along the H dimension as the summation of all colors will bring about a hue-less grey. Based on Hering's opponent theory of color vision (Hurvich & Jameson, 1957), we first divided the hue circle into four basic color bands, red, yellow, green, and blue, and then computed a weighted within-band summation. Amount of each of the four basic colors was derived by centering an integration window, a rectified sinusoidal function in this case, around a given unique hue. The span of the integration window was adjusted to match the range of hues that carried the tint of the center unique color, and then all weighted H values under this window function were integrated, as illustrated in Figure. 1.

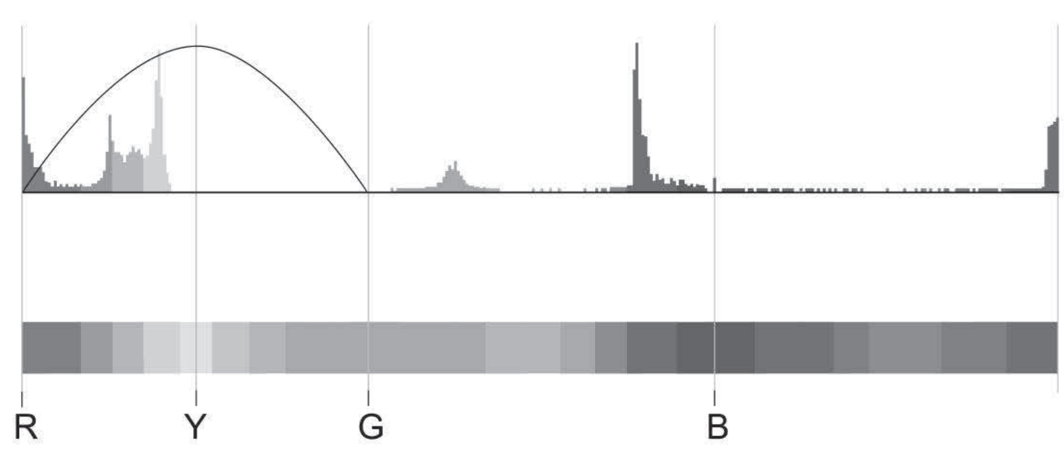

Figure 1. To compute the amount of a basic hue, a half-wave rectified sinewave function was used as a weighting function. The peak of the weighting function was centered at the position of the unique hue, and all colors under the curve were then weighted and summed.

APPLICATION I: COLOR STYLE ANALYSIS OF INDIVIDUAL ARTISTS

To better appreciate the color content of an image, say an oil painting of a given artist, we designed a Mondrian format for visualizing the color composition. With such color visualization format, one can easily detect the personal style of an artist (see Figure 2). I'll present more comparative data in the talk.

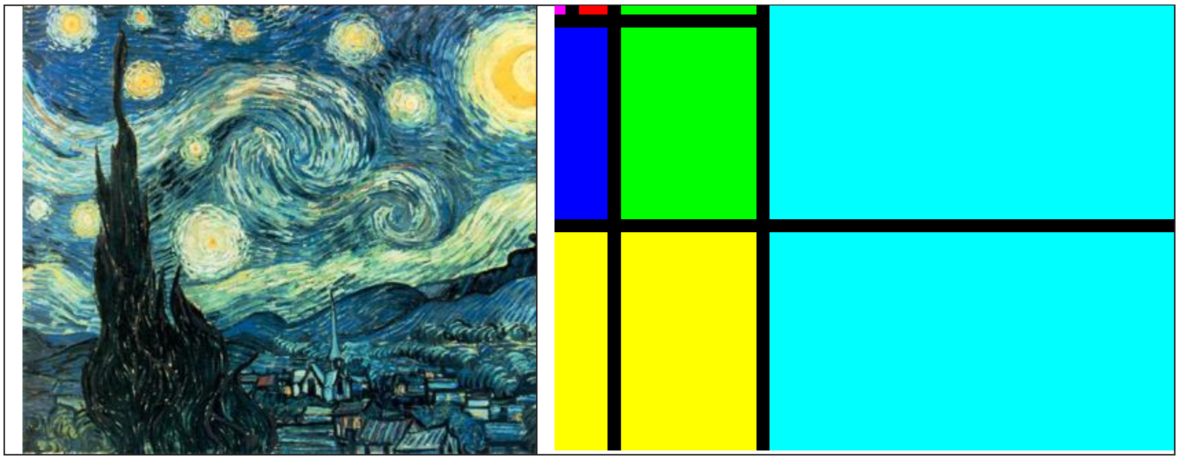

Figure 2 The decomposition of colors in one of the Van Gogh's paintings. The Mondrian format delivers Van Gogh's color style more clearly than the original.（Feng & Chen, 2005）

APPLICATION II: COLOR STYLE ANALYSIS OF GROUPS

Once the color information of individual painting can be extracted, it is straightforward to apply multivariate statistics techniques, such as MDS, to analyze the relative standing of members of a given group on a predesignated color feature. The MDS results in Figure 3 show how paintings from six different countries differ from one another on brightness and warm colors. Through this mapping, one can sensibly talk about regional color styles of different countries or across various times.

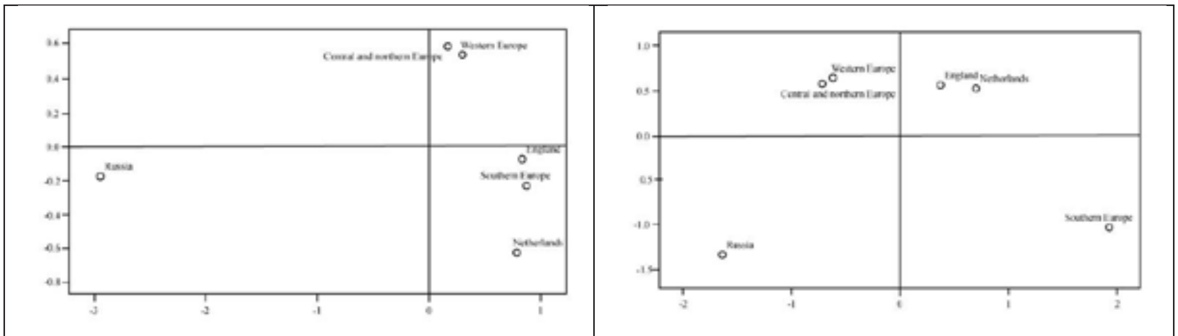

Figure 3 MDS(multi-dimensional scaling) results of (A) Brightness usage (left panel) and (B) Warm color usage (right panel) of paintings from six countries. Please note that even 'brightness' is a single variable, the way it is used by painters of different nationality is two-dimensional.(Hsieh & Chen, 2006).

APPLICATION III: COMPARISON OF COLOR PALETTES

Historically, the impressionists were known for their taking on light and colors. They were very stringent on not to use black in shadows. A modified color analysis protocol can easily demonstrates the technical signatures of Impressionists' and sets apart from that of their contemporaries (Figure 4). Figure 4 shows the results of converting an original image to it hue map. As colors of any hue converge to achromatic black at low brightness levels, we set a brightness threshold in the construction of hue map. Colors of a brightness value below the threshold would be set to black.

Figure 4a and 4c show a 16th century traditional landscape and an impressionist painting, respectively. Figure 4b and 4d are the hue maps of Fig. 4a and 4c, using the identical brightness threshold. The difference between Fig. 4b and 4d is striking. The hue map of a traditional painting is very similar to a colored sketch of the original painting. One can identify all the important details of the objects in the scene. By contrast, one can hardly identify any meaningful object in the hue map of an impressionist painting. As impressionist artists tend to use color instead of brightness difference to define visual object, all contour lines, shades and shadow lose their boundaries in the hue map.

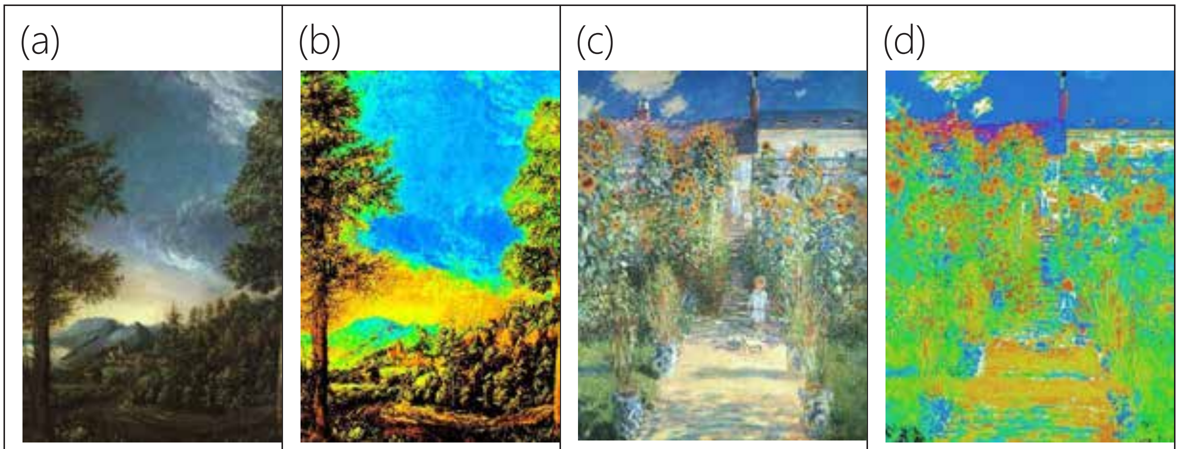

Figure 4 (a) *"Danube Landscape with Castle Wörth", Albrecht Altdorfer, circa 1520-1525, oil on panel.* ; (c) *"The Artist's Garden at Vétheuil", Claude Monet, 1880, oil on canvas*. (b) and (d) are modified hue-only maps of (a) and (c). One can recognize a more or less achromatic painting in (b), but not in (d).(Chen, 2007).

APPLICATION IV: VISUALIZING COLORS IN A FILM

Figure 5 shows the application of color analysis to visualizing colors in a film. Once the color information of a single frame is available, one can track the dynamic of color features with the plot development.

We also tried to compare color use across five film genres, i.e., romance, comedy, horror, sci-fi and action. We found that among the chosen five film categories, patterns of coloring could be divided into two groups - one comprised romance and comedy, and the other horror, sci-fi and action. Colors in romance and comedy tend to have higher contrast and brightness and are rich in red and yellow while in horror, sci-fi and action it is the reverse. Sci-fi films usually show the highest average standard deviation of brightness, red, green, yellow and blue among these five film categories. This indicates that colors of sci-fi films tend to vary greatly as the story progresses (Chen, Wu, & Lin, 2012).

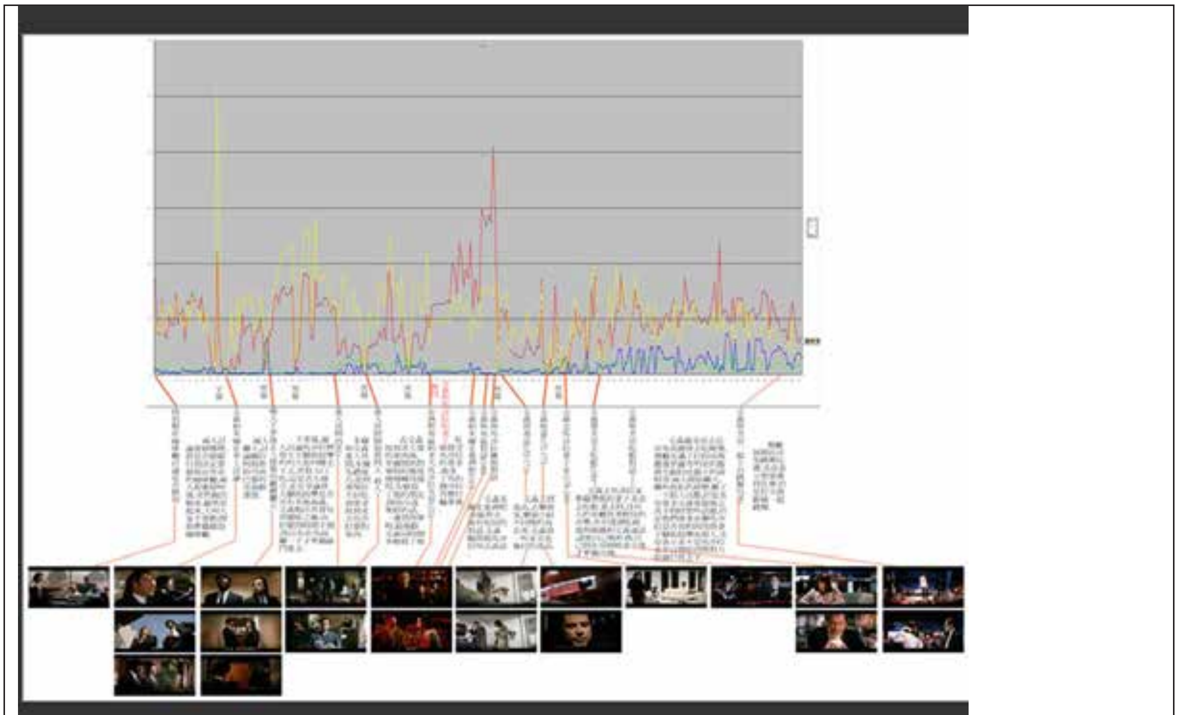

Figure 5 The dynamic of red, yellow, green, and blue as synchronized to the plot in Quentin Tarantino's 'Pulp fiction' (Chen, Wu, & Lin, 2012).

CONCLUSION

With the provided examples, the author would like to demonstrate the plausibility of offering a color communication tool that is friendly to humanists. It is hoped that with a good tool, art historians and critics would devote more volume of their writings on colors.

ACKNOWLEDGEMENT

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Color Correction and Reproduction Assessment of Cultural Heritage Images

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Keywords: Cultural Heritage, Digitization, Reproduction, Color Correction

ORAL SESSION

ABSTRACT

Color images of cultural heritage have been widely used for research, education, exhibition, creative industries. Scholars, students, audiences and consumers are receiving significant information from the color data. However, the accuracy of color acquisition, display and reproduction in cultural heritage preservation area has its unique needs. Some preliminary color correction approaches on practical heritage digitization projects proved that better quality of color reproduction could be achieved by warping color space according to the color quantization distribution of distinct antiquity. Regarding to the irreversible value of cultural heritage, more efforts from the professional community and industry are needed, to preferably preserve and inherit humankind knowledge from heritage documentation.

BACKGROUND

Maybe before they invented tools from stone, the ancient human ancestors had already been able to discuss about color. We have found magnificent colorful rock and cave paintings created at the stone age. Unfortunately, we will never know how they defined the name of distinct colors in ancient time. It can be sure that we have to pay attention to color information on archaeological research, even for the very beginning part of human history. Modern archaeologists adopt various methods to generate the detailed and authentic document of cultural heritage, such as painting, photographing, image scanning, 3d scanning, hyperspectral imaging, etc. Even a small team in cultural heritage digitization area might be able to achieve over 20 TB data per year.

Most of the archaeological data is closely related to color information, including photographs, aerial image, colored 3d points, colored 3d textures, etc. While digital information acquisition methods are used more and more widely on excavation and investment, the early period archaeological document has been digitizing to make better use too. Under such circumstances, archaeologists can get massive colorful data support during their works. So, we have a lot of archaeological databases, libraries and websites now. The application of heritage data keeps growing in recent years. Not only the archaeologists but also almost everyone is using these cultural heritage data, such as making a plan of tourism, learning history from the online museums, creating with the inspiration of ancient designs, playing games with historical elements, etc.

Meanwhile, the requirement of high precision data keeps growing with the application developing. For several years, only the resolution of image and measurement precision of shapes in 2d or 3d has drawn enough attention from the scientists and industries. Until now, many archaeologists, even digitization technical staff still treat color correction optionally.

CHALLENGES

All the monuments and antiquities, made of whatever kinds of material, are all suffering the inevitable time elapse. Uncountable negative factors, such as natural weathering, deterioration, dust, earthquake, flood, humidification, fire, theft, war and so on, keep damaging the cultural heritages with various speed. The fire disaster of Brazil's National Museum on September 3, 2018 reflected how fragile the relics could be. And, in other words, how important it is to keep the detailed documentation of those unique humankind cultural evidences. The invention of paper and printing technology help humankind preserve the tremendous amount of knowledge against all kinds of challenges from nature and ourselves, by keeping multiple copies of the information distributed. Many museums and heritage research institutes take this as part of their strategy and spend many resources on digitization projects.

Along with the increase of heritage data amount, the precision of color acquisition, display, and reproduction are required to be accordingly accurate for complex kinds of application. Challenges come beside all the requirement without exception. During cultural heritage data acquisition period, the precise color correction method is required to ensure the authenticity of the document. For digital display devices, the same color presentation remains demanded on big LED screen, desktop LCD, mobile phone screen, and even TV monitors. For printed reproductions, the same color presentation remains expected on books, posters, and artwork replicas.

The most difficult challenge behind all the requirements is the complex optics theories and practical environments. Color is the integral value of the reflection, refraction, transmission, and maybe illumination in different light frequency bands, which can be affected by the light spectrum, light direction, light brightness, etc. Besides the abovementioned factors, different imaging device will always produce the different color result with device-dependent errors. Especially for cameras from different brands, noticeable differences exist in most of the cases. The BRDF (Bidirectional Reflectance Distribution Function)[1] properties of the monuments or antiquities will cause significant color changes according to different viewing position.

Of course, manually operation will cause the color data error too. Standard operation pipeline and technical regulation are strongly recommended when dealing with cultural heritage digitization works.

ANALYSIS

It's not realistic to suggest all heritage color acquisition works would take place in the professional laboratory with experts and expensive equipment. So, the perspective of documenting cultural heritage with authentic color information must be defined operable for most of the museums and archaeologists. From the definition of CIE 1931 color space[2], we can summarize the following parameters that are related to the color of an object: spectral sensitivity and light spectrum. And from the definition of BRDF, we can summarize the following parameters that are related to the color of an object: BRDF model and positions. We are going to consider all the conditions in an ideal situation, then analyze how the practical circumstances will affect the cultural heritage digitization result.

Light spectrum: It is assumed that the light source is an ideal black-body radiator that can be identified accurately with color temperature. Generally, 5600K is widely used for flashlights, and 6500K is widely used for display. We can expect the light spectrum to be good enough, or, we might be able to accept the small difference with calibration or color correction.

Position: With carefully environment management, we might be able to keep the position and direction of both light source and imaging device still while taking pictures. And we can assume both the light strength and imaging sensor are stable. In practices, if we can light the monuments or antiquities evenly from various sources, position changing might not cause obvious color change.

BRDF: Assuming the BRDF properties of the monuments or antiquities can be simplified as a perfect Lambertian model[3], we can ignore various lighting and viewing directions factors changes. In practices, ancient paintings, murals, caves and wood carvings are close to the Lambertian model.

Spectral Sensitivity: This is the primary factor of the object color, and should be recorded in high precision. If we can best implement working environment with other factors, we will be able to record authentic color data of the monuments or antiquities.

If we can assume so many factors ideally, what makes it so hard to get the accurate color result for cultural heritage? Most of the calibration of light and imaging device are generally reliable, which means they will work fine with most of the situations users perhaps encounter but not be most accurate for any distinct scenes. Then, we might have the opportunity to improve the precision of existing equipment for single objects or similar objects with specialized calibration.

PRACTICES

Since we can theoretically tune the light and imaging devices to get a better color result for the distinct object, one possible solution is to use the standard color chart for color correction. If we can prepare the working environment good enough and the light spectrum is not far away from D65 or D50 standards[4], we can make sure all the color in the chart be highly accurate through simple color correction algorithm.

Assuming the color space is a 3d spatial space, and the color chart values are the key points in the 3d coordination system, we can use 3d morphing methods to warp the original color space to best fit all those key points. A simple algorithm can be designed as follow:

1. Set the corner key points of color space;
2. Create Delaunay[5] tetrahedron from all the key points;
3. Use linear interpolation inside the tetrahedron.

As a preliminary experiment of color correction, we didn't analyze the differences among color space models used in the algorithm. Even if we choose different color space definitions, the color represented by key points will keep the same. Only the color inside the tetrahedron will vary from different color spaces. But if we have many key points and tiny tetrahedrons, the slight difference caused by the color space model should be ignorable. For convenience, we chose sRGB[6] as our working color space to avoid data conversions.

Figure 1. Color correction software with one chart image loaded

As shown in Figure 1, our color correction software interface with a 24-color chart image loaded. Each color has got an accuracy score based on the numerical bias to the standard value.

With the help of those 24 standard color blocks, we can calculate a set of parameters to correct image color acquired under the same condition. Most often, noticeable color quality improvement can be achieved by the correction.

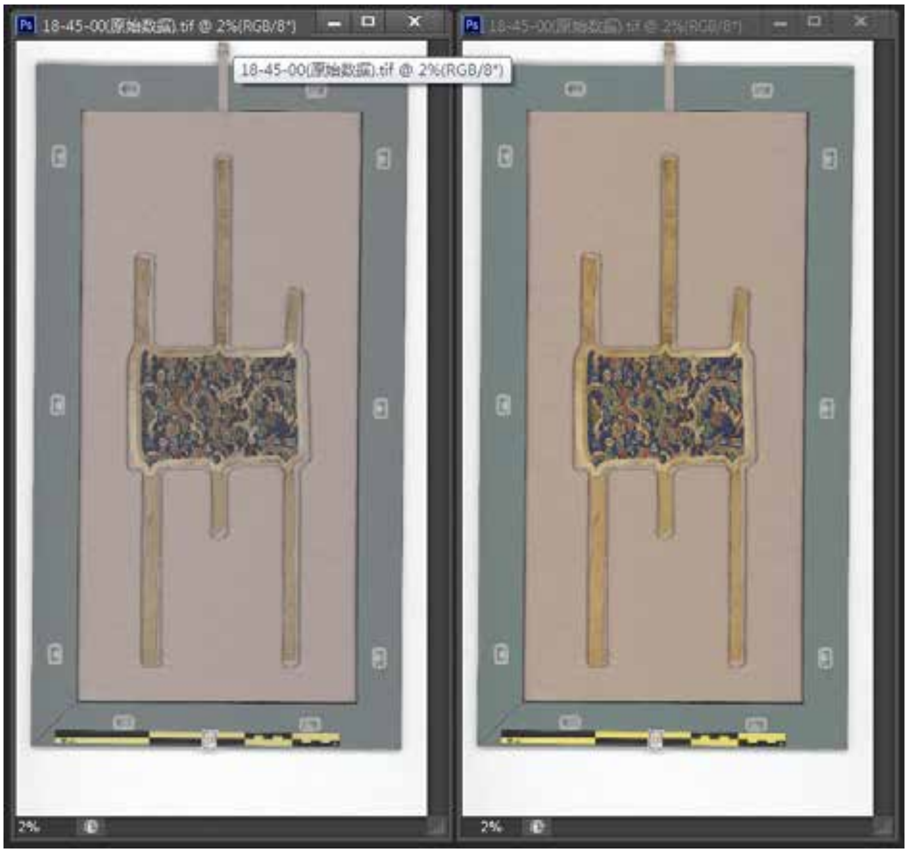

Figure 2. Color correction result samples.

Left: original image. Right: corrected image.

With the flexible key points warping method support, we can easily insert or remove standard color references for color space warping. It means we can use the spectrophotometer to supply corresponding color references for a distinct object or batch of objects.

The same theory of color correction can be used for printing reproduction quality assessment. With the stable color quantization algorithm being absorbed to generate a corresponding color chart of heritage image, the spectrophotometer can be used to assess the print quality of the whole picture. After the quantization index being mapped onto each pixel, a heat map can be generated based on the color difference in CIEDE2000[7] for the entire image. We defined the symbol of the heat map as:

- $\Delta E \leq 0.5$ --- Green
- $0.5 < \Delta E \leq 2.0$ --- Celadon
- $2.0 < \Delta E \leq 4.0$ --- Yellow
- $\Delta E > 4.0$ --- Red

Following is the result of such an assessment of ancient painting printing quality.

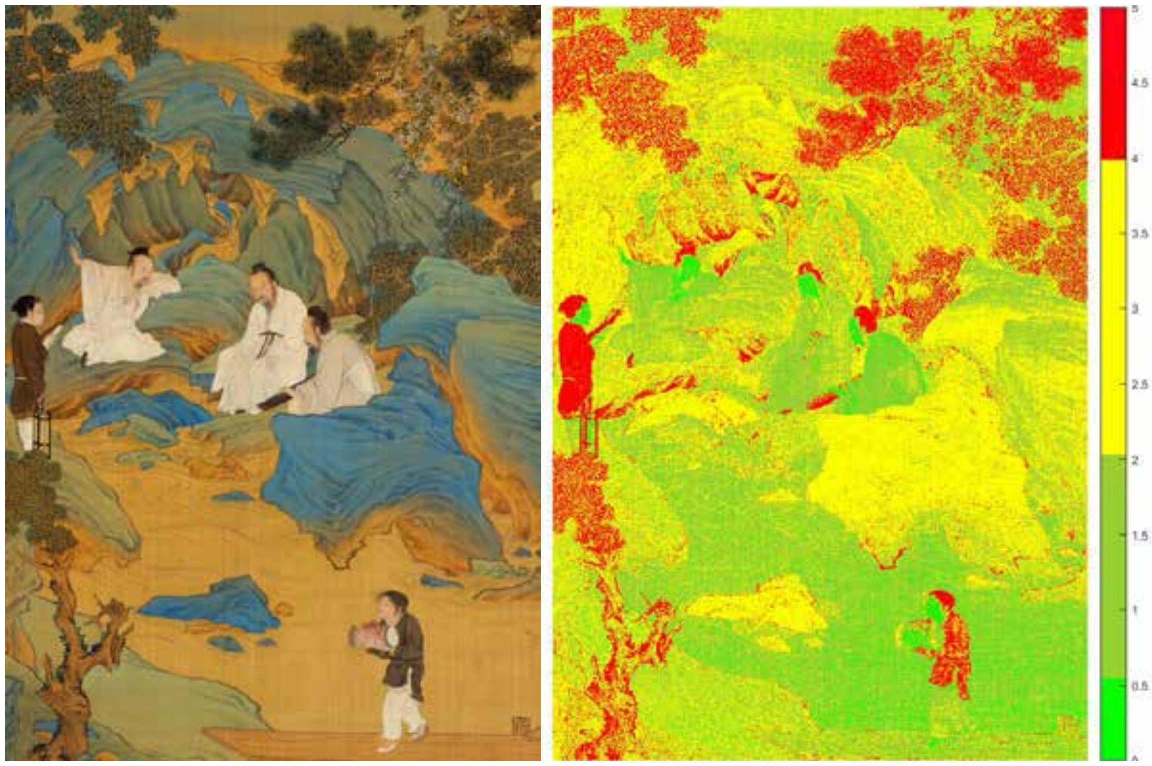

Figure 3. Color reproduction quality assessment

All the red color regions happen to be in the dark color part of the original image. We can find the top 2 differences in the following chart, which proved that the dark gray color had not been reproduced accurately.

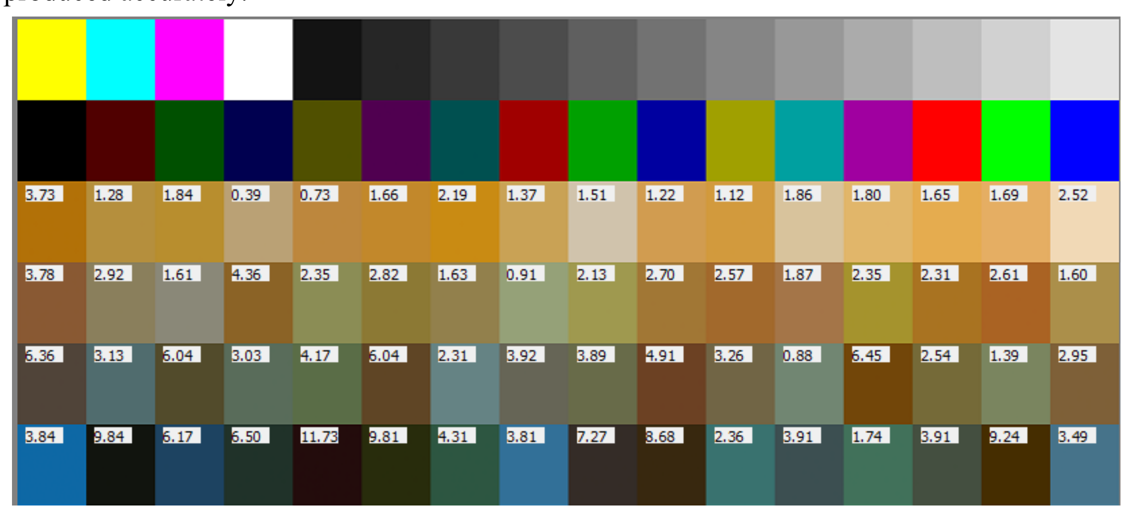

Figure 4. CIEDE2000 color difference chart

With the help of assessment color reproduction quality for distinct color charts, we got the chance to adjust the printing parameters to improve certain color accuracy. The refined print products can reach high similarity with the original antiquities, far beyond the color correction level of the standard color chart and human eye based methods. Such refined print products can well support archaeological research and exhibition based on the image content and color.

ORAL SESSION

PROSPECTION

Human visualization system outperforms almost all the optics equipment for its powerful adaptive ability. The drift of white balance and dynamic range wouldn't cause much trouble for a human viewer to understand the contents of a picture. But if the color of a picture is not accurate, which means the color space of this picture cannot be located over a standard color space with certain small error range, all the color information in this picture can only be used relatively. We can conclude which part of an antiquity is darker or redder than another part, but we cannot tell if the color became darker from two photos taken at different time, not to mention comparing the color difference of two antiquities from separate photos. The color information of cultural heritage document is so important that it can be critical evidence of the identity, date, technology and correlation. The accuracy of cultural heritage document color should be good enough for the use not only by professional archaeologists but also by general students, audiences, even computer algorithms.

The improvement of color accuracy for cultural heritage data acquisition, display and reproduction need many efforts on related researchwhich include algorithm design, software developing, equipment innovation, specialized color chart production, international standards on heritage preservation area, standard operating procedure, etc. As time goes by, some information in the cultural heritage will no longer be reproducible. Even small progress in color reproduction will be able to record more knowledge for humankind. If the same technology can be applied to a large number of cultural relics, the meaning will be priceless.

ACKNOWLEDGEMENT

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COLOR CONSTANCY ON 2D PHOTOGRAPHIC IMAGES

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Keywords: Color constancy, 2D photographic images, color appearance, D-up viewer, Recognized visual space of illumination.

ORAL SESSION

ABSTRACT

It is said that the color constancy does not take place for a 2D photograph. The concept of the recognized visual space of illumination RVSI developed by Ikeda[1)] asserts that the color constancy occurs for a space for which the illumination can be recognized by the observer, which suggests that if we can perceive a 3D scene on a photograph the color constancy should take place for the photograph. We confirmed the assertion by two kinds of experiments. Photographs taken under redly illuminated room and they appeared very reddish but when they were perceived 3D scenes subjects did not feel reddish but almost white to imply the color constancy. Patterns similar to the simultaneous color contrast were prepared for a real room. The central gray patch appeared very vivid color in a real space condition, but it did not present any color on a 2 D photograph. When it was observed through the D-up viewer the gray patch appeared vivid color to indicate the color constancy.

INTRODUCTION

Ikeda proposed a concept that he called the recognized visual space of illumination RVSI. A person enters a space. He recognizes the space. He understands the illumination, high or low and color, that fills the space and adapts to the illumination. This is an action of the brain. RVSI for the illumination is constructed. He perceives color based on the RVSI. The color constancy takes place. To understand the illumination, the recognition of a space is vital. Recognition of a space and understanding of the illumination that fills the space. It is a common knowledge that the color constancy does not take place for a 2D photograph. But according to the RVSI concept there is a possibility of the color constancy in a 2D photograph. Namely if we can recognize a space in the photograph we can understand the illumination and consequently the color constancy. This was indeed proved by Phuangsuwan by two approaches, color appearance and chromatic adaptation.

EXPERIMENTS

1. Color appearance

If one takes a photograph of the room illuminated by an orange light with a camera and looks at the picture afterward in a room lit with a white light, the picture appears to him very orange compared to this perception for the room where he took a picture implying that the color constancy does not occur for a photograph. Ikeda's recognized visual space of illumination RVSI theory predicts that the color constancy will occur for the photograph if one can perceive a 3D scene in the photograph. I did an experiment to confirm the prediction.

A room simulating a living room was lit with fluorescent lamps of which color was adjustable from white of 6,100 K to red of 1,610 K. Thirteen pictures were prepared for the illumination varying from an extreme orange to the white. A D-up viewer was built to get a 3D perception on a photographic picture as shown schematically in Fig. 1. A subject saw a picture P (38 cm wide by 25 cm high) through a hood H at the distance 27 cm from his/her eye. The 2D picture was able to be perceived as a 3D scene. Four illumination colors, L1, L2, L3, and L4 were investigated.

There were 2 conditions to proceed the experiment, D-up and normal viewing. In the D-up condition subject was asked to enter the room that illuminated with some color light and then he/she looked around the room and remembered the color impression of the room. He/she then observed one of the thirteen pictures in the D-up viewer in a random order and judged the color of picture compared to the room with response "redder" or "whiter". In the normal condition the subject directly looked at a picture and responded with "redder" or "whiter".

An additional experiment was conducted to confirm the 3D perception for a picture in the D-up viewer. The picture stimulus had two angle frames at sides which were not parallel as shown in Fig.2 a. The angle of the apex of the frames was on the picture. We confirmed the perceptual angle of the apex was zero when the subject observed the picture in the D-up viewer. A control experiment where the picture was made a mosaic by cutting the picture to small pieces and jammed up them as shown in the Fig. 2 b. The perceptual angle of the frame was measured in the D-up viewer and the same angle 15.5° was confirmed to show no D-up function taking place.

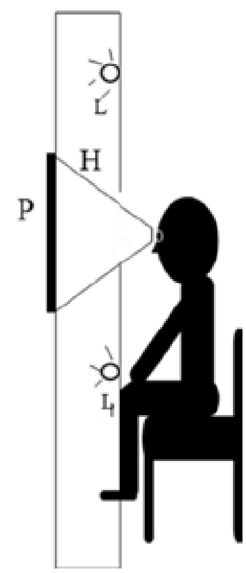
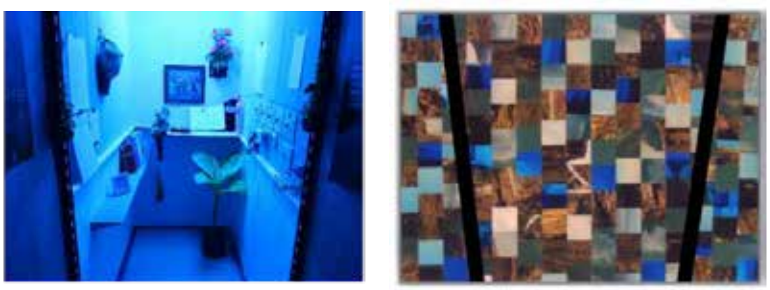


Figure 1. Schematic diagram of the D-up viewer.



(a) **(b)**

Figure 2. (a); a normal picture, (b); a mosaic picture.

2. Chromatic adaptation

When a subject adapts to the illumination of a space, where he/she stays, the color constancy occurs. To investigate the chromatic adaptation, we adopted two rooms technique. The experimental booth was composed of two rooms, a subject room and a test room as shown in Fig. 3. On the separating wall a window W was opened, through which a subject could see a white board T placed in the test room. If the subject room is illuminated with a red light by using, for example a LED light, the window appears very vivid cyan, greenish blue. In fact, the subject is physically looking at a surface of the white board, but the window appears to have a surface and the surface vivid cyan. The vivid cyan color indicates that the subject's eyes were chromatically adapted to the red illumination and consequently a white object appeared to him cyan. In spite of a vivid red illumination in the room the white walls of the room appear to him a normal white to indicate the color constancy occurred. So, the vivid cyan appearance of the window indicates the chromatic adaptation to the red illumination to get the color constancy.

When, however, a picture is taken for the subject room and the subject looks at the picture under a white light the picture appears very reddish to indicate no color constancy in the picture. The RVSI theory predicts that if the picture is perceived a 3D scene the chromatic adaptation should take place and the window W in the picture should appear vivid cyan. We did an experiment to confirm the prediction. We took pictures of the front wall of the subject room lit with one of four colors, red, yellow, green, and blue and made the pictures. A gray patch was pasted at the window position to simulate exactly the window in the two rooms technique. The color appearance of the gray patch was measured by the elementary color naming method by observing a picture in the D-up viewer, by a normal viewing condition and the real window in the two rooms technique as shown in Fig.3.

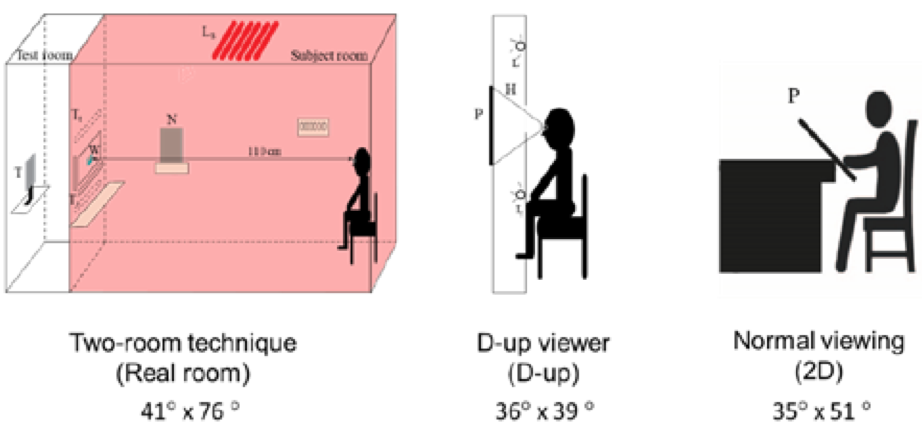
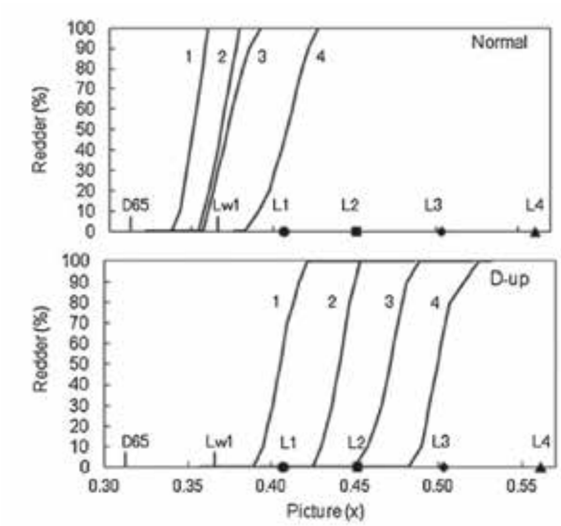


Figure 3. Schematic diagram of three conditions of chromatic adaptation experiment.

RESULTS

1. Color appearance

Figure 4 shows the average result of 5 subjects for the color appearance experiment. The upper graph shows the probability of answering "redder" curves in the normal viewing condition. The abscissa shows the color of the front white wall of 13 photographs. The color of illumination in the subject room are shown as Lw1, L1, L2, L3, and L4. The numbers on curves indicate the illumination of the subject room. It is clear from the upper graph that subjects chose pictures which appeared white for all the illuminations. This indicates that the room color impression was rather white although the room was illuminated by reddish light. To the contrary the subjects selected pictures near to the illumination color of the room in the D-up viewing condition as shown in the lower graph, which implies that the color constancy occurred in the pictures. When the subjects observed pictures through the D-up viewer they chose pictures of vivid color to represent the color impression in the real room. It implied that the color constancy took place in the picture in D-up viewer situation. The pictures shown on the right side give typical pictures that the subjects selected to match with the impression for the real room.



(a) **(b)**

Figure 4. Average result from 5 subjects in probability of seeing curve (a), a sample of chosen picture from Illumination condition L4 (b).

2. Chromatic adaptation

Figure 5 shows the amounts of elements in the elementary color naming experiment. On the abscissa the combination of the viewing condition and the room illumination is shown, thus R-Red indicates real room observation with red illumination, and D-Red indicates D-up viewing with red illumination. Colored bars show the amount of chromaticness, white the amount of whiteness, and black the amount of blackness. It is clear that the chromaticness was large with the real space condition and the D-up condition, but it was zero for the 2D or normal viewing condition to confirm the “must” of 3D perception for the color constancy.

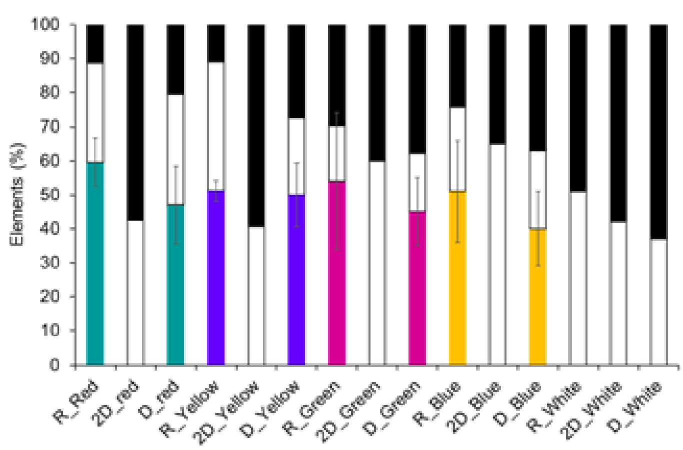


Figure 5. The average amount of chromaticness under 3 viewing conditions.

The color appearance that subject perceived can be plotted on a polar diagram used in the opponent colors theory as shown in Fig. 6 for the red illumination. In the real space case the window appeared very vivid cyan as shown by open circles of individual subjects and a filled circle of the average.

It showed when we adapted to red illumination the color appearance of achromatic shifted to greenish blue (cyan). The result of two-room and D-up viewer showed similar perceiving hue that was the RVSI theory predicted. No color was observed with the normal 2D observing condition but with the D-up viewing condition the central gray patch appeared vivid cyan as in the case of the real space condition.

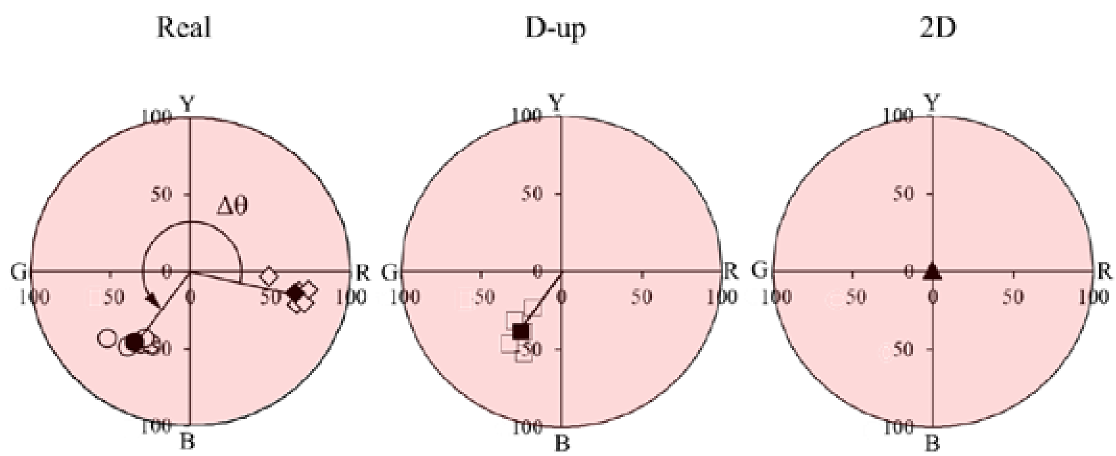


Figure 6. The average result from 5 subjects observed under red illumination plotted on polar diagram.

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ORAL SESSION

THE IMPORTANCE OF COLOR IN THE FIELD OF AGROINDUSTRY

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Keywords: Apperance, color, maturity, customer, market, quality

ABSTRACT

Most consumers are looking for the delight and attractive fresh agricultural products at the same time they also need products with high performance and quality, more nutritious and healthier. Color is one of the most important sensory attributes that directly affects consumer preferences and choices in the market or at the point of sale. This research is intended to provide an understanding of changes in quality and color in real cases with the traditional supply chain approach from the initial conditions of production to the traditional markets of fresh fruit and vegetable products. Sensory evaluations at certain time intervals on fruit and vegetables were studied aimed at categorizing product attractiveness from aspects of color changing and maturity, as well as good handling from the perspective of consumers in a series of fresh product supply chains. This study uses color and appearance factors as quality parameters along the supply chain used, so that the optimal conditions for fresh fruit and vegetable products can be estimated through these parameters.

1. INTRODUCTION

The color and appearance of fresh agricultural products are an important factor of the attractions and determinants of consumers' decisions to buy. At the point of sales, the level of freshness and maturity is used by market participants to provide an indication of the trade system and supply chain. The physical appearance of fruit and vegetable products is usually characterized by colors such as yellowish green on bananas and oranges, green on mustard greens, reddish orange on tomatoes, red on strawberries, and others. The level of freshness in some types of commodities such as also become a desirable attribute for traded fruits and vegetables. This condition is generally indicated by color and the absence of visual defects or others that affect the purchasing decision (Besik and Nagurney, 2017; Fonsah et al., 2008).

Agricultural products must be able to generate strong attraction during distribution and marketing. The product appearance that is not attractive results in not being accepted by consumers because it shows loss of freshness, nutrition, maturity level has not been achieved, can be an obstacle in display and marketing. Generally, the level of vulnerability is characterized by color, visual appearance, scent, texture, appearance, and variety by farmers, collectors, distributors, and wholesalers. While consumers at the final level or those who buy at retailers tend to choose products that have product attributes at optimal levels such as sweetness (yellow with brown spots) on bananas, content of β-carotene (yellow and orange) on tomatoes, and texture on papaya (yellow with red blush) and others.

The existence of dominant colors when the product reaches the dominant level of maturity (such as brown spots on bananas, dull colors in red strawberries, and yellow textures in green vegetables, etc.) are indicators of freshness lost in fruit and vegetable. In addition, the quality defects usually occur when the product passes through the optimal phase at the maturity level as result of poor handling such as white blush cut on carrots, bruises on mangoes (Soviana and Puspa, 2012), brown spots on guava, etc.; will greatly reduce the level of consumer acceptance. In fresh vegetables, the level of toughness becomes a parameter of the withered condition in mustard and broccoli which can reduce the level of consumer acceptance. Yellowing of green vegetables because of the loss of chlorophyll caused these commodities unacceptable (Barrett et al., 2010). Most practices for determining the quality of fresh fruits and vegetables during the supply chain are measured based on sensory measurements and using color measuring instruments. Analytical measurements are used to detect differences (difference tests) or to describe products (descriptive analysis). Analytical sensory testing is carried out by panelists who have both been trained and those who have not been trained. Affective measurements are made to determine preferences (which samples are preferred over others) and usually require large numbers of panelists (Slamet and Nakayasu, 2017).

2. THEORETICAL BACKGROUND

The use of sensory methods is most widely accepted and used by fresh product supply chain actors in Indonesia. Testing the level of consumer preference is a way to determine attributes to identify small differences in quality between similar samples. Business actors use experience when handling products to provide information and determine quality attributes to decide the selling value of products (Shepherd and Schalke, 1995). Nevertheless, sensory testing has weaknesses in accuracy and the standard of assessment due to the receptor ability of each business actors. The results of sensory testing from consumers generally tend to be very varied and often create obstacles in connecting sensory data with chemical compositions to determine differences in the sampling process (Wichchukit and O'Mahony, 2014).

Measurements using equipment include various techniques for determining color, appearance, taste, texture, and nutrient content. The use of test equipment has the advantage of being able to provide more accurate and precise results. Test equipment such as chromameters tend to be more sensitive to small differences between samples and may be able to detect the rate of decline in quality before the commodity is detected by the human senses. The use of sensory and equipment methods together is the most appropriate step to help determine which attributes are important for consumers. Descriptive differentiation and testing tests play a very important role in setting quality standards. Testing using equipment will be more useful in determining the quality control limits and in identifying variations in the mechanism of the process.

3. METHODOLOGY

Identification of fruit supply chains (climateric and non-climateric) and vegetables is carried out in the field by involving farmers, collectors, shippers (transporters), wholesalers, retailers, and consumers to assess sensory (color visual and freshness) of each commodity and its changes to determine the value at the point of sales. The color of fresh products (guava, papaya, banana, tomato, orange, strawberry, carrot, and broccoli) is determined using a CR 400 Minolta Chroma-Meter colorimeter by taking 2 readings in each of the 2 repetitions, expressed in L *, a * and b * colorimetric systems, according to the CIE Color System 1976 allow color characterization through color angles or Hue angles (h°) parameters, which are determined by the tan-1 equation (b * / a *). The equipment is calibrated with the D65 on, the aperture is 10 °, daylight equivalent, and the reading mode is regular transmission; on a white plate reference from porcelain (C6299 Hunter Color Standard) (MINOLTA CORP.1994).

4. FINDING AND CASE DESCRIPTION

Fresh product quality consists of many peculiarity and characteristics that consumers use to choose products that are traded. The appearance of the product based on its color is often used to determine the decision to purchase fresh fruit and vegetables. Color measurement at the traditional market level has a high subjectivity so it is difficult to compare the results based on the standards used. Description of the condition of each fresh agricultural product used as a study is as follows:

a. Strawberry (*Fragaria ananassa*)

- When picking, white, pink and yellow are used as markers. The strawberry red color looks strong blushed on the 2nd and 3rd day after picking by temperature 27 ± 3°C with transparent packaging (L

* a * b respectively 33,82; 21,64; 15,18 and 31, 87; 17,93; 12,43). The traders use styrofoam boxes equipped with ice cubes as cold temperature insulation to extend the storage life of strawberries.
- The optimum level of maturity and freshness that is sensory favored is also achieved on days 2 and 3
- In strawberries, the color component of lightness or brightness tends to decrease during the market. This indicates that the fruit looks darker after reaching the perfect maturity stage. Redness color also decreases in value and tends to be darker, indicates an increase in the red component of strawberries. The yellowness value also tends to decrease, which indicates that the yellow component of the strawberry is getting lower. Color changes during the storage process and this change may also be influenced by the concentration of anthocyanin pigments in the fruit (Keutgen and Pawelzik, 2007).

b. Papaya (*Carica papaya*)
- Green, fresh, and glossy look strong on the 1st and 2nd day after picking by temperature 27 ± 3°C. On the 4th and 5th day yellowish colors begin to appear as a sign of the ripening process. Color measurement in these conditions (L * a * b, 48.64; -15.95; 31.51 and 49.58; -15.50; 33.35).
- The highest selling point in the wholesale market occurs on this time caused by fruit texture (firmness) still in optimal conditions for handling to the potential for mechanical damage (Basulto, et al., 2009).

c. Orange (*Citrus reticulata*)
- Green, fresh, and glossy look strong on the 1st to 3rd day after picking by temperature 27 ± 3°C. On the 5th and 6th day a yellow color appears as an indication of the time of sale to the retail level.
- Sensitively, the texture changes on day 3 and is subsequently caused by the weight loss due to the random arrangement process in the packaging. Color measurement in these conditions (L * a * b, 47.74; -9.96; 25.51 and 44.17; -9.73; 27.10).
- The highest selling point in retail / traditional markets starts on the day 3 due to fruit texture (firmness) still in optimal conditions for handling against potential mechanical damage.

d. Carrot (*Daucus carota*)
- The orange color and the highest freshness level in carrots look strong on the 1st and 2nd day after harvesting (L * a * b, 58.75; 23.67; 33.42 and 57.25; 24, respectively. 59; 34,28). At that time in addition to the traditional market, suppliers also distributed directly to retailers to reduce the rate of loss due to weights loss and mechanical damage.

e. Banana (*Musa acuminata* × *balbisiana*)
- Green and freshness look strong on days 1 to 2 after harvesting and selling from the wholesale market to retail starts mostly on the 3rd day. There is no temperature treatment (room temperature 27 ± 3°C) in this commodity. On the 3rd and 4th day yellowish appears as an indication of the level of maturity.
- Sensory, the texture changes on the 3rd day and is subsequently caused by maturation and weight loss. Color measurement in these conditions (L * a * b, 60.33; -3.59; 46.23 and 67.26; 11.31; 57.35) respectively.
- The highest selling point from the main market to retail / traditional markets starts on the 3rd day due to fruit texture (firmness) still in optimal conditions for handling against the potential for mechanical damage. Retailers do not take products before the 3rd day because the condition of the product is not ready to sell and reduce the risk of damage during storage.

f. Guava (*Psidium guajava*)
- Green and freshness look strong on days 1 to 2 after harvesting and selling from the wholesale market to retail starts mostly at that time. There is no treatment of temperature (room temperature 27 ± 3°C) in this commodity other than primary packaging with plastic, secondary using paper, and tertiary with wooden boxes / crates and newspapers. This treatment is used to reduce the risk of

weight loss and mechanical damage to the fruit. On the 3rd and 4th day there is a yellowish change as an indication of the level of maturity.

- Sensory, the texture and aroma change on the 2nd day and then due to mechanical damage to the surface of the fruit turns brownish. Color measurement in these conditions (L * a * b, respectively 56.19; -15.65; 31.06 and 52.89; 13.66; 29.73).
- The highest selling point from the main market to retail / traditional markets starts on the 2nd day due to color, fruit texture (firmness), and the level of freshness is still in optimal conditions for handling (potential handling) mechanical damage.
- Guava is a fruit with a high respiration rate and a very storage life. Because information about the breathing pattern influences the changes that occur in the fruit during ripening the guava is picked at the half-cooked stage and can last for 8 days at 22 ± 1°C and 78 ± 1% relative humidity. Skin color analysis, ethylene production, during the cooking process, increases on the 4th day to rot. Firmness of fruit texture decreases in the first three days of maturation and skin color changes during cooking in line with the increase in ethylene.

g. Tomato (*Solanum lycopersicum*)

- Green-yellow - orange is the beginning of harvesting. The red orange looks strong on days 2 to 4 after picking and selling from the wholesale market to retail starts mostly at that time. There is no temperature treatment (room temperature 27 ± 3°C) in this commodity other than primary packaging boxes and newsprint or plastic. The freshness and firmness of the fruit are indicated by a hard and glossy texture seen on the 1st and 2nd day. At this time, tomatoes are usually still in the wholesale market with a relatively low weight and mechanical damage. On the 3rd and 6th day reddish color changes as an indication of the level of maturity.
- Sensitively, colors and textures change at days 3 to 6 with color values at POS equal to (L * a * b, 46.99; 6.60; 29.97 and 43.96; respectively; 19,9; 28,32).

h. Brocolli (*Brassica oleracea var. italica*)

- In broccoli, dark green, hard texture (tough), and the level of freshness looks strong on days 1 to 2 after harvesting and selling from the wholesale market to retailers. Temperature and humidity are the main factors to maintain the green color of broccoli in the wholesale market and retailers. Spraying, leaf weeding, and stem availability are carried out to maintain freshness to reduce color changes to yellow, wither, and weight loss and rot.
- Sensory, the level of freshness and color changes during day 1 due to the condition of the product that is easily damaged / rotten and the lack of adequate protection against environmental factors and mechanical damage caused by handling.

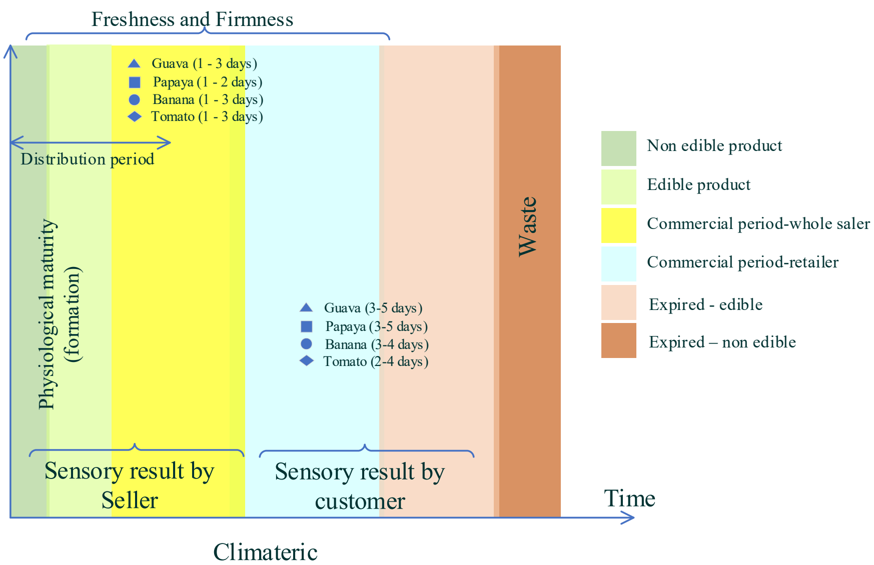

Figure 1. Sales period of climateric products.

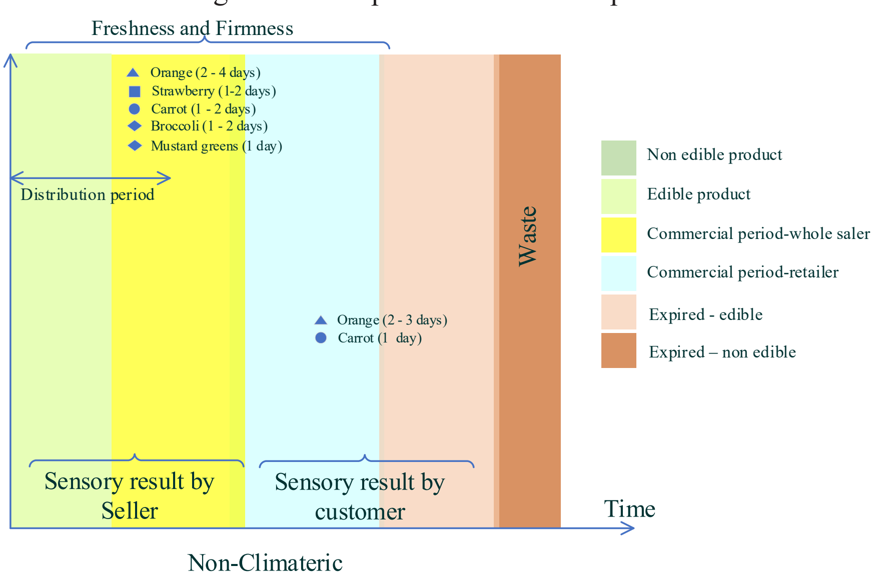

Figure 2. Sales period of non-climateric products.

5. DISCUSSION

Testing the level of preference in this study was carried out during the field survey, observations during transportation and in the wholesale market, sales at retailers, and in the laboratory. The panelists involved in this study included students who explored "experts" based on experience in the field, namely farmers, collectors, distributors, wholesalers, retailers, and consumers in accordance with the flow of handling and supply chain of each of the initial commodities observed with researchers to use as a basis in determining results using tools and sensitively testing with panelists in the laboratory. The grouping is done to minimize subjectivity, equate perceptions of the quality attributes being assessed, and get an accurate assessment of fruit or vegetables in small size to obtain quantitative relationships.

The use of equipment to measure appearance, color and appearance is determined using non-destructive methods established based on visual or physical appearance. These methods are based on evaluating the response of light reflected from the surface of the product or transmitted when passing through it. There are three components needed for color perception, 1) light sources, 2) objects that modify light with reflection or transmission, and 3) eye / brain combinations from an observer. Visual literature is easily adopted and referred to by workers in the wholesale market in using colors and appearance as a faster and easier basis for determining quality rather than using equipment.

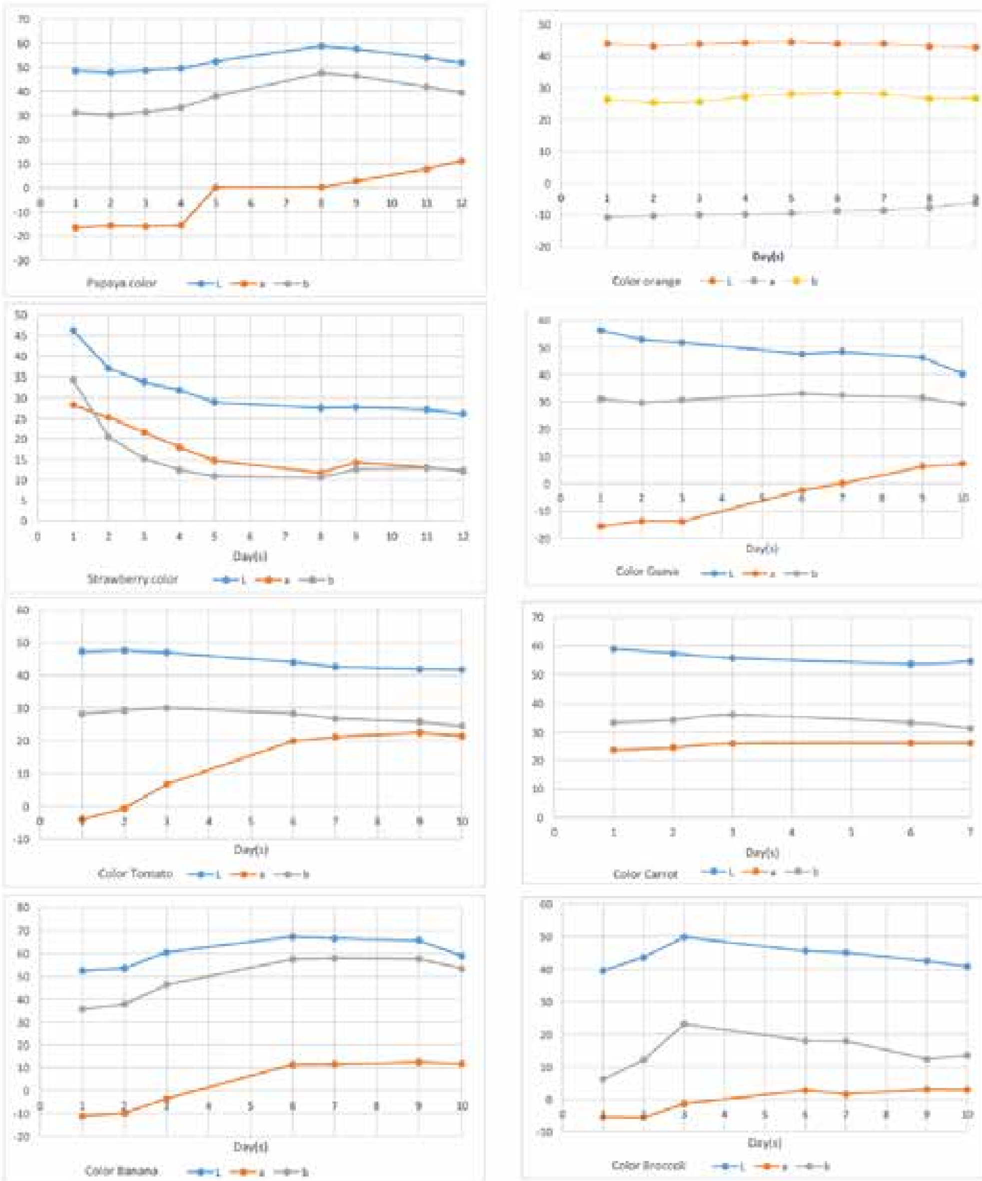

Figure 3. Color measurement from various fresh agricultural product.

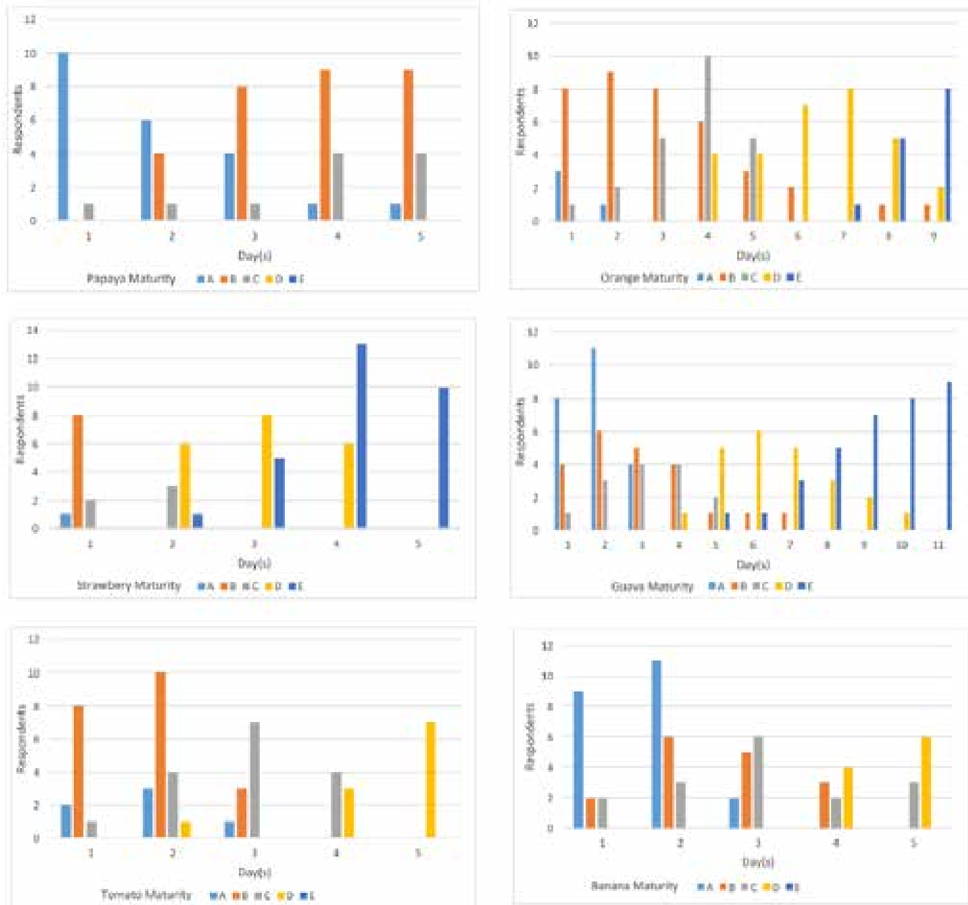

Figure 4. Maturity level from various fresh agricultural product (A=20% immature, B=60%, C=80%, D=100% ripe, E=>120% overripe).

The observations of color, maturity, and appearance attributes indicate that conditions for commodities that have hard textures having a shelf life are better than samples for commodities with soft textures and leaves with significant color changes over time. The short time and distance of sales makes farmers and business actors in each commodity not use certain chemicals to delay maturation and reduce the risk of loss. Maturity and freshness are important attributes for evaluating product quality and potential weight loss at retailers. An environment with high humidity is needed to inhibit transpiration and water loss in fruit and vegetable commodities. The results of studies at the wholesale market and retailers show a decrease in weight loss on room temperature conditioning which results in product freshness in a short time.

Traders, especially retailers, strive for product appearance by selecting and sorting product size, color, maturity level, spraying or splashing water into products, using used packaging, and using the best products as samples to influence consumer attractiveness. Sensory variations, lighting levels, conditions in open spaces (not sensory test chambers), the presentation of samples without presentation standards causes varying levels of assessment over time. Respondents need about 2-4 minutes to evaluate each commodity. After a sensory evaluation carried out in the morning the measurements were then carried out using the Colorimeter instrument for determination of darkness) from white to black) and for color (from yellow to red, red to blue, and green to yellow) (Ruslan and Roslan, 2016).

In this study, backgrounds that might influence product color perceptions are assumed not to affect the colors obtained from visual observation. Some other factors that might influence the results of sensory measurements include the appearance of commodity shapes, size or dimensions (product size or volume), level of consumer preference for products in the daily diet, aroma, texture, and sensory abilities of individual respondents.

6. CONCLUSION

Consumer acceptance and marketing of fresh agricultural products on traditional markets require quantitative testing support and are easily adopted in practice. It is useful to determine the results of a more accurate and accountable sensory evaluation. The combination of the assessment of the color and maturity of a fresh agricultural product can help actors in each supply chain's tier to assess the product quality according to the optimal level of maturity so that it can be more acceptable to consumers.

7. ACKNOWLEDGMENT

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ORAL SESSION

STUDY ON COLOR CATEGORY IN JAPANESE BY USING A CLUSTERING ANALYSIS

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Keywords: color category, color naming, k-means analysis, gap statistic, WCS

ABSTRACT

Most studies on color category use word-based analyses, but it sometimes causes difficulties to study *color categories*, not color terms. The present study introduces an example study on color category by applying clustering analysis to color naming study in Japanese language. The mean number of color names was 17.6, and the optimal number of color categories derived by the cluster analysis was 19. The categories included 11 basic color terms and 8 additional color terms that were unique to Japanese. Since this analysis does not rely on the linguistic characteristics, may be useful for the studies of color category in various languages and for the comparison of color categories across language and cultural differences.

INTRODUCTION

Categorization of colors has been studied in various languages. Berlin and Kay (1969) proposed the universality of basic color terms: most languages contain color terms that are common across people in various languages and cultural backgrounds. They defined the *basic color terms* as 11, including three achromatic terms: they are red, green, yellow, blue, purple, pink, orange, brown, white, black, and gray. The color category stands for a group of similar colors, and the color category does not necessarily correspond to color terms. For example, an expert farmer can discriminate whether a fruit is ripe enough to pick or not by its color. In this case, very subtle difference may be used in a categorization criterion and it is often difficult to describe with words. Or, if similar but slightly different group of color chips were named with different terms by different persons, how can you justify combining these groups as a category? To study about color *categories*, clustering analysis is more essential than a word-based study. In the followings, I will explain about how we applied clustering analysis to the result of color naming experiment.

METHODS

The analysis was applied to data collected from Japanese participants by freely naming colors for 330 color chips from World Color Survey. The participants (N=57) were allowed to use any color names under a *monolexemic restriction*: compound words (e.g., reddish purple) or use of modifiers (e.g., *pale* blue) were prohibited. The *k*-means analysis is a method to classify data into a given number '*k*' by repetition of a simple rule and this has been applied to color naming data (Lindsey & Brown, 2006). In most cases, the sum of residual distance between cluster elements and the mean of corresponding cluster is used as the measure of penalty. Since this k-means analysis is an iterative method from randomly chosen starting points, the residual differences vary from run to run. In the present study, we used gap statistics (Tibshirani et al, 2000) to measure the optimality. For the smaller number of *k*s, the gap statistic measure decreases with *k,* meaning the improvement of clustering. The gap statistic starts to increase at some point of *k,* meaning that the number of cluster exceeds the optimal value. Therefore, the optimal *k* can be obtained by watching this change in gap statistic with *k*.

In our study, the *k* value was tested between 2 and 24, and the gap statistic was calculated after *k*-means clustering for all *k* values to derive gap statistic differences for the flanking *k*s; this procedure was repeated for 10,000 times. The transition of gap-statistic difference from positive to negative values was summarized across the 10,000 repetitions to find the highest frequency point of *k* value. When applying the *k*-means analysis, data for achromatic terms were excluded.

RESULTS & DISCUSSIONS

The optimal number of *k* for chromatic category was 16. The average of each cluster was derived and the most frequent number of color terms was assigned as the "label" of each cluster. These chromatic clusters correspond to the chromatic categories, and it included eight universal basic color terms (*aka*/red, *ao*/blue, *midori*/green, *ki*/yellow, *pink*, *orange*, *cha/*brown, *murasaki*/purple) and non-universal color terms (*mizu*/cyan, *hada*/skin-tone, *matcha*/yellowish-green, *yamabuki*/gold, *cream*, *ai*/indigo, *enji*/maroon, *oudo*/yellowish-brown).

The color term 'mizu' was not considered as a basic color terms in the similar study in 30 years ago (Uchikawa & Boynton, 1987; *U&B87*, hereafter), because the use of mizu & ao (blue) on identical color chip was more frequent across participants, than in the result of our study. The degree of separation between *mizu* (or *sora*/sky) and blue became more distinct from U&B87. The degree of separation between two color categories are measured by overwrap ratios, derived in the following way. To compensate for the difference in the number of participants between two studies (U&B87: N=10; our study: N=57), 10 participants' data were randomly chosen. For the color categories in one participant, the fraction of participants used other color terms was derived in each color chip. This was repeated for 1,000 times to derive the histogram of overwrap ratio. The fraction of overwrap was around 60% for blue and mizu, which was around 80% in U&B87. This ratio is as similar as the overwrap between pink and red in U&B87, which is now around 40%. The overwrap ratios between blue and green are around 20% in both studies.

The use of *k*-means analysis on color naming data and its associated analysis were useful for the derivation of new finding in color category.

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ROBUST COLOR CORRECTION STRATEGY BASED ON CHROMATIC ADAPTATION MODEL

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Keywords: color correction, image signal processing, camera spectral sensitivity functions

ABSTRACT

Color correction module in digital camera converts the device-dependent RGB responses into device-independent color descriptors like CIE XYZ tristimulus values. The conventional approach pre-calculates and stores several illuminant-dependent color correction matrices (CCMs) in the calibration phase, and then decides which one should be selected in the working phase as per the information provided by the prior module.

Based on the CAT02 chromatic adaptation model, a robust color correction strategy without concerning the calculations of illuminant-dependent parameters is developed in this study, towards increasing the tolerance for the illuminant estimation errors. The experimental results indicate that the proposed strategy can be regarded as a competitive alternative to the conventional approach, which significantly reduces the upper limit of residual errors for the color correction module and improves the color reproduction accuracies for the scenarios that can hardly be reasonably estimated by the color constancy algorithms.

INTRODUCTION

The recorded raw responses (pixel intensities) of different digital imaging devices on the same target may vary due to the diversity of their physical properties like spectral sensitivity functions and black levels [1]. The color correction module in the image signal processing (ISP) pipeline of digital cameras plays a key role for the accurate color reproduction.

The conventional color correction approach pre-calculates and stores several *illuminant-dependent* color correction matrices (CCMs) in the calibration phase [2], then decides which one to be selected in the working phase as per the information provided by the prior illuminant color estimation module. Unfortunately, because of the imperfect accuracy of the illuminant estimation, color correction module may consequently choose and apply an inappropriate matrix, which leads to the converted images suffering from color degradation.

In this study, an efficient and robust *illuminant-independent* color correction strategy is proposed to alleviate the color degradation caused by the inappropriate CCM selection. By replacing the calculations of CCMs with the characterization of camera spectral transform matrix (CSTM), the proposed approach decouples the CCM selection from the illuminant estimation module and thus improves the robustness of color correction.

METHODOLOGY

The idea behind the illuminant-independent color correction strategy is very straightforward: supposing that the imaging device has been characterized as a colorimeter, the target responses after color correction could be calculated by applying chromatic adaptation model like CAT02 [3] to the recorded responses. Since CAT02 requires no calibration of illuminant-dependent parameters, this strategy highly improves the tolerance for the errors by the illuminant estimation module.

A. Camera Spectral Transform Matrix (CSTM)

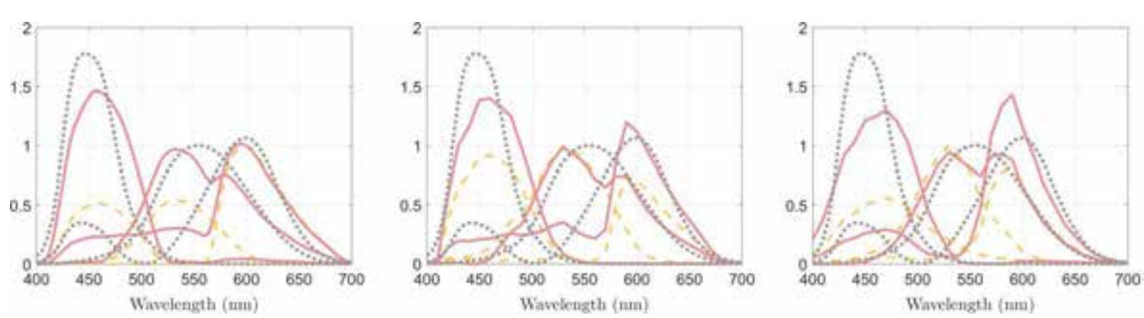
For simplicity, in this study the characterization for the RGB digital camera is achieved by finding a linear transformation that transforms the camera spectral sensitivity functions $\mathbf{S}_{cam}$ to CIE1931 color matching functions $\mathbf{X}$. Without loss of generality, the characterization can also be done by more complex transformations, e.g., projecting camera spectral sensitivity functions to a higher order space and finding a non-linear mapping.

In a similar way of optimizing spectral power distribution of light source in the LED lighting community [4], we find the optimal 3×3 camera spectral transform matrix (CSTM) $\mathbf{M}_{cam}$ by minimizing the *p-parameter* between the transformed spectra and the color matching functions, with some color difference constraints:

$$\mathbf{M}_{cam} = \arg\min \sum_{k} \frac{\| (\mathbf{M}_{cam}\mathbf{S}_{cam}^{\mathrm{T}})^{(k)} - (\mathbf{X}^{\mathrm{T}})^{(k')} \|_1}{\| (\mathbf{X}^{\mathrm{T}})^{(k')} \|_1}, \quad s.t.\ f_{cd}\left(\mathbf{M}_{cam}\mathbf{S}_{cam}^{\mathrm{T}}\mathbf{R}, \mathbf{X}^{\mathrm{T}}\mathbf{R}\right) < T_{cd},\ \forall \mathbf{R} \in \mathrm{R} \tag{1}$$

where $(\mathbf{M}_{cam}\mathbf{S}_{cam}^{\mathrm{T}})^{(k)}$ is the transformed spectral sensitivity function of $k \in \{r,g,b\}$ channel of the test camera, $(\mathbf{X}^{\mathrm{T}})^{(k')}$, $k' \in \{\bar{x},\bar{y},\bar{z}\}$ is one of three color matching functions, $\|\cdot\|_1$ denotes the ℓ_1 norm, $f_{cd}(\cdot,\cdot)$ represents calculating color difference between two sets of tristimulus values, and T_{cd} is a pre-defined threshold, which would be set to 3 units of CIEDE2000 color difference in this study. According to the basic integral model [5], $\mathbf{M}_{cam}\mathbf{S}_{cam}^{\mathrm{T}}\mathbf{R}$ is the transformed camera response for the object with spectral *irradiance* $\mathbf{R}$, and $\mathbf{X}^{\mathrm{T}}\mathbf{R}$ is the corresponding CIE1931 XYZ tristimulus value. Since the accuracy of achromatic color reproduction is particularly important for the ISP, the spectral irradiance set R will be constructed by multiplying the spectral reflectance of a perfect reflector and the spectral power distributions of 5 common illuminations, *i.e.*, CIE D65, CIE D50, CIE A, CWF, and TL84, which imposes 5 constraints in Eq. (1).

The solution to the constrained nonlinear function Eq. (1) can be found by the interior-point algorithm [6]. Figure 1 plots the camera spectral sensitivity functions of 3 out of 20 test cameras after optimal transformations. More details about the test devices will be explained in the next section.



(a) (b) (c)

Figure 1. Transformed camera spectral sensitivity functions for (a) Canon 5DMarkII DSLR, (b) Nikon D700 DSLR, and (c) Phase One DSLR. *Yellow dash lines*: original spectral sensitivity functions, *Black dot lines*: CIE1931 color matching functions, *Red solid lines*: transformed spectral sensitivity functions by CSTMs.

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B. CAT02-based Color Correction

CAT02 chromatic adaptation model is a key module in the CIECAM02 color appearance model [3], which takes as input the tristimulus values of the test object $\mathbf{q}$ and the white object $\mathbf{q}_w$ before adaptation under the test illuminant, the tristimulus value of the white under the reference illuminant $\mathbf{q}_{w,ref}$, and the degree of adaptation D, returns the tristimulus value of the corresponding color $\mathbf{q}_a$ of the test object after adaptation:

$$\mathbf{q}_a = f_{CAT02}\left(\mathbf{q}, \mathbf{q}_w, \mathbf{q}_{w,ref}, D\right). \tag{2}$$

For application of camera color reproduction, the $\mathbf{q}_{w,ref}$ and D can be fixed. Typically, $\mathbf{q}_{w,ref} = [95.047,\ 100.00,\ 108.883]^{\mathrm{T}}$ is the XYZ triplet of the perfect reflector under the canonical illuminant (in this study, CIE D65), and D is set to 1 to represent complete adaptation.

The raw RGB response $\mathbf{p} = [r, g, b]^{\mathrm{T}}$ at pixel $\mathbf{x}$ recorded by the camera can be transformed to the (approximate) device-independent XYZ values $\hat{\mathbf{q}} = \left[\hat{X}, \hat{Y}, \hat{Z}\right]^{\mathrm{T}}$ by the matrix multiplication:

$$\hat{\mathbf{q}} = \left(\mathbf{M}_{cam}\mathbf{S}_{cam}^{\mathrm{T}}\right)\mathbf{R}_{\mathbf{x}} = \mathbf{M}_{cam}\left(\mathbf{S}_{cam}^{\mathrm{T}}\mathbf{R}_{\mathbf{x}}\right) = \mathbf{M}_{cam}\,\mathbf{p}, \tag{3}$$

where $\mathbf{R}_{\mathbf{x}}$ is the spectral irradiance at the position corresponding to $\mathbf{x}$.

With Eqs. (2) and (3), the device-independent adapted tristimulus value at pixel $\mathbf{x}$ can be calculated as

$$\hat{\mathbf{q}}_a = f_{CAT02}\left(\mathbf{M}_{cam}\mathbf{p}, \mathbf{M}_{cam}\mathbf{p}_w, \mathbf{q}_{w,ref}, D\right), \tag{4}$$

where $\mathbf{p}_w$ is the camera RGB response of the white object (equivalent to the response to the light source) that can be predicted by the prior illuminant estimation module.

EXPERIMENTS

Given a test image after white-balancing, the conventional CCM-based color correction approach pixel-wise transforms the camera response $\mathbf{p}$ to the device-independent value by a matrix multiplication:

$$\hat{\mathbf{q}}_{ccm} = \mathbf{T}(\hat{\mathbf{p}}_w)\mathbf{p}, \tag{5}$$

where $\mathbf{T}$ is a pre-calculated color correction matrix out of several ones. The color correction module determines which matrix to pick up by comparing the estimated color $\hat{\mathbf{p}}_w$ of the test illuminant with the colors of several calibration illuminants. In this study we calculated the Euclidean distances between the estimated test illuminant color and the calibration ones in the camera RGB space and returned the index of calibration illuminant that was of the smallest distance. In the calibration phase we pre-calculated six 3×3 CCMs for six common illuminants (CIE D65, CIE D50, CIE A, CWF, TL84, F8), and normalized elements in each matrix such that the sums of each row were equal to 1, which would keep the responses of the achromatic pixels unchanged before and after color correction.

To simulate the estimation errors by the illuminant estimation module, we intentionally introduced biases to produce erroneous illuminant color estimates, upon which both the conventional and the proposed color correction approaches were tested. Followed by the previous work studying the performances of color constancy algorithms, the intentional estimation biases were set in the range of 0.1 to 10 degree in angular error, with Δuv not great than 5‰ unit [7].

Twenty camera models and 15 test illuminants were tested in our experiments. Figure 2 plots the spectral sensitivity functions of the test cameras and the spectral power distributions of the test illuminants.

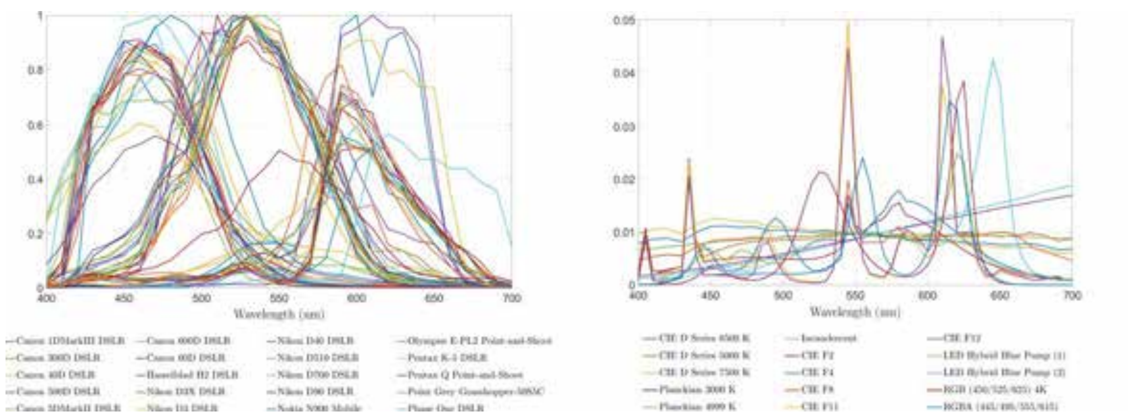

Figure 2. (a) Spectral sensitivity functions of 20 test camera models. (b) Spectral power distributions of 15 test illuminants

A. Synthetic data

We first compared the proposed color correction strategy with the conventional CCM-based approach by investigating the color reproduction errors on X-Rite Classic ColorChecker. Given the spectral reflectance $\boldsymbol{\rho}$ of a patch on the ColorChecker, its ground truth XYZ tristimulus value under the canonical illuminant can be calculated as

$$\mathbf{q}_{can} = \mathbf{X}^{\mathrm{T}} diag(\mathbf{I}_{can})\boldsymbol{\rho}, \tag{6}$$

where $\mathbf{I}_{can}$ is the spectral power distribution of the canonical illuminant. Similarly, its raw camera RGB response under the test illuminant is

$$\mathbf{p}_{test} = \mathbf{S}_{cam}^{\mathrm{T}} diag(\mathbf{I}_{test})\boldsymbol{\rho}. \tag{7}$$

We used both color correction approaches to correct camera response $\mathbf{p}_{test}$ as per Eqs. (4) and (5). For the conventional approach, it should be underlined that the chosen matrix $\mathbf{T}(\hat{\mathbf{p}}_w)$ could only be one out of the 6 pre-calculated matrices, while the actual test illuminant $\mathbf{I}_{test}$ might be of great diversity.

CIEDE2000 color difference averaged over 24 patches was employed to measure the color degradation. The overall results for 30,000 pairs of simulations (20 test camera models × 15 test illuminants × 100 repetitions with random estimation biases per camera + illuminant combination) are listed in Table 1. To eliminate the impact of illuminant estimation biases, a post-white-balancing would be performed to all the transformed responses such that the achromatic pixels were correctly reproduced.

We also kept those cases where the conventional color correction approach picked up a "wrong" CCM and compared the performances of two approaches, as listed in Table 2.

By comparing Tables 1 and 2, it is evidently shown that the proposed CAT02-based color correction strategy is superior to the conventional approach when the illuminant estimation module fails to produce accurate illuminant prediction.

Table 1: Comparison of CIEDE2000 color difference for the conventional CCM-based color correction approach and the proposed approach

Color correction approach	Conventional (CCM-based)	Proposed (CAT02-based)
Mean	**5.4663**	5.8721
Median	5.1299	**4.8642**
25% best	3.3797	**3.2422**
25% worst	**6.1617**	6.7484

Table 2: Comparison of CIEDE2000 color difference with respect to cases where the conventional color correction approach picked up a "wrong" CCM

Color correction approach	Conventional (CCM-based)	Proposed (CAT02-based)
Mean	6.6797	**5.5595**
Median	6.3044	**4.7267**
25% best	4.1740	**3.2239**
25% worst	7.5145	**6.3377**

B. Real image data

To evaluate the perceptual color degradation for the images, we utilized directional statistics-based color similarity index image quality assessment (DSCSI-IQA) metric [8], which had been proven to be successful in quantifying the perceptual quality of color images consistently with subjective evaluations, to assess the qualities of the color corrected images. Given a reference image and a test image, a similarity score is calculated by the DSCSI-IQA metric, of which the higher value stands for higher similarity between the image pair, and consequently less perceptual degradation.

Sixty-eight hyperspectral images were tested in our experiments [9, 10]. For every pixel in a hyperspectral image, its (device-independent) ground truth and camera response were calculated as in Eqs. (6) and (7), then were converted into sRGB space for the evaluation by the DSCSI metric. The overall results for 204,000 pairs of DSCSI scores (20 test camera models × 15 test illuminants × 68 hyperspectral images × 10 repetitions with random estimation biases per camera + illuminant combination) are listed in Tables 3 and 4. Just as reported in the previous subsection, a post-white-balancing was performed to the color corrected image before IQA evaluation.

Table 3: Comparison of DSCSI scores for the conventional CCM-based color correction approach and the proposed approach

Color correction approach	Conventional (CCM-based)	Proposed (CAT02-based)
Mean	**.8860**	.8825
Median	**.9210**	.9118
25% best	**.9316**	.9294
25% worst	**.7493**	.7417

Table 4: Comparison of DSCSI scores with respect to cases where the conventional color correction approach picked up a "wrong" CCM

Color correction approach	Conventional (CCM-based)	Proposed (CAT02-based)
Mean	.8699	**.8855**
Median	.9071	**.9190**
25% best	.9180	**.9368**
25% worst	.7254	**.7315**

The results of hyperspectral images data are consistent with those of synthetic ColorChecker data. The DSCSI scores of the conventional approach largely drop off when the illuminant estimation errors increase and the wrong matrix was selected, while the proposed approach demonstrates better robustness for these hard cases.

CONCLUSION

In this study a robust color correction strategy based on CAT02 chromatic adaptation model was proposed towards increasing the tolerance for the illuminant estimation errors. By decoupling the calculations of color correction matrices from illuminant estimation, our approach improves the robustness of color correction and simplifies the calibration processes. The experimental results suggest that the proposed approach achieves comparable performance with the conventional CCM-based approach for the common scenarios, and obviously outperforms the latter for those cases where the matrix was inappropriately selected. The robustness to the illuminant estimation errors makes the proposed approach become a competitive alternative to the conventional approach in practical uses.

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ORAL SESSION

Study of Color Volume Metrics Reflecting Image Quality of HDR Displays

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ABSTRACT

The existing color volume metrics, usually underestimating the visual effects of very dark colors, are found to be unaccommodated to predict the image quality (IQ) of high dynamic range (HDR) display. In other words, an HDR display with higher image quality will not necessarily have a larger color gamut or color volume under the existing metrics.

In this study, several color volume metrics were compared based on the physical measurements of 2 HDR displays, aiming to develop a visually correlative color volume metric. The tested models are built in, respectively, CIEXYZ, CIELAB, CIELUV color spaces and CIECAM02 color appearance model, taking the luminance response of human visual system into consideration as well. Then some subjective evaluation experiments on the HDR displays were conducted to test the performance of the metrics on predicting image quality. It is indicated that the color volume metric with the model of $\log_2(L)a^*b^*$ outperforms others in characterizing the image quality of HDR displays, of which the capability to present extremely high contrast or rather bright and deep dark scenes is also revealed.

INTRODUCTION

Market of HDR display is thriving through past few years, and an incremental number of TV and mobile phone manufacturers are providing HDR devices as well. In consequence, a demand of image quality (IQ) evaluation for HDR display arises. The subjective experiments that previous study [1] employed to evaluate the IQ of HDR displays are invariably expensive and time-consuming. The industry therefore desiderates a compendious method to predict the IQ of HDR display. The 2-dimensional color gamut that some research used to predict subjective preference [2] does not suit for HDR displays due to the similar chromaticity reproductivity of most HDR certified devices. Thus 3-dimensional color spaces containing luminance axis are taken into consideration. The existing color volume metrics, such as CIEXYZ color space which adopt a linear luminance dimension, are found to underestimate the visual effects of dark colors and fail in predicting IQ of HDR display.

In this study, several novel color volume metric models based on the considerations of human vision were proposed. Some HDR TVs were measured and color volumes of them were calculated under different color volume metric models. Then some subjective experiments were conducted on the displays in different viewing conditions. Analysis of the subjective experiments was done to acquire interval scale value. The results indicate that the color volume metric with the model of $\log_2(L)a^*b^*$ outperforms others in characterizing the image quality of HDR displays.

HDR COLOR VOLUME METRIC MODELS

An ideal color volume metric model for HDR display should be highly relevant to the IQ of a HDR display, and therefore IQ can be simply characterized by numerical values of the color volume. As a color volume metric, the model should also present good chromaticity uniformity and simplicity. Therefore, the involved color metric models in this study are the slightly modified version of existing color models. The color volume of the HDR TVs in deferent viewing conditions will be calculated based on The physical measurement data.

The existing color metric models are somewhat underestimating the visual effects of dark colors. Color spaces like CIEXYZ employ a linear luminance axis, of which the values often mismatch the perceptual feelings. In consequence, the lightness axis Y of CIEXYZ color space is replaced by a $\log_2(L)$ axis, where the L represents luminance. The $\log_2(L)$ axis is expected to match the human vision response to luminance in this research.

For color spaces like CIELAB and CIELUV, the reference white, usually a standard light source or the peak white of the device, is used to compress the luminance axis. The compression is accompanied with lose of peak luminance and black luminance information. Hence, the reference white of the two models are set to be the peak white of the display itself to simulate the color adaptation of human vision, and the lightness axis of these models are replaced by a $\log_2(L)$ axis as well.

The CIECAM02 color appearance model [3] is considered to be an appropriate approach for the modeling of human color vision, but its adaptability to HDR display is unrevealed. In view of this, the JCh color space from the CIECAM02 color appearance model is also involved in the study.

Finally, the original CIEXYZ color space and CIELAB color space (with a standard D65 illuminator as reference white) are employed in the color volume calculation as a reference to the modified models proposed in this study.

PHYSICAL MEASUREMENTS

An OLED HDR TV and a LCD HDR TV were employed in the experiments, and some of their physical parameters are listed in Table 1. All the physical measurements and subjective experiments were performed under the HDR mode of the displays.

Table 1 Physical parameters of 2 HDR TVs

Parameters	OLED HDR TV	QLCD HDR TV
Pixel resolution	4196×2160 pixels (4K)	
Size	55 inch	65 inch
Peak luminance (cd/m^2)	774.85	952.16
Black luminance (cd/m^2)	0.000306	0.037868
Contrast	2.53×10^6	2.51×10^4

The physical measurements, recording XYZ values of different RGB for the HDR TVs, were performed with a Konica Minolta CS-2000A spectroradiometer. Both TVs were measured in two viewing conditions (front view and 45° side view) to gather more data. To obtain the color gamut shell of the displays, the XYZ values for 6 surfaces of the RGB cube were measured with an interval step of 16. A total of 6936 (17×17×6×2×2) XYZ data was finally collected for the calculation of color volume.

SUBJECTIVE EXPERIMENTS

Besides the physical measurements and color volume calculations, subjective experiments were carried out to test the IQ of 2 HDR TVs under 2 viewing conditions. The results were utilized to calculate the interval scale value (Z-score) and were used as a reference to the performance of the color volume metric models.

A panel of 19 observers, including 12 males and 7 females with normal color vision, participated in the subjective evaluation. Observers were asked to watch the HDR test images on two TVs and score their preference to the TVs on several image attributes. The HDR images were generated by a PC with HDR signal generator, and conveyed to the two TVs by a splitter. According to the IEC standards [4], the viewing distance was 3 times of the display's short edge length, and the background luminance of the room kept under 5 lx during the test. To avoid visual fatigue, the experiments were divided into 2 sessions, for which duration was about 30 minutes including a 2-minute dark adaptation and a 1-minute light adaptation. A total of 30 HDR images were used for the evaluation, covering general HDR scenes like landscape, portraiture, indoor scene and architecture. Four image attributes were evaluated in the experiments, i.e., Overall Preference, Brightness, Blackness and Contrast, the definitions of them are as follows:

Overall preference: the perceptual preference of the displayed image.

Brightness: the perceptual lightness of the brightest regions in the displayed image.

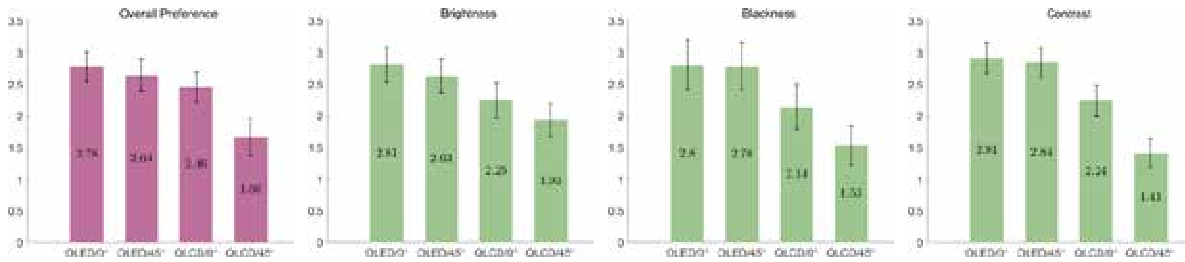
Blackness: the perceptual darkness of the black regions in the displayed image.

Contrast: the perceptual integral contrast of the displayed image.

The experiments were conducted through the psychophysical method of category judgement, of which 9 categorical scale grades of subjective feelings were employed for the evaluation according to ITU-T P.910 [5]. In a single grading, the observer was asked to watch a HDR image presenting on 2 TVs simultaneously in a certain viewing condition (front view or 45° side view), and score the grade of 4 image attributes as previously mentioned for both TVs. The image presenting order for every observer was random to avoid possible influence. The subjective experiments collected a total of 9120 observer grading scores, i.e. 19 observers × 30 images × 4 image attributes × 2 viewing conditions × 2 TVs. The results were utilized to calculate the interval scale value (Z-score), which can represent the image quality of the displays.

DISCUSSION

The results of subjective experiments are shown in Figure 1. The 4 image attributes seem to be highly consistent and steady, indicating that the OLED TV in front view demonstrates best IQ, followed by OLED TV in side view, LCD TV in front view, and LCD TV in side view is the least preferred. Comparing the results to physical parameters of the TVs, it is clear that higher peak luminance is not necessarily a key factor for better IQ. On the other hand, the lower black luminance does improve the IQ for the OLED TV. Besides, the IQ of LCD TV badly drops in the side view condition due to the color gamut damping caused by its panel mechanism. Considering the high consistency of image attributes, only the Overall Preference is chosen as a representative of IQ and be the reference to the color volume metric models.



(a) (b) (c) (d)

Figure 1 Interval scale values of 2 HDR TVs in front view (0°) and side view (45°) for image attributes (a)Overall Preference; (b)Brightness; (c)Blackness; (d)Contrast.

The physical measurements reveal that the color gamut of both displays reduce under 45° side view. Specifically, the peak luminance of OLED TV drops to 521.6 cd/m^2, but the black luminance just increases slightly. The peak luminance of LCD TV drops sharply to 280.9 cd/m^2, and the black luminance come to 0.136 cd/m^2.

The results of volume calculation for color metric models are listed in Table 2. It should be noticed that different color metrics have different color scales, thus their color volumes cannot be directly compared. With the reference of subjective preference, it can be found that the CIELAB and CIELUV models with log$_2$(L) axis show relatively consist performance on predicting IQ. Figure 2 illustrate the normalized color volumes and the subjective scale values.

Table 2 Color volumes for different color metric models

Model	OLED/0°	OLED/45°	LCD/0°	LCD/45°
Preference	**2.78**	**2.64**	**2.46**	**1.66**
CIEXYZ	61.62	41.66	86.64	19.39
CIELAB	8.44×10^5	8.51×10^5	10.51×10^5	7.81×10^5
CAM02 JCh	1.37×10^5	1.28×10^5	1.72×10^5	0.79×10^5
CIEXYZ, log$_2$(L)	2.22	2.29	1.61	0.93
CIELAB, log$_2$(L)	1.47×10^5	1.44×10^5	1.15×10^5	0.65×10^5
CIELUV, log$_2$(L)	2.31×10^5	2.27×10^5	2.02×10^5	1.18×10^5

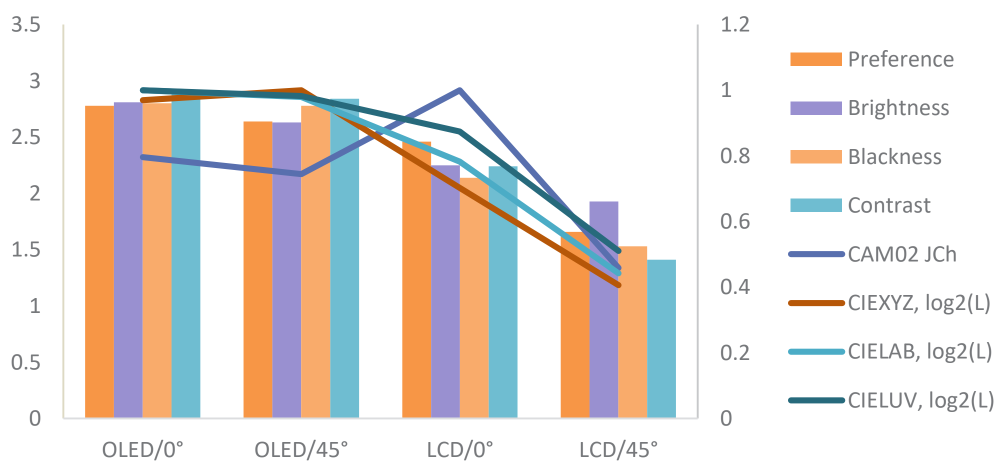


Figure 2 Normalized color volumes for different color metric models

In the original CIEXYZ and CIELAB models, the LCD TV under front view condition presents the highest color volume due to its extraordinary peak luminance. But it fails to defeat others in subjective experiments, indicating that the original CIEXYZ and CIELAB models are not suitable for the IQ prediction for HDR display. The CIECAM02 JCh model also fails in predicting the IQ of HDR display, since the lightness J of this model do not concern the visual effects of dark colors, and is not a practicable model for HDR display. The CIEXYZ color space model with $\log_2(L)$ axis seems to have good accuracy. But according to this model, the OLED TV under side view, of which color gamut must be minor than that of it under front view, has a higher color volume. The fact reveals the unsteadiness of this model.

Fortunately, the CIELAB and CIELUV color space models with $\log_2(L)$ axis achieve good consistency with the IQ, showing a potential capability to predict the IQ for HDR display. Their Pearson correlation coefficient towards the subjective preference is 0.9856 and 0.9976, respectively, with no significant difference. Both models can be considered to be suitable color volume metric models for HDR display, but considering chromaticity uniformity of the color metric, the CIELAB color space with $\log_2(L)$ axis will win out with slight advantage.

CONCLUSION

In this study, several novel color volume metric models based on existing color spaces were proposed to predict the IQ for HDR display. Color volumes under different models were calculated based on the physical measurement data of 2 HDR displays under 2 viewing conditions. Subjective experiments were conducted to obtain the scale value of subjective preference, which was used as the representative of IQ and reference of the performance for the models. Further analysis reveals that CIELAB and CIELUV color spaces with a $\log_2(L)$ axis are preferable for representing IQ, and in addition, the CIELAB based model has advantage in chromaticity uniformity, being more appropriate to characterize the IQ of a HDR display.

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Investigation of Multispectral Demosaicking Algorithms for Spectral Image Reconstruction

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Keywords: multispectral imaging, demosaicking algorithm, spectral image reconstruction

ABSTRACT

The multispectral imaging system based on multispectral filter array (MSFA) is more compact, low-cost and faster than other types of multispectral imaging systems, such as filter-wheel based, LCTF based and LED based. The challenging problem for MSFA is multispectral demosaicking, since each spectral band is severely undersampled in the MSFA. In this paper, the complete process of spectral estimation based on MSFA is firstly analyzed, and then the scheme for testing the multispectral demosaicking algorithms by simulation is explained. Finally, the interpolation based multispectral demosaicking algorithms is discussed.

INTRODUCTION

In recent years, multispectral imaging (MSI) has been studied for many fields, such as remote sensing, medical applications, and color reproduction. Some multispectral cameras have also been proposed, but practical use of multispectral imaging has generally been limited because of the extremely high cost of applications and their lack of portability. Multispectral filter arrays (MSFA) are a possible solution to this problem, and various filters and demosaicking methods have thus been proposed. Both the investigation of a new demosaicking method and the development of a technique to determine the filter patterns and spectral sensitivities of MSFA are important challenges to improve the quality of demosaicked images. In general, there are two domains of CFA (color filter array) arrangements: rectangular and hexagonal. Since conventionally images are digitized and stored in rectangular way, and most demosaicking techniques use rectangular arrays [1]. Accordingly various filter arrangement and filter arranging algorithms have been developed. As for demosaicking methods for MSI, most algorithms were transferred from the CFA counterparts, such as interpolation based algorithms and MAP (Maximum a-Posteriori) technique. In this paper, the complete process of spectral estimation based on MSFA is firstly analyzed, and then the scheme for testing the multispectral demosaicking algorithms by simulation is explained. Finally, the interpolation based multispectral demosaicking algorithms is discussed.

SPECTRAL ESTIMATION BASED ON MSFA

Figure 1 illustrates the process of spectral estimation based on MSFA. The object is captured by the MSFA based multispectral camera, and the mosaicked multispectral image is generated according to different filter arrangements. The mosaicked multispectral image is then transformed to demosaicked multispectral image by various demosaicking algorithms [2]. At last, the spectral reflectance is estimated with the demosaicked multispectral image by the adopted spectral estimation algorithm.

As shown in Fig. 1, the factors impacting the spectral estimation include filter arrangement of multispectral camera, multispectral demosaicking algorithms and spectral estimation algorithms.

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Although different layouts of filter arrangement have been designed, for one certain multispectral camera the filter arrangement is usually fixed [3]. The demosaicking algorithm derives the multichannel camera responses for one pixel from the mosaicked image, and it will influence the spectral estimation since the spectral estimation will estimate the spectral reflectance from the multichannel camera responses. So adopting proper demosaicking algorithm is important for MSFA based multispectral camera.

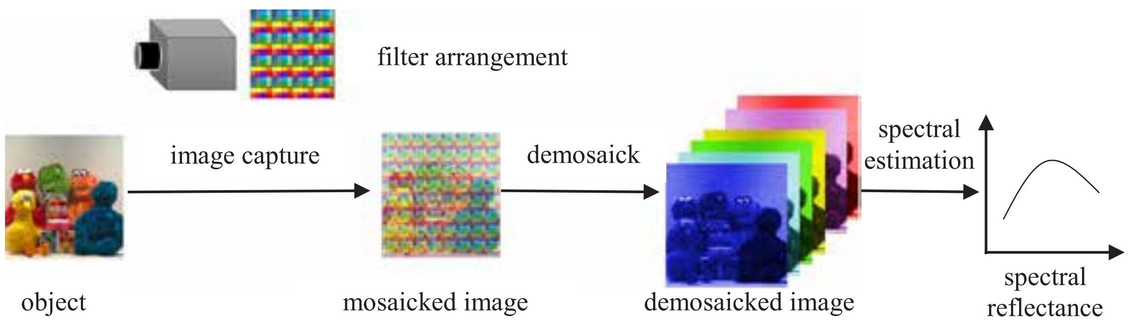

Figure 1. The schematic diagram for spectral estimation based on MSFA

SCHEME FOR TESTING THE DEMOSAICKING ALGORITHMS BY SIMULATION

Simulation can enormously facilitate testing the demosaicking algorithms, since the spectral characteristics of hardware can be simulated, measured or estimated beforehand, such as light source, sensor, filter, meanwhile large multispectral or hyperspectral image database can be available from some famous research institutes. Thus, the scheme for testing the demosaicking algorithms is proposed, as illustrated in Fig. 2.

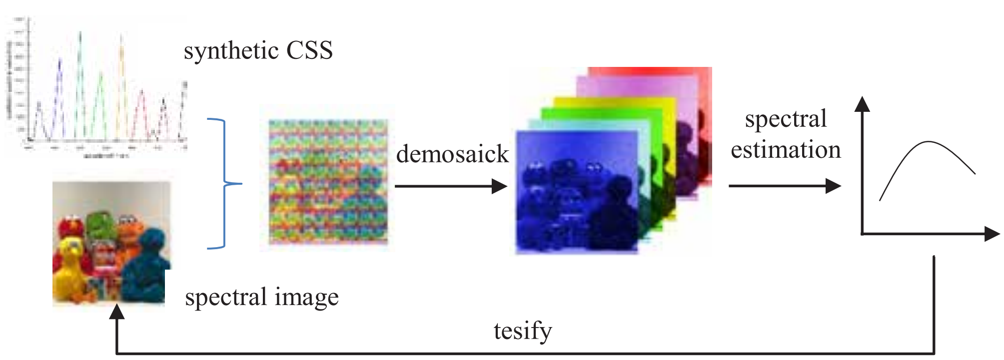

Figure 2. The scheme for testing the demosaicking algorithm

The synthetic camera spectral sensitivity (CSS) is the compound of spectral characteristics of light source, filter and sensor. The synthetic CSS can be calculated after obtaining the spectral characteristics of light source, filter and sensor respectively, either can be directly estimated with color charts. The spectral image could be download from the websites of some research institutes, such as the CAVE Lab in Columbia University. Then the mosaicked multispectral image can be generated with the synthetic CSS and spectral image in terms of the filter arrangements [4]. The demosaicked multispectral image can be obtained with the testing demosaicking algorithm. The spectral reflectance for one pixel is estimated by the spectral estimation algorithm based on the demosaicked multispectral image, i.e., the spectral image is restored. Then the testing demosaicking algorithm is evaluated by comparing the restored spectral image against the original one with some metrics, such as RMSE or color difference.

INTERPOLATION BASED DEMOSAICKING ALGORITHMS

1. Nearest neighbour interpolation. This is the example of a multivariate interpolation, which is based on mathematical operations on nearby instances. It is simplest method which copies an adjacent pixel of the same color channel. It selects value of the point nearest to the missing pixel. It seems to be useful for generating previews when limited computational resources are given. Most common use is in real-time rendering to select color values for a textured surface.
2. Bilinear interpolation. This is also an example of multivariate interpolation. The red value of the non-red pixel is computed as the average of the two or four adjacent red pixels, and similarly for blue and green pixels. It is an extension of linear interpolation for interpolating functions of two variables (e.g., x and y) on a regular 2D grid. The key idea is to perform linear interpolation first in one direction, and then again in the other direction [5].
3. Weighted bilinear interpolation. The interpolation method can be visualized as a convolution process using certain kernels. In this method, all four pixel orientations are interpolated and the newly computed pixels are located at the center of the convolution kernel. The coefficients in the kernels are estimated by the distance from the location of the pixel that is interpolated.
4. Bicubic spline interpolation. The bicubic spline interpolation method is a common algorithm used in color images with superior improvements in its performance over bilinear interpolation. However, the cost is increased computational complexity. This interpolation method is first applied in the horizontal direction followed by interpolation in the vertical direction. The bicubic spline interpolation method computes new values from a low resolution image by fitting a third order polynomial between two neighboring pixels with polarization filters oriented at the same angle.

The main problem with the interpolation-based demosaicking methods is that these methods are heuristic in nature. There is no concrete mathematical model which can be used to develop an optimal demosaicking process. This proves to be a hurdle in the flexibility offered by the demosaicking method. There is also a need for consideration of practical factors like degradation and noise that can be added in the process of image acquisition. The existing interpolation based methods would fail to produce a satisfactory result in the presence of noise and blur added by the acquisition process. More sophisticated demosaicing algorithms exploit the spatial and/or spectral correlation of pixels within a color image. Spatial correlation is the tendency of pixels to assume similar color values within a small homogeneous region of an image. Spectral correlation is the dependency between the pixel values of different color planes in a small image region.

CONCLUSION

The whole process of spectral estimation based on MSFA is presented, and the scheme for testing the multispectral demosaicking algorithms by simulation is stated. Then, the interpolation based multispectral demosaicking algorithms is discussed. When developing demosaicking algortihms, computation speed is important for real-time application, while the spectral estimation accuracy is more important if time is not a main consideration. Besides spatial correlation, spectral correlation is another points for improving the demosaicking result.

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VISUAL ETHNOGRAPHY: PHOTOGRAPHY AND COLOR

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ABSTRACT

Visual ethnography has played a significant role in ethnographic and anthropological studies. Visual Ethnography allows researchers to challenge existing images as technology and visual research methods improve. It is important to understand that the technical choices provided by the research will already create the possibilities of altering the cultural representation. This is the result of brand or technology used and the default color profiles or mechanical distortion of the product.

The objective of this paper is to explore the areas of how the technological methods of a visual ethnographer, focusing on photography, affects cultural representation. The understanding of color in photography and the important role that color plays in visual ethnography.

Research consisted of ethnographic images taken by the author to explore color and its role in visual ethnography. Images cover the Lahu tribe of Chiang Rai, The Konyak headhunters of Long Wa, Nagaland, and the Rolling Rockets skate soccer team, in Accra, Ghana. Additionally, the paper will explore field methods of color temperature balance and color charts to ensure color accuracy.

The goal of the author is to start a discussion of technical awareness of the equipment used while considering the importance that color plays in the understanding and decoding of cultural representation

INTRODUCTION

The ethnography study of daily life, identities, cultures, truths are linked with visual images (Pink, 2006). Visual ethnographic works on us when the ethnographer produces photographs or videos as a research product (Kharel, 2015). The research helps us understand cultures, music, art and much more. Visual ethnography is used to improve human perception, infrastructure development and cultural understandings to name just a few. This discipline allows us to gain access, collect data and identify issues and uses creative means to establish ideas (Prosser, 1992). A key element to this knowledge is the use of color. Color is in everything we see. What we associate with color is our perception of light. Carlos Rubbia (1984) provides an idea for our strong reaction to color in his resonance theory. The basic breakdown is that our bodies are 1 billion parts light to 1part matter. Our bodies have natural frequencies and when we are exposed to a particular wave length / color our bodies want to be in tune with that color causing a psychological and physiological response. As color will cause an emotional response the visual ethnographer has to be deliberate with the use of color.

Technology plays a significant role in ethnographic and anthropological studies. Improving observational methods of study while improving behavioral and personal methods. Allowing more details to be seen while exploring the ordinary. Visual Ethnography allows us to challenge existing images. There is an increase in 'hybrid' works between visual arts and 'practice-led' research (Gibson, 2013). Constant improvement in technology allows us to observe human behavior and see what was once not obvious in greater detail. It is important for a visual ethnographer to understand the technical and theoretical aspects of the mediums used to achieve this research. It is important to understand that the technical choices made by the research will already have the possibilities of altering the cultural representation. This is result of what brand or technology is utilized and their default color profiles or the mechanical distortion of the product. There is a fine line in maintaining the balance between aesthetics and accurate representation of culture. Works such as Cocorico Monsieur Poulet (Rouch, 1974), Before They Pass Away (Nelson, 2013), Genesis (Salgado, 2013), The People of Omo Valley (Pandya, 2016) and various works by Stephen McCurry all showcase a development of pictorial ethnography. Many of these photographers do not consider themselves anthropologists in the traditional sense but are acting as visual ethnographers in today's ever connected digital world.

The objective of this paper is to explore the areas of how the technological methods of a visual ethnographer, focusing on photography, affects cultural representation, the understanding of color in photography and the important role that color plays in visual ethnography. Visual images and socio-cultural representations are embedded in ethnographic research (Boangiu, 2008).

Research consists of ethnographic images taken by the author to explore color and its role in visual ethnography. Images covered studies of the Lahu tribe of Chiang Rai, The Konyak headhunters of Long Wa, Nagaland, and the Rolling Rockets skate soccer team for the physically challenged. Additionally, the paper will explore field methods of color temperature balance and color charts to ensure color accuracy. Photographic post-production technics for editing on appropriate software and how to achieve images that do not distort the cultural representation of ones research will be covered.

Results will showcase before and after images as result of color temperature balance and color calibration to achieve accuracy for visual ethnographic research.

While the technological choices selected by the visual ethnographer carry the possibilities of cultural distortion based on the limitations of the technology, the creator should not be any less concerned for taking an aesthetic image. The goal of the author is to start a discussion of technical awareness of the equipment used while considering the importance that color plays in the understanding and decoding of cultural representation.

It is important to understand some basic principles in ethnographic research before we start the analysis of our images. The researcher must be reflexive and understand one's own perception of the world around them (Legald, 2015). Understanding how you are approaching the research and your pre-conceived views will help with accuracy of final works. One must also approach research ethically. The ethnography must respect the subjects and let the subject see and understand what you are doing. In the works that we will explore in this paper the author had spent several weeks with the subjects while photographing them.

To capture the photography there were two approaches to the conduct of research during the project. Research method one involved traditional research methods of articles, journals and books along with pre-existing images when possible. The second approach was an exploratory process. The author spent time with the subjects and observed their everyday lives and determined the relevant story to share with the audience. As a visual ethnographer one must consider how these images will be viewed. As these images are unique the author must not only consider the academic values of the images but also consideration for public dissemination. If the true goal of the research is to shed light on a particular culture the reach must be beyond that of the academic community.

EQUIPMENT

The technical equipment used to document must provide the highest quality images and accurate color. A Profoto B1 portable studio light, a Canon Speedlite 580 EXII, a Godox s-Bracket Bowens mount, 1 Godox 90cm Umbrella Softbox and 1 Profoto octa-softbox were used to control the lighting. The softbox controls light as the effective size of the light is determined by the physical size and the position in relation to the subject (Adorama, 2018) as seen in Figure 1, this will also help control of consistent color cast. The camera used was the Canon 5d mark III with a Profoto Air Remote. The color temperature, the characterization of the spectral properties of a light source, of the Profoto B1 portable studio light gives off a consistent color temperature of 6150 Kelvin while shooting in normal mode while the Canon Speedlite 580 EXII shoots approximately at a color temperature of 6000 Kelvin. It was known that daylight will be approximately 5600 Kelvin meaning that the portable studio lights are slightly cooler in color than the sun. As the Canon 5d mark III with Adobe RGB color space is being used the white balance was set to 6150 Kelvin as the key, main light, the Profoto B1 (figure 1), will be determining the color. The Canon Speedlite 580 EXII will be used as a rim light meaning that is will be a source from behind the subject. When the images are being taken outside the sun, 5600 Kelvin, will be located behind many of our subjects adding a subtle warmer color to the image.

***Figure 1*: Softbox, Lighting test with Konyak head hunter in Long Wa, Nagaland. March 3,2017**

To ensure accurate color balance a grey card will be used for the first image of each lighting set up. This image can then be used during post production in Adobe Lightroom as a way to ensure proper white balance and true colors are presented. It is true that many ethnographers will not get to edit their images for a time after they return and may not be able to recall a particular shade or the light conditions from the actual image context (Fewkes, 2008) which is why usage of a color balance too is vital. There are more complex ways to control the color but in this particular situation the author was climbing mountains or exploring back streets with heavy equipment and limited to equipment that could be carried on his person. An additional factor is time spent with the subject. Often the subjects were on the move, it was not wanted to cause more of a disturbance as the author was there for visual ethnographic purposes and not tourism. A general sense of curiosity by the subject is developed so the image would often be shared with the subject (Figure 2).

***Figure 2*: Sharing the final image with Konyak woman, Long Wa, Nagaland. March 2, 2017**

IMAGES

The works are broken down into the main categories of Long Wa - Hunters, Headhunters, Lahu - Hunter and The Rolling Rockets of Ghana. As Margaret Mead said, “What people say, what people do, and what they say they do are entirely different things” (Isaacs, 2013). This statement is important to a visual ethnographer as the aim was to observe and document but not to influence the subjects. The author would often spend weeks with the subjects documenting them. During this period, it was found that the colors photographed changed as the subjects stopped parading their artificial image as life had to move forward. I will first introduce my images and then explore the color behind these images.

Long Wa, Nagaland is located in North East India and is home to some of the last living tattooed headhunters of the Konyak tribe. Their culture is that of a hierarchy-based system and the people live off of hunting and farming which is community based. My first image (figure 3) is that of an elder hunter wearing a traditional hunting uniform

Figure 3: An elder hunter shares his traditional hunting outfit mid hunt. This outfit can only be seen on elder hunters. Long Wa, Nagaland. March 3, 2017

My second image is an elder headhunter photographed in front of his home in a traditional outfit.

Figure 4: An elder headhunter stands in front of his home in traditional outfit. His home proudly displays the Gayal skulls that he has hunted over the years. Long Wa, Nagaland. February 27, 2017

My next image takes us to the Northern Thai province of Chiang Rai where a village of Lahu ethnic members live in a sustainable hunting and farming village located high in the mountains.

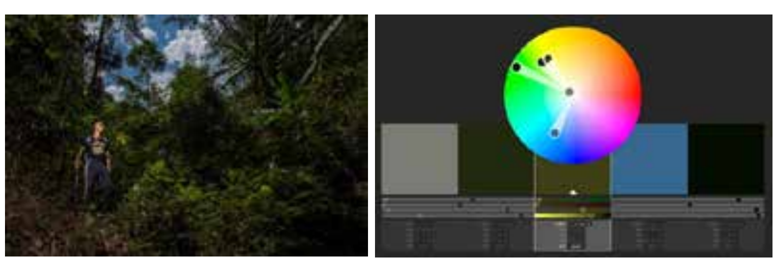

Figure 5: A young hunter appears from the forest. Chiang Rai, Thailand April 18, 2017

The last image is from a lower income area in Accra, Ghana where the Rolling Rockets Skate Soccer team practices. The team’s aim is to change the stigma of disabilities in Ghana. All the players are homeless and are street beggars but are trying very hard to move away from this as the sport is being able to provide a small income for these men.

Figure 6: Two players colliding into each other during practice. Competition is intense during practices as a place on the team means free meals, water and stardom. Accra, Ghana September 11, 2017

COLORS

A lot of research went into the work prior to visiting the locations photographed along with a reflexive understanding of color. The understanding of color greatly differs in urban, rustic, rural and cultural settings (MacLaury, 2005). I had an idea of what I would be documenting but because of the remoteness of these locations I did not have a lot of information to work with, but this would evolve. I would be using my time with the subjects to observe and document my subjects. I had a deliberate use of color for each of my subjects. Beside each one of the images listed above is a color palette created by Adobe Color similar to those prior to my travels. The color palettes represent the main themes from each image. I wanted to use brown in many of these images as brown generally represents earth, warmth, exotic, simplicity and agricultural roots. For figure 3 and 4 this was important as their culture, lifestyle and animistic beliefs are based on their agricultural roots. Figure 5 is an image that was spontaneous and only lasted for approximately 1 minute as I was walking through the jungle. The young hunter came out of the woods and was surprised to see us but allowed me to take one image before he moved on. I wanted to use the green to isolate the subject with a bit of the blue sky to be seen. While blue is often used to denote space, distance and natural environment having the blue sky being wrapped by the green foliage and the blue of the subject's clothing surrounded by green I wanted the feeling of remoteness and having a slight claustrophobic feeling. Figure 6, brown reflects the coarseness of the ground and used to contrast the red and yellow in the image. I wanted color to play the psychological component for emotions. The red to show the fast pace and have the heart beating fast representing the intensity of the training. The warmth of yellow to represent the hope and challenges these players are facing. Since photographing these subjects 4 of players have passed away from their illnesses while other players have managed to stop street begging. I aimed to use warm colors as these colors tend to come towards us (Woodman, 2018) which represents the movement of the game. It is important to note that the colors are true to the location. This is key to avoid 'local color' as discussed by Hawkins (2008) where international magazines blurred the boundaries between "local" and "exotic" color to help sell issues of 'mysterious' cultures.

CONCLUSION

It is important as a visual ethnographer to capture images which truly reflect the societies studied. The Konyak tribes of Long Wa are still suffering from texts such as The Naked Nagas (von Furer-Haimendorf, 1939). Part of documenting these cultures is the accuracy of color. As William Eggleston said "The world is in color. And there's nothing we can do about it" (Mensel, 2018) Visual ethnographers displaying their work will be for public dissemination reaching beyond the academic community. Images displayed will have a finite lifespan and we use up a portion of an artwork each time is it exhibited (Kennedy, Reiss, Sanderson, 2016). It is up to the visual ethnographer to maintain color standards to ensure the original meaning is not altered.

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BETTER COLOR, BETTER CITY: SHANGHAI URBAN COLOR SURVEY AND ANALYZING

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ABSTRACT

Urban color is an important carrier of urban characteristics and urban spirit. Although Shanghai is known as the international exhibition of architecture and also has many excellent modern historical buildings, researches on urban color has not been paid some attention. With the approval and implementation of the Shanghai Urban Planning (2017-2035), urban color is on the way of paying an important part of a beautiful city. Funded by the Key Decision-making and Consultation Project of Shanghai government, the research is to line out the urban color structure based on multi-cases' study on urban color management ways. Based on the analysis of historical building colors, modern landmark colors, natural environment colors and humanistic color of Shanghai, the research is to propose the overall color image, target positioning, and spatial structure. Combined with the old city and community regeneration, this research is to set up the planning strategy and policy suggestions to build better urban color environment.

INTRODUCTION

Color is the identification element of urban style, an important carrier for expressing urban character and spirit, and a key link for making cities more attractive and temperature-sensitive. Promoting urban color planning and refined management research to create a fascinating urban form is of great significance to improving the environmental quality and competitiveness of Shanghai's cities. In order to find out the development status and problems of Shanghai's urban color, the research group conducted a 68-day on-the-spot investigation and wrote 208 research logs. The survey covered all regions outside the Shanghai Overseas Loop and key areas outside the outer ring, completed 1515 citizen satisfaction questionnaires, held 15 expert interviews and demonstration meetings, and found that the lack of planning management in Shanghai led to the lack of characteristics of urban color and lack of order in spatial distribution. The lack of highlights in important areas and the lack of basis for color management. To this end, the research put forward suggestions.

RELATED INFORMATIONS

The 18th National Congress of the Communist Party of China put forward the concept of "beautiful China" and emphasized that the construction of ecological civilization should be placed in a prominent position and integrated into all aspects and processes of economic construction, political construction, cultural construction, and social construction. At the Fifth Plenary Session of the 18th CPC Central Committee held in October 2015, "Beautiful China" was included in the "13th Five-Year Plan". On October 18, 2017, President Xi Jinping pointed out in the report of the 19th National Congress to accelerate the step of building beautiful China.[1]

On January 3, 2018, Li Qiang, President of the Shanghai Municipal Party Committee, said in the investigation of the Municipal Bureau of Urban Planning that Shanghai should “continue to deepen the refinement of special plans and carry out in-depth research and advancement on urban design, urban color and advantageous industries”; On the 15th of the "Shanghai Urban Master Plan 2017-2035" implementation mobilization meeting, Li Qiang raised the color of the city. Two weeks later, at the implementation mobilization meeting, Li Qiang further explained why he would pay attention to and raise this issue.[2] The Shanghai Urban Master Plan (2017-2035) proposes to lead Shanghai into a remarkable global city, a city of innovation, a city of humanities, an ecological city, a socialist modern international metropolis with world influence.[3]

In fact, since March 2000, the Beijing Municipal Government promulgated the “Regulations on the Maintenance and Maintenance of Building Facades in Beijing” (Beijing Municipal People’s Government Order No. 56), proposing that “the main color of the facades of Beijing urban buildings is mainly adopted. Since the color of the gray tone is used to create a stable, atmospheric and elegant urban environment, many cities have carried out related research and planning practices.[4] With the rapid increase in urban construction across the country, the necessity of urban color planning has become more and more recognized, and its research has been carried out in many cities. On the one hand, everyone recognizes the necessity and importance of urban color planning. On the other hand, in terms of planning methods, it has also begun to expand from the concept of simply emphasizing the main color in the early days, considering the color setting of different divisions.

From a global perspective, the practice of urban color innovation and management is on the rise. For example, in June 2009, the White Roof Movement initiated by US Secretary of Energy Zhu Diwen helped American families achieve energy savings of 75% during the implementation period, responding to global warming and receiving strong response and promotion in the United States.[5] Edi Rama, the current Prime Minister of Albania, used the color to change the city's rundown and depression during the period of 2000-2011 as the mayor of Tirana, and he promoted the number of tourists to increase by 10% every year. He was also elected as the beautification project of "The best mayor in the world in 2004."[6]

SITE SURVEY AND INVESTIGATION

The results of the team's satisfaction questionnaire show that, overall, in the overall image of urban color in Shanghai, 11.66% of respondents think it is very good; 77.53% think it is good, and only 10.81% think it is average. Very good and good ratios add up to nearly 90%. However, in terms of overall satisfaction with the quality of Shanghai's urban color environment, only 3.30% are satisfied, 55.90% think it is more satisfactory, 39.72% think it is average, and 0.69% think it is less satisfied. The comparison shows that the sum of the satisfied and satisfied ratios is close to 60%, which is 30% worse than the overall good image of the previous color and 90%. In general, this option increases by nearly 10 percentage point. This also reflects that although the overall image of Shanghai's urban color is good, the satisfaction of the people is not particularly high.

Affected by the color of historical buildings, the light color is the main color of the building facade within the Shanghai Overseas Ring. Among them, light yellow and beige are mostly used. Light yellow is bright and clean, and the overall effect is good. The renovation of old residential districts is mainly light yellow, yellow, light pink, pink and gray. A few buildings are mainly blue and green. After 2000, the newly built communities are mainly light brown, light red brick, light yellow and light red paint. There are maroon and red in between.

Take a detailed analysis within the inner ring as an example. The interior of the inner ring is very rich in color, and the five major colors are distributed. Relatively speaking, the yellow color and the red color are the most popular, the blue color is the second, the neutral color is less, and the green color is the least.

The spatial distribution of the architectural colors within the inner ring is generally very fragmented and the tendency to fragmentation is very obvious. In the important node areas, the color tendency of most nodes is not clear enough, and there is no contrast or echo relationship with the architectural colors of the surrounding areas. The important riverside interface is only the Puxi section of the Bund. The color is more uniform and the coordination is better. The colors of other sections are more chaotic, without order and characteristics, and lack of effective guidance. The areas along the inner ring elevated road, the north-south elevated, and the Yanan road elevated are more chaotic and lack space order. In ordinary areas, the overall situation is relatively chaotic, but in a small number of local areas, there is a more obvious color tendency, and the color base has not yet formed.

Evaluation of good or better architectural color, generally has several characteristics, such as, the form is simple, clean, complete; the color is comfortable and bright or stable; it is consistent with the surrounding environment and function.

ORAL SESSION

CONCLUSION

1. Shanghai lacks an overall urban color space structure, with prominent colors and fragmentation. Although the pale yellow and light red paints used in the outer walls of the Shanghai residential area have partially revealed the prototype of the urban color base, the pale yellow stone of the Bund Riverside building interface, the dark blue glass curtain wall of Lujiazui, and the south side of Pudong Century Avenue. The continuous glass curtain wall interface also forms a more obvious color axis or node, but the overall color space structure of Shanghai is not clear, and the urban color of important landscape nodes, corridors, riverfront interfaces, and external windows lacks features and details.

2. The existing style planning pays insufficient attention to the traditional color context, and the color context has not been effectively passed down and valued. It lacks obvious color base and lacks exciting and great color works with sufficient influence in the world.

3. The lack of maintenance management regulations and the lack of subsequent color maintenance have led to the detachment of exterior paints and the smudges of tile smudges. The advertisement shop, night lighting and other colors are disorderly. Although Shanghai is carrying out the "five violations" rectification and the "three beauty" construction, due to the lack of a unified overall planning in the early stage, the lack of a sound maintenance management system in the later period, the implementation effect is not guaranteed.

SUGGESTION

Due to the accumulation of history and the color preferences of the citizens, Shanghai's urban color has a unique personality and characteristics, with a strong color and development potential. It is recommended to fully consider the Shanghai residents' preference for warm and bright colors and the current warm and vibrant urban color, to ensure the order and logical relationship of color, to form a clear and affirmative color base of the city, and to be based on the goal of “excellent global cities”. Encourage the emergence of great color works, with the "global color capital" as the target of Shanghai's urban color construction, with "warm, bright, modern and fashionable" as the Shanghai city color image brand. The specific recommendations are as follows:

1. Implement color refinement management to ensure the goal of urban color creation.

a,In the historical and surrounding areas, an architectural color history information archive database, a historical architectural color map, and a rigorous color restoration system based on the results of stratified generation detection are established, and the color management strategy of the historical style area and its surrounding landscape control coordination area is clarified.

b,Key areas such as the central activity area, urban sub-centers, regional centers, important waterfront areas, important transportation hubs and corridor areas, etc., prepare special plans for color, highlighting the characteristics, highlights and urban spirit. The key areas are divided into two levels: municipal-level key points and district-level key points, which are prepared by the Municipal Planning Bureau and compiled by the district planning bureaus.

c,In addition to historical areas and key areas, the color guidelines for different types of areas are introduced. The color of the general area is an important part of the foundation of the city's color. It requires a very strict and clear control strategy, including clear color planning, modular color scheme, strict control regulations, clear reward and punishment system, regular inspection and Corrective, timely feedback and program adjustments to form a clear urban color base in the short term.

d,The color management and control strategies of different administrative divisions, combined with relevant planning, have legal effects. It is recommended to combine the overall planning of the various districts in Shanghai to increase the overall planning of urban color and legalize urban color planning. Systematic management of all levels of general regulations, control regulations, revisions, and color design in various administrative districts.

e,The color of the country is based on the positioning of "Jiangnan Water Town, Bean Shed Melon Frame", which continues and creates the nostalgic style of Xiaoqingwa, powder wall, farmhouse, bean shed, and flowers around the wall, creating a completely different color from the town. The traditional Jiangnan water town color style.

2. Bring together the strengths of all departments to compile a series of special color plans to create excellent quality and color highlights.

First, strictly control all aspects to ensure the implementation of color planning. The Municipal Bureau of Land and Resources and the Municipal Housing and Construction Committee are responsible for strengthening the control of architectural colors and environmental colors in the planning and design of new buildings, land transfer, project approval, and completion acceptance, to ensure the implementation of color planning.

The second is to develop a strict external wall cleaning and painting system. Led by the Municipal Greening and Municipal Affairs Bureau, the Municipal Housing Management Bureau will cooperate to formulate relevant regulations for the cleaning and maintenance of the exterior wall of the building, and strengthen the color control of the existing building renovation and exterior flour decoration.

The third is to prepare special plans and implementation plans for outdoor advertising stores, and correspondingly increase the content and control requirements of color design.

The fourth is to compile other special plans such as the city's lighting color special plan, the city's plant color special plan.

3. Establish effective implementation safeguards

The relevant administrative departments of district planning, land, construction, housing, city appearance, greening, transportation, etc. shall establish a unified planning and coordinated color planning management framework. All districts and streets (towns) combine the whole district or street (town) with the construction of Sanmei, formulate a plan for color remediation in the near-term, improve the ability of first-line management and law enforcement supervision, and ensure the effectiveness of urban color management.

At the same time, public participation will be strengthened to promote bottom-up management. Encourage the public, enterprises, community planners and other participants to implement sharing and co-governance in the process of color planning, project publicity, construction and implementation, and maintenance supervision; and organize a multi-disciplinary team of color experts. In the expert committee of the Shanghai Municipal Planning Commission, we have added well-known experts and scholars in the industries of color planning, color design, lighting color, etc., through the whole process of urban color-related planning review, urban design program review, construction project plan review, and post-maintenance management. provide technical support.

4. Encourage a comprehensive color education system to enhance the level of color understanding, appreciation and design of the whole people.

The first is to establish a professional education and training institution for urban color. It is recommended that the Municipal Education Commission take the lead and cooperate with the Municipal Bureau of Culture and Media to establish cooperation with internationally renowned color design education institutions to promote the development of color education and training institutions and enhance the overall aesthetic and creative capabilities of the city. The second is to establish a related research institution for Shanghai city color. It is recommended that the Municipal Science and Technology Commission take the lead in setting up the Shanghai Urban Color Research Center to apply big data, artificial intelligence, psychology, optics, imaging, archaeology and other fields to the creation of urban colors. At the same time, hold high-end color academic forums and The color design competition will enhance international influence.

5. Increase policy support for the color industry

Lead by the Municipal Development and Reform Commission, increase policy support for the color industry, encourage color-related industries, cooperate with internationally renowned research institutions and enterprises, such as AIC, IACC, NCS, Muscles, etc., expand the color industry chain, and introduce industries that encourage color design. The development of the incubation mechanism supports the formation of a color industry cluster, with the joint efforts of all parties to achieve urban color taste and overall color environment improvement.

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INFLUENCE OF THE DIFFERENCE BETWEEN PLANER ILLUSTRATION EXPRESSION AND VR EXPRESSION ON THE PREFERENCE OF INTERIOR COLOR DESIGN

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Keywords: interior, design, preference, VR, preference

ABSTRACT

The color design of the interior design targeting young women is discussed. Authors have investigated the color design of interior of cafe and living / dining room. It was revealed that a sense of calmness is required in both spaces. Furthermore, interior that used vivid color scheme was found to be hard to be preferred as cafe and living / dining room. In recent years customers have become able to choose interior design with Virtual Reality (hereinafter referred to as VR) rather than photos or illustrations. So, we will clarify the difference in the preference of the color design of the interior between the case of seeing by the planar illustration and the case of seeing by the VR.

INTRODUCTION

There are various services that using Virtual Reality (This is denoted as “VR” below). For example, computer games and appreciations of arts that using VR are well known. This research is intended to apply VR to the user’s choice of interior color design.

Until recently, users have chosen rental rooms by photos or illustrations of leaflets and web sites generally. However, recent users began to be able to use VR at home using smartphones. And they started to look for apartments and rental houses using VR. VR services have the following advents for users.

- Can save a time and money to go out.
- It helps someone who can not go out.
- User can easily see a lot of interior samples.
-

Thus such as VR services will become increasingly popular in the future.

But there’s a possibility that the user’s feeling may be signify differ between pictures and VR. Color has “Area effect”. The color is felt more vividly when seeing it in a larger area than a small area. Furthermore, when expressing space with VR it is felt more stereoscopic than photos and pictures. Then such as differences between expression of VR and pictures may affect user’s impressions of the interior design. Therefore, difference between flat interior expression and VR interior expression is verified to this research.

PREVIOUS RESEARCH

The interiors of café are popular among relatively young women in their 20s to 30s in Japan. They coordinate their interior of the house or the room with reference to the design of café.

The authors have been researching about similarity between café interiors and living / dining room's interiors. So the cafes and living / dining rooms are used for experimental stimulus used in this research. Kobayashi researched café interior and furniture color preferred by young people in their twenties [1]. And they revealed young people prefer 5Y to 5YR hue colors interior. So, the colors they have 1.25 YR hue are mainly used in the experiment of this research.

COLOR DESIGN FOR INTERIOR

Combining multiple colors can represent more complex impressions than mono color. So color used for interior is a combination of multiple colors. Generally at least about three colors are used for interior design. There are divided into 3types "Base color", "Main color" and "Accent color".
The table 1 shows interior color's features. We prepared 14 experimental stimuli based on 6 coloring method. The table 2 shows the colors used for the experimental stimuli. These values are expressed in the Munsell color system The 6 kinds of coloring methods are as follows.

- The color schema using multiple tones : Use colors of various tones (condition 1, 2).
- The color schema using Separation : Use multiple hues for accent (condition 3, 4).
- The color schema multiple hues : Combine colors of different hues (condition 5, 6).
- The color scheme with clear color : Use white, black or bright colors (condition 7, 8).
- The color scheme using muddy color : Use gray or gray mixed colors (condition 9, 10).
- The color scheme using gradation : Use colors to become a gradient (condition 11, 12, 13, 14).

Table.1 Interior color features

	Base color	Main color	Accent color
itemas	wall, floor, ceiling	furnitures, curtain	accessory, cushion
breadth the area	70%	25%	5%
length of period of use	long	middle	short
good point for color selection	A basic color is good for users not to get bored.	Color to be the center of the interior design.	It can easily be changed. It may be a unique color.

Table.2 Colors used for experimental stimuli.

	wallpaper			carpet			sofa			cushion-1			cushion-2			curtain		
	Hue	Lightness	Choroma	Hue	Lightness	Choroma	Hue	Lightness	Choroma	Hue	Lightness	Choroma	Hue	Lightness	Choroma	Hue	Lightness	Choroma
coloration1	1.25YR	8.90	1.00	1.25YR	1.70	1.50	1.25YR	3.70	5.50	1.25YR	6.70	7.00	1.25YR	6.00	15.00	1.25YR	7.50	3.50
coloration2	1.25YR	3.70	5.50	1.25YR	1.70	1.50	1.25YR	8.90	1.00	1.25YR	6.00	15.00	1.25YR	6.70	7.00	1.25YR	7.50	3.50
coloration3	1.25YR	8.20	6.00	1.25YR	2.70	3.00	1.25YR	6.70	7.00	5BG	7.50	7.00	1.25YR	8.20	6.00	5BG	7.50	7.00
coloration4	1.25YR	2.70	3.00	5BG	8.00	6.00	1.25YR	6.70	7.00	1.25YR	8.20	6.00	5BG	7.50	7.00	1.25YR	6.70	7.00
coloration5	5.00YR	8.20	6.00	5BG	8.00	6.00	5Y	9.00	6.00	5BG	8.00	6.00	5Y	9.00	6.00	5Y	9.00	6.00
coloration6	1.25YR	5.50	12.50	5BG	5.50	9.00	5Y	8.00	11.00	5BG	5.50	9.00	1.25YR	6.00	15.00	5Y	8.00	11.00
coloration7	N	9.50	0.00	1.25YR	8.90	1.00	5.00YR	8.20	6.00	N	9.50	0.00	1.25YR	6.00	15.00	5YR	8.20	6.00
coloration8	N	9.50	0.00	1.25YR	8.90	1.00	5.00YR	8.20	6.00	N	1.00	0.00	1.25YR	6.00	15.00	5YR	8.20	6.00
coloration9	1.25YR	8.80	3.00	1.25YR	2.70	3.00	1.25YR	5.40	3.50	1.25YR	3.70	5.50	1.25YR	3.80	3.50	1.25YR	7.50	3.50
coloration10	1.25YR	2.70	3.00	1.25YR	7.50	3.50	1.25YR	5.40	3.50	1.25YR	3.80	3.50	1.25YR	3.70	5.50	1.25YR	7.50	3.50
coloration11	1.25YR	8.20	6.00	1.25YR	2.70	3.00	1.25YR	6.70	7.00	1.25YR	3.70	5.50	1.25YR	8.20	6.00	1.25YR	6.70	7.00
coloration12	1.25YR	2.70	3.00	1.25YR	8.20	6.00	1.25YR	6.70	7.00	1.25YR	8.20	6.00	1.25YR	3.70	5.50	1.25YR	6.70	7.00
coloration13	1.25YR	5.40	3.50	1.25YR	1.70	1.50	1.25YR	5.60	1.20	1.25YR	1.70	1.50	1.25YR	8.00	1.20	1.25YR	5.60	1.20
coloration14	1.25YR	1.70	1.50	1.25YR	5.40	3.50	1.25YR	5.60	1.20	1.25YR	8.00	1.20	1.25YR	1.70	1.50	1.25YR	5.60	1.20

VR TECHNOLOGY

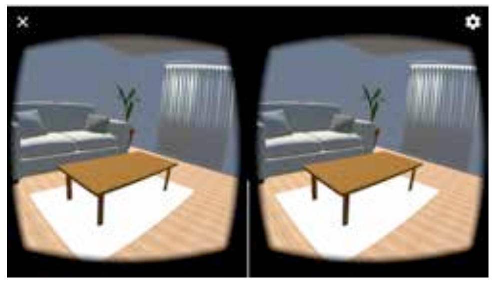

Fig.1 Image of sight seen by VR using a smartphone

VR is a technology for conveying information constituted by computers so as to stimulate human senses. By doing so, VR creates a virtual space between people and computers. Several studies on the impression that people receive from VR space have been done. Yoshizawa examined whether the size and reality of VR's space can be felt by people as well as real space [2]. They projected a VR on a screen with a weight of 2000 and a height of 2667mm in the experiment. But generally such screen is not owned by many people. So we use VR which can be seen with smartphone. VR

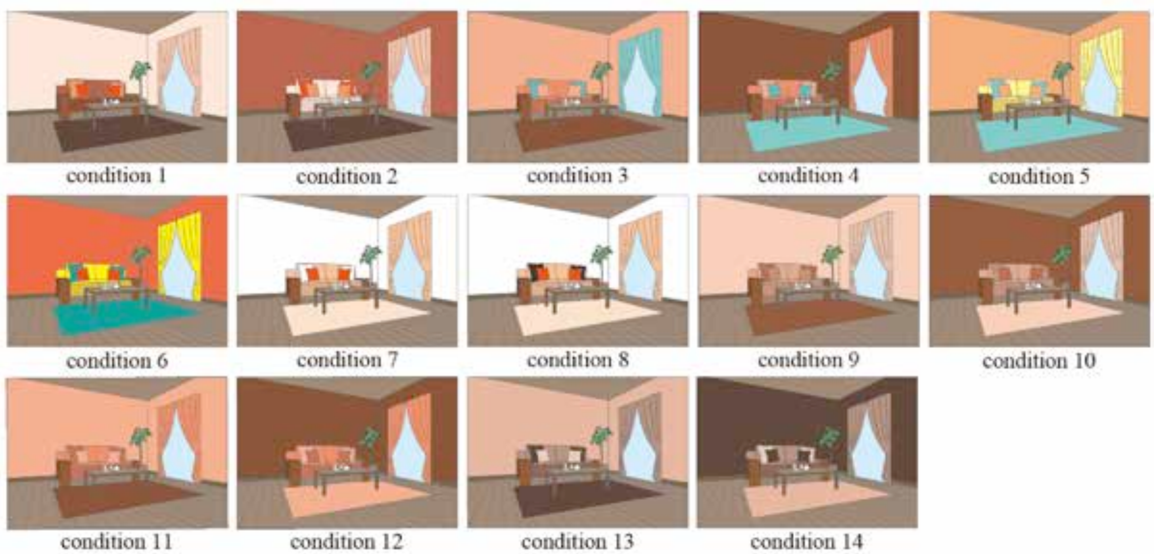

Fig.2 The experimental stimuli of illustration

Fig.3 experimental stimuli of VR

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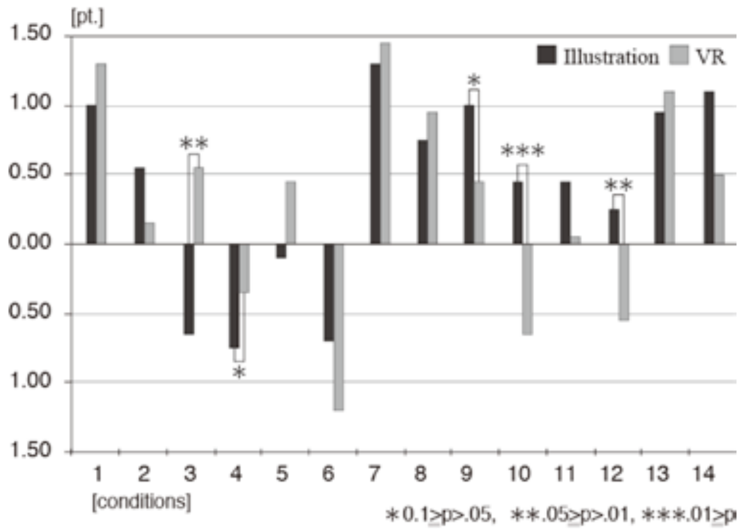

Fig.4 Result of the experiment

using smartphone can be easily seen everywhere. The stimuli of VR used for the experiment are made with Unity [3].

EXPERIMENTAL METHOD TO EVALUATE INTERIOR ILLUSTRATIONS

In the experiment, subjects evaluated the preference by watching at illustrations that printed out the interior color design of 14 experimental stimuli. The subjects evaluated the preferences of 14 stimuli that printed out on an A3 paper. The evaluation method was seven stage of SD method.

The subjects were 20 female college students aged 18 to 20 (The average age is 18.7 years old. standard deviation : 0.714). Fig.2 shows illustrations that are experimental stimuli.

EXPERIMENTAL METHOD TO EVALUATE INTERIORS WITH VR

In other days, the subjects evaluated 14 experimental stimuli of VR and evaluated their preference. Fig.3 shows 14 VR stimuli. The brightness of the interior lightning set 3000 Kelvins. The subjects of this experiment and the previous experiment were the same. The order of 14 experimental stimuli in VR was changed at random for each subject. Seven stages of SD method was used for evaluation. In the case of using a tone color scheme using a bright color on the wall surface, the evaluation was the highest in both the illustration and the VR.

The subjects were told that the experiment could interrupted if their conditions got worse. However, none of the subjects became sick during the experiment.

RESULTS OF THE EXPERIMENTS

Fig.4 shows result of the experiment. Vertical axis is the average of preference. Horizontally axis is the conditions of the stimuli. The average of the preference for illustrations was the highest when seeing condition 7. The average of the preference for VR is the highest when seeing condition 7 also. The average of the preference are higher when seeing condition 1, 7, 8, 13 out of using other cases. On the other hand, there are significant differences between the preferences for illustrations and the preferences for VR when seeing condition 3, 4, 9, 10, 12.

The average brightness of the wallpaper color of conditions 1, 7, 8, 13 was 8.33, and the average of saturation was 1.13. The average brightness of the color of the wallpaper of conditions 3, 4, 9, 10, 12 was 5.02, and the average of saturation was 3.60. The colors of the walls of the five experimental stimuli were medium to dark. And color saturations were a bit high in each case. The preference for color stimuli using light colors on walls decreased when VR was used for evaluation.

Fig.5 Stimuli which were preferable in both cases of being seen by illustration and by VR.

Fig.6 Stimuli that had significant differences between
preference of seeing by illustration and the preference of being seen in VR.

In addition, when evaluated using VR, the value of preference for color stimuli of medium brightness of the wall is higher.

Therefore, the interior design that has moderate wallpaper brightness will be able to convey users' attractiveness to those users who look at VR rather than illustration. On the other hand, the interior design that has bright wallpaper is easy to be liked by the user even when it is shown by illustration, even when it is shown by VR. In addition, the difference between the evaluation of both is small.

CONSIDERATION

The reason why there was a difference in evaluation between VR and illustration expression was considered. Subjects preferred interior design of bright wallpaper in this experiment. Three-dimensional computer graphics expressing the brightness of the room is thought to have influenced the evaluation of the desirability. Also, when viewed by VR, it is considered that the subject felt the experiment stimulus was larger than the illustration. Since the color is felt vividly when the area is large, the impression of the subject is considered to be a difference between the VR and the illustration.

CONCLUSION

In this study, we compared the preferences of the interior design with the interior design of the illusion seen in VR. The subjects were 20 female college students aged 18 to 20. Subjects were asked to evaluate the preference that they received them by looking at the experimental stimuli of the illusions and VR. As a result, interior designs of bright wallpaper were favorably evaluated in both cases. On the other hand, there was a difference between the brightness of the wallpaper and the saturation of the medium with a high saturation, when viewed in VR and in favor of viewing in the illusion. The result of this research is expected to be applied to a system that the user searches for preferred interior using VR.

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INFLUENCE OF STRUCTURE AND COLOR PACKAGING DESIGN FOR CUSTOMER PERCEPTION IN THE CASE STUDY OF ORGANIC PRODUCTS

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Keywords: Structural Packaging, Color Design, Customer Perception, Organic Product

ABSTRACT

The appearances of a product and packaging are influencing customer perception. The packaging presents an essential mission in generating product expectation. The objective of this research is to investigate the effect of structural and color design for customer perception in a case study of lemon juice organic products. The methodology is to apply the perception mapping for Determination of customers' perception and the Analytic Hierarchy Process (AHP) for Criteria Prioritization. The research found that the different experience of participants effect on product perception. The participant group A perceives by the visible color of the product inside importantly, and group B focuses on shapes and texture more than visible colors. The priority weighting value is calculated to organize the evaluation criteria of packaging design for lemon juice products in the following order; 0.381 f Portion size 0.222 f Image 0.197 f Structure& Texture0.142 f Text 0.058. The contribution of the research is to apply to the packaging design. The designer can prioritize the customer requirement criteria and achieve consistency of comparisons between alternatives according to the judgments.

INTRODUCTION

Organic products are becoming popular among consumers who concerned about health care. The first thing customers will see product and touch is packaging. However, it is not clear whether the customer recognizes the value of the product inside. The study of how customers select organic product is a complicated decision that is measured by several criteria. The appearances of a product and packaging are influencing customer perception. The line on packaging design carries particular semiotic significance [1]. The expectation of customers depends on product experience such as price, usability, product shelf life. However, The packaging presents an essential mission in generating product expectation such as Numbers, Letters, Illustration and Picture, Symbol, Decoration, Material, Shape, and Color [2]. The objective of this research is to investigate the effect of structural and color design for customer perception in a case study of lemon juice organic products.

METHODOLOGY

Perceptual mapping [1] can be used to determine customers' perception, and appearance criteria in organic products in a case study of lemon juice product and Analytic Hierarchy Process (AHP) method [3] can be applied to prioritize criteria and evaluate the consistency of judgments. The methodology of this research consists of two parts.

Part 1 Determination of customers' perception

In this case study of lemon juice products. There are six different alternatives to packaging in shape, texture, and color. The participants randomly divided into two group; The 11 participants

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group A who experts in agricultural farm and understand the process from farm to folk. The 16 participants of Group B who do not have experience in an organic farm. The participants were instructed to complete the task on their criteria [1].

Part 2 Criteria Prioritization

Usually, there is a difference in opinion of each decision makers. The customers can decide according to their needs in product and depend on experience and expectation. They should determine the significant weight by using AHP. In this research have five experts from two agricultural farmers, one graphic design specialist, one structural packaging design, one specialized in marketing management of agriculture product development. AHP is determined by pairwise comparisons, which involves the evaluation of each criterion with all the other criteria at the given hierarchical level. Each comparison transforms into numerical value on a scale 1-9 (‘1’ means ‘equal importance’ and ‘9’ means ‘Absolutely more important’ [3]. The priority weighting value (W_i) obtain from the Eq. (1) and Eq. (2). The maximal eigenvalue (λ_{max}) calculates in Eq. (3). The evaluation of the consistency judgments calculates from the Eq. (4).

$$b_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \quad (1)$$

$$w_i = \frac{\sum_{j=1}^{n} b_{ij}}{n} \quad (2)$$

$$\lambda_{max} = \frac{1}{n}\sum_{j=1}^{n} b_{ij}\frac{(Aw)_i}{w_i} \quad (3)$$

$$\mathrm{CI} = \frac{\lambda_{max} - m}{m-1}, RI = \left(\frac{1.98(m-2)}{m}\right), CR = CI/RI, CR \le 0.1 consistency \quad (4)$$

RESULT

The objective of this research is to investigate the effect of structural and color design for customer perception in a case study of lemon juice products. The result of the determination of customers’ perception of participants group A and B shown in Figure 1.

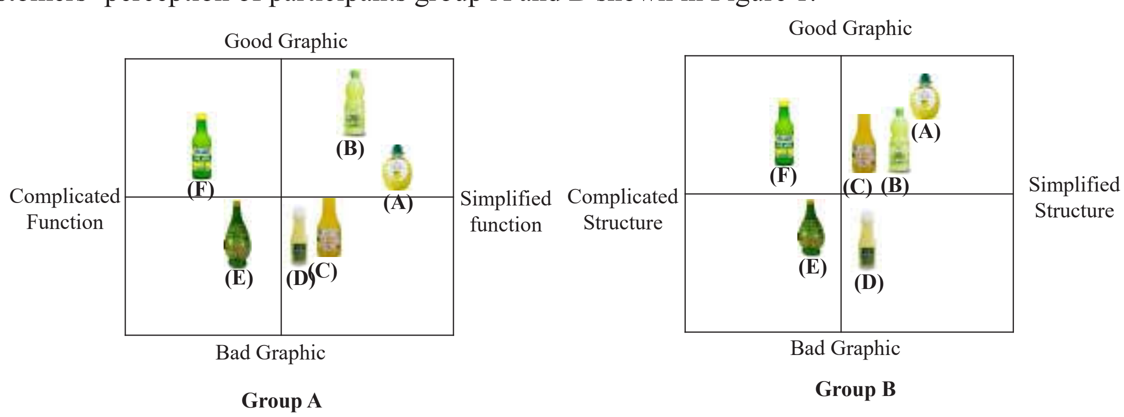

Figure 1. Perceptual mapping of lemon juice products

The participants' group A who experts in agricultural farm and understand the process from farm to folk. They selected alternative B is good graphic information and simplified function to use. They perceive product importantly by the visible color of the product inside. The participants' group B who do not have experience in an organic farm. They selected alternative A is good graphic information and simplified function to use. They focus on shapes and texture criteria before visible colors criteria. In the section of discussion with five experts and 27 participants. The essential criteria of the packaging design for customer perceptions in the case study of lemon juice product are to include Color, Portion size, Image, Structure&Texture, and Text. Then, the researcher and experts have to set the preferences of evaluation criteria. The hierarchical structure of the packaging design with six types of alternative shown in Figure 2.

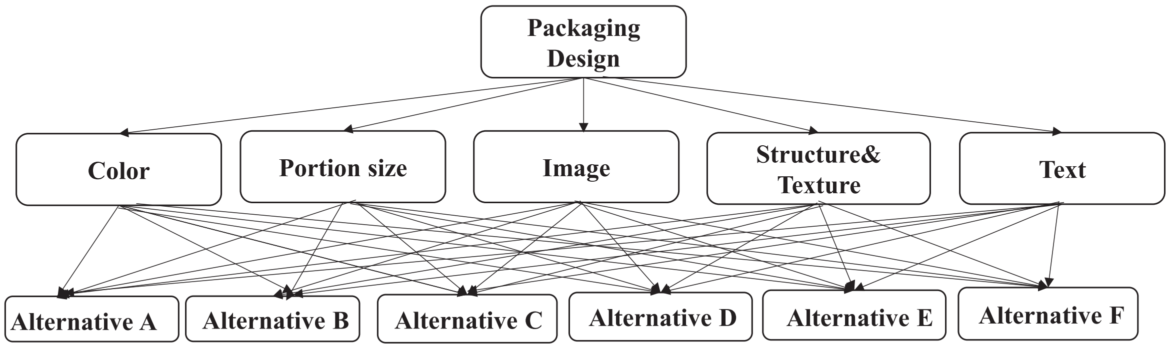

Figure 2. The hierarchical structure of the packaging design for a lemon juice product

The result of comparisons in the form of a preference matrix (A) shown in Table 1.

Table 1: The preference matrix for the evaluation criteria

Criteria	Color	Prortion size	Image	Structure & Texture	Text
Color	**1.0**	1.5	1.9	2.7	6.6
Prortion size	0.3	**1.0**	1.3	1.8	4.5
Image	0.5	0.8	**1.0**	1.4	3.4
Structure & Texture	0.4	0.5	0.7	**1.0**	2.4
Text	0.2	0.2	0.3	0.4	**1.0**
Total	2.3	4.0	5.3	7.3	17.9

The researcher and experts determine the maximal eigenvector for the criteria by using Satty's method [3]. The calculation of normalized the preference matrix shown in Table 2.

Table 2: Normalised comparison matrix

Criteria	Color	Prortion size	Image	Structure & Texture	Text	Row evarage	Priority Weighting Value
Color	0.436	0.367	0.367	0.367	0.367	0.381	0.381
Prortion size	0.109	0.250	0.250	0.250	0.250	0.222	0.222
Image	0.226	0.190	0.190	0.190	0.190	0.197	0.197
Structure & Texture	0.163	0.137	0.137	0.137	0.137	0.142	0.142
Text	0.067	0.056	0.056	0.056	0.056	0.058	0.058

The preference vector (w) is the Priority Weighing Value to determine the order of the criteria priority.

$$Aw = \begin{bmatrix} 1.0 & 1.5 & 1.9 & 2.7 & 6.6 \\ 0.3 & 1.0 & 1.3 & 1.8 & 4.5 \\ 0.5 & 0.8 & 1.0 & 1.4 & 3.4 \\ 0.4 & 0.5 & 0.7 & 1.0 & 2.4 \\ 0.2 & 0.2 & 0.3 & 0.4 & 1.0 \end{bmatrix} \begin{bmatrix} 0.381 \\ 0.222 \\ 0.197 \\ 0.142 \\ 0.058 \end{bmatrix} = \begin{bmatrix} (0.381)(1.0)+(0.222)(1.5)+(0.197)(1.9)+(0.142)(2.7)+(0.058)(6.6) \\ (0.381)(0.3)+(0.222)(1.0)+(0.197)(1.3)+(0.142)(1.8)+(0.058)(4.5) \\ (0.381)(0.5)+(0.222)(0.8)+(0.197)(1.0)+(0.142)(1.4)+(0.058)(3.4) \\ (0.381)(0.4)+(0.222)(0.5)+(0.197)(0.7)+(0.142)(1.0)+(0.058)(2.4) \\ (0.381)(0.2)+(0.222)(0.2)+(0.197)(0.3)+(0.142)(0.4)+(0.058)(1.0) \end{bmatrix} = \begin{bmatrix} 1.849 \\ 1.095 \\ 0.957 \\ 0.690 \\ 0.282 \end{bmatrix}$$

The consistency of comparison calculated the maximal eigenvalue;

$$\lambda_{max} = \sum_{i=0}^{m} \frac{x_i}{c_i} = \frac{1}{5}\left(\frac{1.849}{0.381} + \frac{1.095}{0.222} + \frac{0.957}{0.197} + \frac{0.690}{0.142} + \frac{0.282}{0.058}\right) = 5$$

$$CI = \frac{\lambda_{max} - m}{m - 1} = 0, RI = \left(\frac{1.98(5-2)}{5}\right) = 1.19, CR = 0; CR \le 0.1 consistency$$

The priority weighting value is calculated to organize the evaluation criteria of packaging design for lemon juice products in the following order;

0.381 $\succ$ Portion size 0.222 $\succ$ Image 0.197 $\succ$ Structure& Texture0.142 $\succ$ Text 0.058

DISCUSSION

The objective of this research is to investigate the effect of structural and color design for customer perception in a case study of lemon juice organic products. Customers' purchase decision was instructed to complete the task on their criteria. The expectation of customers depends on product experience. In this research of perception mapping, the different experience of participants effect on product perception. The participant group A perceives by the visible color of the product inside importantly. The participant group B focuses on shapes and texture more than visible colors. In term of purchasing decision, the customers are different opinion and criteria depending on experience and expectation. The prioritized criteria determine by using AHP. This method is significant weight and checks the consistency of comparison. The contribution of the research is to apply to the packaging design. The designer can prioritize the customer requirement criteria and achieve consistency of comparisons between alternatives according to the judgments.

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THE INFLUENCE OF HDR IMAGE ON SATISFACTION OF VIRTUAL REALITY (VR.) TO PROMOTE TOURISM IN NAKHON NAYOK PROVINCE)

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Keywords: Virtual Reality (VR), Virtual Environment (VE), High Dynamic Range (HDR)

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ABSTRACT

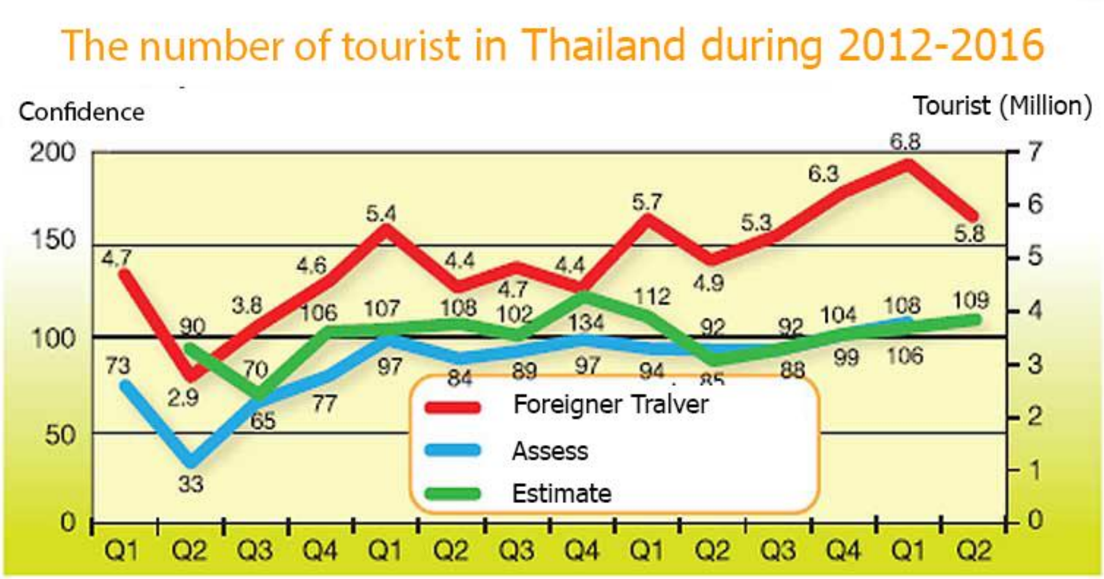
The Virtual Reality Technology (VR) has interesting in the world of entertainment media for example VR Game, VR Movie, and also VR Tour. Therefore this research aim to create VR Tour to promote tourism in Nakhon Nayok province In addition to investigate the influence of HDR image to satisfaction of traveler. The sample group are 40 tourist who come to visit famous place in Nakhon Nayok province and 30 local people who are the tourism owner or authorities. The VR has create by taking spherical panorama image (360x180 degree field of view) with multiple exposure technique (+2 EV, 0EV,-2EV) and merge in to HDR image and create the VR tour. The VR tour can view by use VR Headset or VR glasses and also view on desktop computer. The research tool are online and offline questionnaire to collected data. The result found that the opinions of tourist indicated the VR tour can simulate climate and feeling similar the real world (4.65, S.D 0.42) and the image is beautiful more than real world. (4.53, S.D 0.42) In addition the VR is useful technology for traveler because they can determine whether to go or not. The opinions of people in the area show that VR is efficiency channel to promote tourism (4.68, S.D 0.48) but they inadequate knowledge and equipment to create the VR by themselves although training provide. (3.55, S.D 0.55) However they recommend there are many factor effect to determining to travel example climate, economy, season, activity so the number of traveler does not depend on VR.

INTRODUCTION

The 21 century the mobile device like a smart phone and tablet are widely use in the life style of people so the strategy marketing has change on smart device channel. The advertise campaign are trying to deliver real-life experiences to users more than only on the display for example VR game, VR advertising, and also VR Tour. The advantage of VR technology is user can view the virtual world 360 degree with high quality image video and sound to increase the emotion similar the real would. The Virtual Reality Technology (VR) has interesting in the world of entertainment media to day.

Figures 1. VR Game (L.) VR Tour (R.)

Now a day Thailand government has driven innovation, technology and creativity to promote and support business sector use digital technology and innovation adding value to product and service especially tourism industry. The number of tourists is likely to increase. (The information by National Tourism Development 2012-2016)



Figures 2. The confidence of Thailand tourism during 2012-2016

Nakhon Nayok province is a famous city for traveler because many popular place example The Khun Dan Prakan Chon Dam, The Ganesha Park, The Bucha Buddhist memorial park

Therefore this research aim to create VR Tour to promote tourism in Nakhon Nayok province and share know ledge of VR to local people. In addition to investigate the influence of HDR image to satisfaction of traveler.

The research objective are 1.) Create VR Tour to promote tourism in Nakhon Nayok province. 2.) Study influence of HDR image VR Tour to satisfaction of viewer. 3.) Study the opinion of traveler to VR Tour. and 4.) Study the opinion of local people who are the tourism owner or authorities to VR Tour.

The research hypothesis are 1.) The VR influence to number of tourist 2.) Tourists have a positive opinion of the virtual reality system developed. 3.) Local people have a positive opinion of the virtual reality system developed.

The research methodology is one-shot case study

$$X \longrightarrow O$$

X : Independent variable (VR Tour with HDR Image)

O : Dependent variable (Satisfaction/Opinion of Viewer)

The sampling group consist 2 group 1.) Traveler who come to visit in The Khun Dan Prakan Chon Dam, Ganesha Park, and Bucha Buddhist memorial park and 2.) local people who are the tourism owner or tourism authorities.

The Research tool used consisted 1.VR Tour 2. Questionnaire (Off line) to collection data on field and 3. Online Questionnaire to collection data viewer on the web after they watch the VR tour

The VR Tour has create by taking spherical panorama image (360 x180 degree field of view) with multi row 30 degree, 0 degree, -30 degree and each image taken with multiple exposure technique (+2 EV, 0EV,-2EV) as figures show

Figures 3. Camera angle of multi row panorama technique

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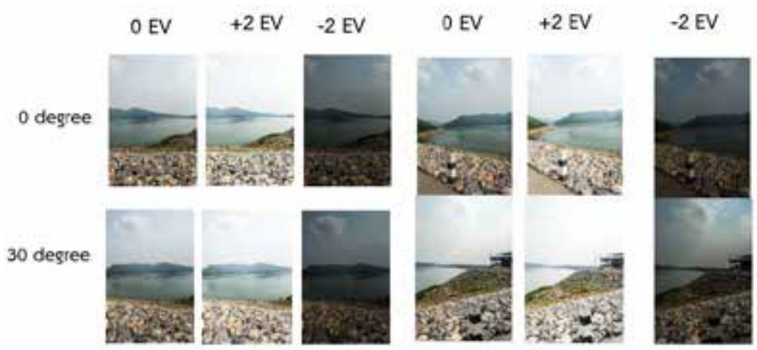
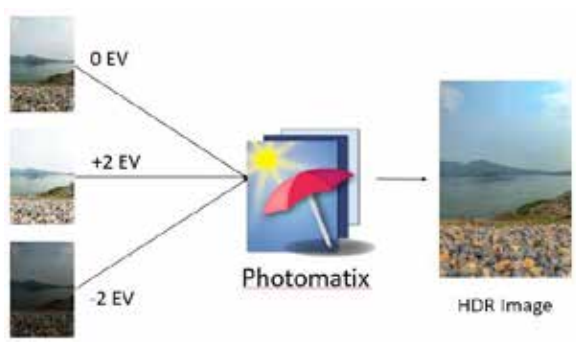


Figures 4. Multi exposure taking photo technique

After take a photo in multi exposure and multi row a number of image should be 130-140 image depend on angle view of lens. All image has merged in to HDR image by Photomatix Pro software, the HDR photo contain wider range of luminance to that experienced through the human visual



Figures 5. Merging image to HDR with Photomatix Pro software

The HDR image has import to Lightroom software to enhance color such as exposure, white balance, sharpness, contrast, highlight, shadow etc to make a beautiful image. Then import to Pano2QTVR software to convert spherical panorama image to cubic panorama image. The cubic panorama contain 6 cubic face front, back, right, left, top, down, to simulate the cubic world. This step the image has filled black hole at the above and below of image and convert back to spherical panorama it is the final step

Figures 6. Final HDR spherical panorama image

to create the VR tour researcher use the Panotour Pro software to make the VR system in the VR consist the 50 scene of famous tourism place in Nakhon Nayok province to link each scene to VR tour. Traveler can view VR tour by use VR Headset or VR glasses and also view on desktop computer simulate viewer in the real world.

Figures 7. VR Tour

The data analysis used average and Standard Deviation : S.D

$$\bar{x} = \frac{\sum X}{n}$$

$$SD = S = \sqrt{\frac{\sum_{i=1}^{N}(X_i - \bar{X})^2}{N}}$$

Figures 8. Research Statistics Average and Standard Deviation

After sample group view VR tour they answer questionnaire to collect data and analyzed. The result are the opinions of tourist indicated that VR can simulate climate and feeling similar the real world (4.65, S.D 0.42) and the image is beautiful more than real situation. (4.53, S.D 0.42) In addition they think VR is useful technology for traveler because they can determine whether to go or not.

Table 1: The opinion of sample group to VR tour

List of Question	) $\bar{x}$)	) S.D.(
The VR gives a realistic feel.	4.53	0.44
The VR can provide information about a location.	3.44	0.58
The HDR 360 degree image view is beautiful.	4.48	0.35
The sound of the atmosphere is appropriate.	4.05	0.65
Link to location point is appropriate	4.35	0.77
The VR makes you wish to go to a real place.	3.58	0.43
Design buttons, symbols are easy to understand.	4.23	0.33
The VR makes you understand the atmosphere of the place well.	4.65	0.42

Table 2: The oppinion of local people or tourism authorities to VR tour

Question	) $\bar{x}$)	) S.D.(
The VR is attractive to tourists.	4.42	0.33
The VR can present the atmosphere of the place.	4.68	0.48
The VR can be alternative media to promote	4.02	0.43
The VR make a number of tourist increase	3.44	0.53
The people in the tourist location has benefited from VR.	3.25	0.75
If training provide for you. What level of interest do you have?	3.84	0.63
If the VR has developed for the tourist or community. What level of interest do you have?	3.55	0.55

The opinions of people in the area show that VR is efficiency channel to promote tourism (4.68, S.D 0.48) but they inadequate knowledge and equipment to create the VR by themselves although training provide. (3.55, S.D 0.55) However they recommend there are many factor effect to determining to travel example climate, economy, season, activity so the number of traveler does not depend on VR.

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THE STUDY OF THE VISUAL ELEMENTS IN WAT PHUMIN MURAL PAINTING

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ABSTRACT

The study of the visual elements in Wat Phumin mural painting have 2 objectives which are ; 1.to study and analyse the visual elements in the mural painting of Wat Phumin 2. to find out the art identity of mural painting of the local artist of Wat Phumin. The combined research conjoining of documentary study and filed trip study was used in order to get the information. This research found that ; 1. The visual elements are clear and naive,in line,dot,shape,form,texture,color,value, and space, the line is clear and the shape and form are new creation by the local artisan such as various human figure, animal,tree,architecture ,the ship ,the weapon,etc., the contour is obviously and the use of linear perspective and aerial perspective,illusional dimension by the local artisan is also appeared in Wat Phumin,which are the characteristic of the mural painting in Bangkok at the same era by the reign of King Rama IV. 2. The other visual elements such as the space are full of figures that contain the story of the Buddha Jataka in the local environment,daily life and activities of local people such as weaving,hanging out ,hair dressing, smoking,communicating,sewing,carrying the water , and some scene the foreigners are appeared ,etc. the artisan designed the shape and form in big size , men and women are appeared in beautiful posture and obvious emotions ,the artisan mostly provided the tattoo on the man skin ,the clothes in the mural painting of men and women are different,and using native pattern which are significant in Nan province, while the line and contour of the figures are vividly appeared.The variety of the textures and details are the local creative which are understandable and outstanding , however, the artists were able to make the best use out of the limited colors to create their works and give the details by using the local art elements and give the Lanna style or identity as well in expression.

INTRODUCTION

The case study of the visual elements is in the ordination hall of Wat Phumin, Nan Province that located in Northern region of Thailand, one of the most complete and beautiful mural painting, focuses on the wisdom that portrays Buddhism with faith and local aesthetics through mural painting. (Wyatt 1989). Here,the artisan has placed the story of Buddhism on the top of the four walls, demonstrating the faith and respect for Buddhism. The story of Khantakumar to the end.

In addition to the beauty of the painting, the artist has incorporated the essence of Lanna characters and reflects the way of life of the Nan people as well as the important events of the late Nan ruler.The mural exploration begins from the north wall, which is the entrance gate. Then keep watching on the right direction to complete the four walls. To study and analyse the visual elements in the mural painting of Wat Phumin, the researcher devided into basic art elements which are ; dot,line,shape,form,texture,value,rhythm and space.

With the visual elements that coincide with the 4 porticos building is a very challenging task for the painter. There are four sides wall by 4 direction of the porticos and eight side walls that require the ability to design and plan the mural. The murals painting of Wat Phumin make the study. All can see the distinctive features of the episode. In one wall, there is a picture of Buddhism, history, images, allegories and everyday life. By the painter. The composition of the Buddhist image on the top followed by the image of the allegory. And the last part is Daily life scene on the bottom of the wall ,some walls are flexible in duration. Rhythm of the line and color are also found repeatedly such as straight lines , curvy line ,the black and red color of the clothes along the scene. The continuity of the episode and the aesthetics of the beautiful visual elements.(Figure A1-A4)

Figure A

Dot: The dots in the mural painting of Wat Phumin are used in some particular positions to create a texture or surface such as a spot on a leopard,a dot pattern on the skin of a serpent, and a dot on the skin of a white elephant. The dot creation can paint with a small size to the bigger size of the brush and freehand dot ,according to the mural painting,there can show many type of paint brush such as in the animal skin,floor texture,plants and tree,etc. Big and small dots are well created to show the texture.

Line: The painters use a variety of lines to draw murals: straight lines, lines, horizontal lines, diagonal lines, wavy lines, and many lines that sometimes it portray emotion of lines. The borders are clear, Like traditional Thai painting in the same era, using both vertical ,horizontal line and different types of line in sketching,and if it has many episode or depiction,the painter will separate the scene by using Sin Tao Line which is look like the wavy ribbon. The Sin Tao line can divided the mural painting into segments on the wall. In some areas of the wall there are pilaster separated because the interior mortar does not cover the structure such as the column. It appears as a pilaster in the wall inside, but the painter continued blending the relief line by the line and color in the painting so that can be continuous in seeing the mural painting on the wall. There is a selection in which position will use thick lines and which position is suitable to use thin lines for the description of the man, woman, costume, face, body, arms, legs, hair and head jewelry. The difference between male and female lines, such as ; mustache and body tattoos, is what emphasizes the physical aspect of masculinity. Then the hair of the male. The hair is short in the center of the head, around the head,etc. There are long pants for the male and the long skirt for female, long skirt has the pattern like the flowing water using the line to create a variety of surfaces, then there is a picture of the Buddha image. The disciple, as well as the person in the Buddhist history or allegory, is linear. By the atmosphere. From the other elements together. Architectural details include the castle, royal residence, pagoda. In this architectural image, royal palaces are detailed with fine lines and elaborate patterns, symbolic of the castle. Like roof overlay while the vernacular house picture are normal decorated. However, the painter tried to use the lines in the virtual architecture. The line of sight was seemingly a visionary, even though it was not theorized by Western theories. However, it reflects that in the late Rattanakosin period in the north there are traces of imitation Western scenery. Like many of the temples in the central region, built in the reign of King Rama IV, animals and animals are real in nature. There are many things that a painter must write. Variety Have used the potential To draw a line To convey to the people. Watch the temple or congregation easy to understand. And look at the overall line is an important part to make the painter. Main elements to find the perfect. Allow each wall to lead to the use of other elements unobstructed.

Figure B

Shape: The shape of the palace is similar to that of the temple. In the paradise paradise of Indra. Painter has to work hard in shaping. Of what is real Something is not in nature And there are many things to imagine, such as giants, birds in Himmavanta forest, etc. In some places. The painter selects the shape. The Lord Buddha, in a direct view, is sitting in a cradle of glass. Some of the disciples look at some of the figures in side dimensions. In some positions, the painter tries to shape them in the shape of the front of the architecture. The duplicate of shape can be seen oftenly with the local rhythm and bearing.(Nimsamer 1980).

Form: The painter's imagination brings the form closer to the real object, the more realistic form, and the color and weight of the fractured state of the battle in the war. This is a great example of good shape in the murals of Wat Phumin. The three-dimensional form that the artist tried to convey was almost as good as the lines and rhythms of the quadrilateral squares of curved lines. The rounded shape of the pagoda and the use of solid lines in the air is the arches of the pendant.

Texture: The surface and texture is a difficult task that challenges the painter. Many of the spots are well done, including the costumes of people in pictures that are both human. The person in the Buddhist history faces the skin, the texture of the person is a foreigner. Costume, Hair, beard, eyes, mouth, animals, instruments, weapons ,tree in nature, rivers, architectural paintings that mimic lime and wood works.

The proportions of the person in the wall are emphasized when the Lord Buddha and his followers are portrayed in the image. In the allegory, there is a small portrait and corresponds to the proportion of other things in the picture, proportion and balance. In the spotlight It has a magnificent proportions, but sometimes in the person, such as the limbs and head of the person. There is no relationship to the body. Daily life or folk legend The size of the person is focused only on certain points. People who are close to distant are almost the same size.

Value : The shadow and brightness of some colors, taking into account the clarity. Some points need to show the skill of gradation from light to dark, such as faces, costumes, water scenery, water and mountains, trees, rhythms and sizes. By weight In addition, it is found in the weight of flowers, such as the color of lotus petals.

Color : Painters use a variety of colors to divide each picture on the wall. The paint is peeling off, leaving a trail of white interior paint. Before writing a mural.The golden color is special, emphasizing the castle, the palace, the costume of the giant angel and the king, etc. The color of the skin or objects in the picture with a gradient of relative to the surface of the object, the painter has the ability in the color combination There are many colors of red, indigo, many colors, orange, black, white, green, gray, brown, pink, blue and gold are used opposite colors. The atmosphere of the image such as orange and blue. the group of ancient colors found in the mural of the ordination hall and depict the value of the work created by the local artisan. The study identities basic colors: red,blue,white and black as the primary group. The other colors found are green, orange and yellow with many shades of its color that look like gold as the specific color used particularly on the body of the Lord Buddha and the structures of the palace. The colors used here are unique and differ from those seen in the present time or those found today. The base color is often featured in both bright colors and dark colors, accentuated by bright colors or hues and high intensity colors such as red and orange from the background. The coloration has a pattern of high intensity colors over low intensity base colors. This invokes faith, mystique feelings, corresponding with magical elements in the Buddhist stories. In addition, colors are also used as symbols in painting.

Space : Space setting is used in the main scene such as the Lord Buddha with his disciples,the artist leaves the blank area for the Buddha in the equal space setting and balancing with his disciples . The painter put details into empty space that shows nearly full details in some walls, some walls fill up the blank space with bright the background color. It is planned to use a written narrative with visual narration as in the mural painting of Northeastern Thailand ,it has texts tales and themes.(Brereton and Somroay 2010,25). The Lanna Characters will be written where the area is empty. Sometimes the painter used the same color background in order to control the atmosphere of one episode.(Figure C1-C4)

Figure C

Rhythm: The rhythm in the mural painting of Wat Phumin expressed the use of duplicate linear to create a rhythm in the picture, such as wooden floor texture which appeared both in vertical and horizon, fences, walls, and rhythms of various size trees. With the size of the rhythm direction of the woman's woven lines, the horizontal line creates the rhythm of the person. Single and grouped. The relationship of the person in the picture with the rhythm face-to-face. Then switch to another way as if there is a conversation.(Figure D3). Repetition of color are used in many visual elements such as shapes and forms of figure,architecture,human ,animal,mythical animal,etc, which can help the artist creating a photo rhythm and bearing. Some compositions are tightly packed with various details such as plants,foliage, architecture, landscape elements, humans and animals are drawn as flat, so it can said that the space are mixed between native artist understanding and western world that influenced in Bagkok mural painting which are the characteristic of Thai traditional painting of Bangkok Period(Boisselier 1974 ,74.)

Figure D

Wat Phumin was built around 400 years ago and was restored during the reign of Ananda Vorrithidej in the year 2410 (late reign of King Rama IV).(Somchet 2015,4-6.) It took 7 years to repair the mural in the temple. Luang wrote in this period. Painting or "Hoop" in Wat Phumin is a fable in Buddhism. But if the details of the way of life of the city in those days .Most of the images in the mural painting of Wat Phumin are told about "Pedophilia".The story of the life of the people.In the past, the culture of dress, especially the dress of women who often dress.Weaving with hand , Foreign trade in the rush, etc. In The reign of King Rama V depicts Western influences that blend in with the native way in the mural painting.(Maneechot 1986). These paintings attributed to Buddha images, writing and finely written. Although the protagonist is written as a class, the owner of wedding dress with beauty, but excellent off the shiny gold painter wrote freely. Mural paintings of Wat Phumin is to use curves or does it use the natural conditions such as the mountain rocks, mound a story breaks, painting murals of Nan are mostly paintings that reflect the way of life of the people in the city contributes dress style of people in paintings that have a gorgeous wood carvings. By drawing the hand is used to contrast with the background color will be noticed, that women often have to wear a skirt. Which is the true identity of Nan women.(Figure B1-B4)

In the case study, can say that Wat Phumin compare with Lanna style, because Lanna style paintings have a special format, different from other paintings to highlight the beauty of Northern values. People usually have a round face, eyebrows raise, fair skin color. The eyes of quite relaxations and a glimpse into the various most popular woman . Men's hair dye is then to tie around head. Some men have undercut hairstyles and popular tattoo by the waist down to the leg. In addition to paintings, murals of Wat Phumin, then there are also paintings, murals of Wat Nong Bua, in Thawang Pha District of Nan province is beautiful(Figure E2). Both these temple paintings are written as 2405 (in Buddhist Era or around c.1862) which reflect the lifestyle of the Nan in the past as well .(compare the Figure E1-E2). Some example about the local style which is very significant is the scene of Mrs.Si Wei , from the mural painting of Wat Tamon Temple, Long District, Phrae, which is the work of the same artist with the mural of Wat Phumin, Nan Province.(Figure E3) The Tai Lue lady figure ,the masterpiece of the nearby city mural painting that dating in the same era or maybe the same school or the same artist that shows the beauty of Lanna Identity, and the last example is the local mural painting from Wat Buak Krok Luang, in Chiangmai ,the dress pattern in the painting is called flowing water pattern and the other visual

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elements in the picture is the most obvious resemble to the women dress from Wat Phumin mural painting. (Uthong 2005,150). (in Figure E4)

Figure E

This research can be concluded that ; 1. The visual elements are clear and naive,in line,dot,shape,form,texture,color,value, and space, the line is clear and the shape and form are new creation by the local artisan such as various human figure, animal,tree,architecture ,the ship ,the weapon,etc., the contour is obviously and the use of linear perspective and aerial perspective,illusional dimension by the local artisan is also appeared in Wat Phumin,which are the characteristic of the mural painting in Bangkok at the same era by the reign of King Rama IV. 2. The other visual elements such as the space are full of figures that contain the story of the Buddha Jataka in the local environment,daily life and activities of local people such as weaving,hanging out ,hair dressing, smoking,communicating,sewing,carrying the water , and some scene the foreigners are appeared ,etc. the artisan designed the shape and form in big size , men and women are appeared in beautiful posture and obvious emotions ,the artisan mostly provided the tattoo on the man skin ,the clothes in the mural painting of men and women are different,and using native pattern which are significant in Nan province, while the line and contour of the figures are vividly appeared.The variety of the textures and details are the local creative which are understandable and outstanding , however, the artists were able to make the best use out of the limited colors to create their works and give the details by using the local art elements and give the Lanna style or identity as well in expression.

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THE COLOR OF MANORAH THAI PERFORMANCE'S COSTUMES IN SOUTH OF THAILAND

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Thai Dancing Art is one art discipline that provides human beings in a society with mental and emotional aesthetics. Dancing art can also influence human being's ways of life and reflect ways of life and activities. The identity of dancing art has been varied from time to time until it forms a standard pattern and colors with Thai identity. One Thai dancing art with outstanding identity in color is Manorah or Nora performance. Manorah is a southern folklore derived from generation to generation and has been well known. Moreover, Manorah is a Southern performance with its identity in color of dressing performance differing from the same performance of the other regions in Thailand and around the world. Nowadays, a problem is Manorah or Nora performance is likely to be lost in the future. Researcher require to study and collect about knowledge and information about costumes of Manorah performance. The method of research is to study and collect the informations of Manorah costumes in part of colours and patterns. Researcher had interview to artist of Manorah, Maker of Manorah's costumes and qualified people who specialize in Nora performance around Songkhla and Pattalung province.

Manorah costumes are colorful, beautifully, gracefully and elegantly designed and decorated. Moreover; they are handmade products with color of beads arranged in unique patterns and styles. In the part of colours, one of the unique features in Manora Thai costumes are colours of beads. The colours of bead in Manorah costume has different colours which primary colour in cycle of color circle such as red yellow and blue. Moreover, the colour of bead is secondary colour such as green and orange. The composite colour make the pattern clearer is black and white.The colour of bead has meaning of faith in the past such as bead's blue colour is meaning about permit the virtue luck and fortune. Bead's yellow colour is mercy and charming from the people all around. Bead's black colour is protect ourselves from unlucky and satan. The green colour of bead's meaning is be wealthy and propitiousness. The black bead is mean to live long life and healthy. In addition, the colour of Manora pattern such as Pikul flower pattern or Thai design pattern tis identity in colour of pattern dressing performance create by maker is differing from the performance of the other regions in Thailand and around the world.

Thai Dancing Art is one art discipline that provides human beings in a society with mental and emotional aesthetics. Dancing art can also influence human being's ways of life and reflect ways of life and activities. One of Thai dancing art with outstanding identity in color of costume is Manorah or Nora performance. Manorah is a southern folklore derived from generation to generation and has been well known. Manorah costumes are colorful, beautifully, gracefully and elegantly designed and decorated. Moreover, Manorah is a Southern performance with its identity in color of dressing performance differing from the same performance of the other regions in Thailand and around the world. In addition, they are handmade products with color of beads arranged in unique color, patterns and styles.

Colours of Manorah costumes

Manorah's Bead Accessories

Bead accessories are tools that Manorah use for decoration and used as their costume. In the past, this costume is also known "Chalong Pra Ong". This bead costume is called so because it is usually made from little beads of different colours, threading together to create various patterns, such as fish-bone, crystal ball, and triangle patterns. The pieces of the beads strung together are used to cover Manorah's shoulders, chest and necks. This costume is called Bead Accessory which create by bead's costume maker in South of Thailand.

Manorah's beads accessories

Bead accessories have evolved in the history and its evolution can be described into three patterns: king costume, lotus pattern, and five-piece pattern. After that, bead accessories are said to continue evolving; the pattern is designed for the more convenient use, and the color is developed accordingly to the changing times both in colors and patterns.

The colours of Manorah bead costume in the past until nowadays

Traditional Believes in the past about Bead Colours

P revious research has shown that beholders of Manorah bead costumes do not carry the idea that certain colours of the bead can bring good luck or bad luck. The bead costume artists often choose the colour according to their own preferences, or the colours are specified by the Manorah artists who want to wear them. Manorah artists may want to wear certain colours and they order the costume to be made in the colour they like. It is found that the inherited costumes are normally kept as they were, without changing or modification. However, studies of the colour of the beads, such as Wichienrat (1989), describes the significance of the bead colour as follows.

Blue: The beholders can be blessed to have great achievement in work and fame.

Yellow: The beholders of the yellow beads are believed to be charming and patient, and receive great mercy. When travelling or doing business, the beholders will be supported.

Dark blue: The beholders are believed to be wealthy; they will have luck in gambling.

Brick colour: The beholders are believed to become immortal; they will be saved from weapons or animal attack.

Black: The beholders are believed to be saved from devils, plagues, accidents, bad magic and animal attack.

Jade colour: It is believed that this bead colour will bring the beholders the valuable things, i.e. gold and silver.

Clear bead: It can be as clear as diamond. The beholders are believed to be protected from any bad intentions of dishonest men and women.

White jade: This bead colour has properties of longevity and healing.

Colours of the Manorah's beads Nowdays

According to the survey, interviewing the experts and qualified people who specialize in Nora performance and studying from documents indicated that the colors of the beads which are weaved as bead accessory can be any colors such as white, yellow, blue, red, black, purple, and orange .Moreover, the colors that are not mentioned above can also be used; it can be made accordingly to what the performers or bead accessory artists prefer .However, one interesting aspect that should be taken into consideration in weaving bead accessory is trying not to match bright colors with bright colors, and dark colors with dark colors such as white with yellow or purple with red because this would makeit more difficult to recognize the pattern; so-called “blind colors ”or the pattern will not appear prominently.

The color of Manorah Thai performance’s costumes in South of Thailand

Colors of Manorah’s beads

Colours of the beads used in Manorah’s costume resulted from the use of contrasting color beads strung together into patterns. The use of contrasting colours allows the obtained patterns to be seen clearly. It is said that beads in any colors can be used, such as white, yellow, blue, red, black, purple and orange. Genuine or primary colours and secondary colours are used. However, the use of the colour may depend on the artists’ preference.

Colours Selection

Choosing the bead colours can be driven by different reasons.

1. The artist’s experience and preference: Individuals may have their own preferences, expertise, and experiences. This results in different patterns of bead accessories, according to the artists’ creation and preferences, as well as user’s preference.

2. Personal belief: It is a traditional belief that certain colours bring luck to certain people. For instance, people who were born on certain days should wear certain colours. This belief holds true for Manorah costume.

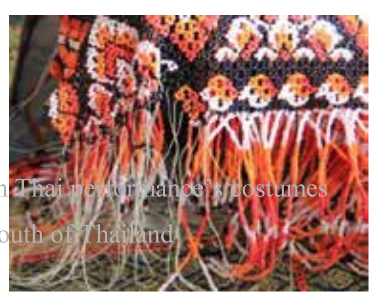
3. The occasion on which the bead costume is worn: the occasion or event in which Manorah performs can influence the colour of the beads used, such as in a royal welcoming event or WaiKru (Teachers) ceremony, and occasion on which the Manorah artist wants to dress differently from others.

Upon studying the colors of beads used in Manorah costume, the researcher becomes aware of the reasons and belief for bead costume artists in Songkhla and Phattalung to choose certain colours of the beads for their work. In addition, based on the the interview with Manorah artists : Nora Thammanit, Nora Nattapong and Nora Thawee about colours of choosing Manora beads, the reasons behind choosing certain colors, and the colors used in the costume could contribute to the beauty of Manorah bead costume.



The colours of Manorah bead costume nowadays

However, the abovementioned properties of the bead colour are not relied on by the bead costume artists. From the interview, they are mainly concerned with the visibility of the patterns; they tend to avoid placing light coloured beads next to other light coloured beads. This makes it difficult to see the designed pattern. Similarly, dark coloured beads are dispreferred to be placed next to beads of another dark colour as this does not give bright designed patterns.

The color of Manorah Thai performance's costumes in South of Thailand

Warm colours of Beads


Cool colours of Beads

Photo from Nora Bandasak

Additionally, the modern artists who created the colours of Manorah beads have started to use warm colours and cool colours into the creation of Manorah bead costume. This results to the well-blended and more beautifully designed piece of art. Moreover, the expert said that the colours of Manorah costumes will develop by the colours and materials more beautiful and graceful in the future.

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ORAL SESSION

NEURAL CORRELATES OF COLOR HARMONY

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Keywords: fMRI, color harmony, brain, fusiform gyrus

ABSTRACT

Using functional magnetic resonance imaging (fMRI), we investigated the neural basis of color harmony in connection with psychological judgment. We measured brain activity when the participant (14 participants) judged a pair of color patches to be harmonious or disharmonious using button pressing response. We found significant harmony condition activation in the brain area of fusiform gyrus (corresponding Brodmann Area BA37), occipital cortex (BA18/19), intraparietal sulcus (BA7), inferior frontal gyrus (BA47) and other areas. Thus we found the fusiform areas involving V4 is likely critical region for color harmony judgments.

INTRODUCTION

Neural basis of color harmony in connection with psychological judgment is remained unsolved. It is well established that individuals tend to gravitate toward harmonious color combinations as a source of general comfort. This can be reflected in the clothing combinations we select, the interior décor we prefer, and so on. Research on color theory has a long history. For example, Theory of Colors, a book published by Goethe in 1810, established a wheel describing principal components of colors, which consist of three primary (yellow, red, and blue) and three secondary colors (orange, green, and violet); it was thought that harmonious relationships existed between colors opposite (complementary) each other on this wheel (Goethe, 1970). Additionally, Munsell (1907) developed a color order system that was based on three perceptual properties: hue, value (lightness), and chroma (saturation). With the development of this system, all perceptible colors could be accommodated in a slightly distorted spherical solid. Based on this system, Moon and Spencer (1944) proposed identity, similarity, and contrast as three principles for color harmony, while Judd and Wyszecki (1963) proposed four principles of color theory including order, familiarity, similarity, and unambiguity. Both principles suggest that harmony is created when neighboring colors share similarities or contrast in hue. More recent studies have focused on how to generate harmonious color combinations based on hue, saturation, and lightness. These psychological studies have sought to validate and predict harmony scores based on these three properties (Ou et al., 2011). These studies used CIELAB to quantitatively assess differences in uniform color space. The CIELAB system has three perceptually even interval scales, which include lightness (*L_*), red-green(*a_*), and blue-yellow (*b_*). Additionally, chroma(*C_*) and hue(*H_*) are calculated from the length and angles of vectors used on the *a_b_* plane, respectively. This system aims to identify uniform changes in perceived colors depicts a color palette with examples of harmonious, neutral, and disharmonious color combinations.

Methods

In the preliminary experiment, using 20 participants (19-30 years-old), we made a color palette that contained 27 colors (six hue; red, orange, yellow, green, blue and violet) across four tones (vivid, pale, light-grayish and dark) and three achromatic colors (white, gray and black) which were chosen from the Practical Color Coordinate System (PCCS developed by Japan Color Research Institute) to make harmonious color combinations. Using two-color combinations, we made 351 pairs of color combination pairs and each pair was presented on a CRT screen and asked the participants to rate harmony score based on 9-point scale (Figure 1).

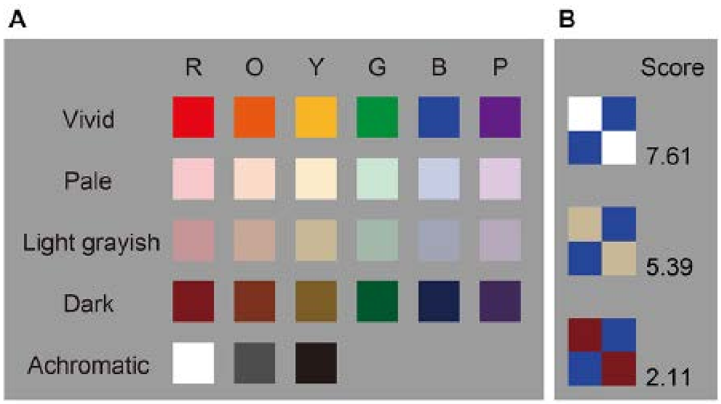

Figure 1 27 colors used in the experiment (A) and its combinations (B)

Behavioral and fMRI data

After collecting psychological scores based in the preliminary experiment, we performed the fMRI experiment using different participants. In the fMRI experiment, using 14 participants (aged 20-33 years-old), we measured brain activity when the participant judged each pair to be harmonious or disharmonious under the Harmony/Disharmony conditions using button pressing response. While, we asked the participants to discriminate color difference only under the Difference condition. Thirty seconds were elapsed for each trial and 10 presentation and corresponding response. Color difference was equated both in the Harmony and Disharmony conditions.

We introduced MRI scanner (Verio, Siemens Corp.) and brain activations were analyzed using SPM8. The fMRI experiment was conducted in a 3-T MRI scanner (Trio, Siemens, Germany). A forehead strap and form pads were used to reduce head motion. Functional images were obtained using a gradient-echo echo-planar pulse sequence (TR = 2500 ms, TE =30ms, flipangle=90, voxel size=3x3 x3mm; 36 axial slices).

Results and Discussion

In calculating the significant differences between Harmony>Disharmony condition, we found significant Harmony condition activation in the brain area called fusiform gyrus (corresponding BA37), occipital cortex (BA18/19), intraparietal sulcus (BA7), inferior frontal gyrus (BA47) and other areas. Thus we found the brain area having neural correlates of color harmony judgment in the area of visual areas from occipital to temporal brain, specifically, fusiform areas involving V4 [7] is likely critical region for color harmony judgments.

Acknowledgement

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DEVELOPING CREATIVE CONTEMPORARY PAINTING UNDER THE FLOWERS - HAPPINESS THEME

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Keywords: Contemporary Painting, The Flowers - Happiness Theme and using flowers as symbols

ABSTRACT

This applied research entitled "Developing of Creative Contemporary Painting under the Flower-Happiness Theme" aimed to develop creative contemporary paintings by using flowers as symbols for the concept of happiness. The elements of the flowers in terms of shapes, colors and floral beauty provide the impetus for the inspiration for the creation of expressions of happiness using the development of art principles including development criteria, experimental practices, and creative inputs for fine arts according to artistic principles. Researcher studied the literature reviews, concepts and theories of happiness under the principles of fine arts and synthesizes the artistic dissemination methods, and painting techniques that communicate the expressions of happiness. Then the paintings were evaluated and analyzed in three aspects include the artistic meaning, feeling, principles, and the value of understanding of paintings.

Findings revealed that the interpretation of paintings using the symbols of flowers can express happiness in eight ways including: 1) conscious controlling happiness, 2) simple happiness, 3) appreciative happiness, 4) love happiness, 5) freedom happiness, 6) healthy happiness 7) hopeful, and 8) reciprocity happiness. Findings also showed that the paintings expressed realism and fantasy by using the oil colored techniques on canvas. Those paintings' surfaces were flat with the brushstroke and later were colored using the palette-knife. In addition, the cool and warm tone colors were used and built harmony utilizing shapes, colors, and the use of the surface to create the movement in pictures that represent the imagination rather than what is real. Suggestions and implications are also addressed in studying and development of contemporary painting according to the uniqueness of ideas and methods of fine arts dissemination in the future.

INTRODUCTION

In terms of the attitude to the meaning of life and its effects to human's way of life, if it could be noticed, the happiness must be the most desirable thing and preferable in order to seek and reach the goal of life which might result in the peace of mind. Not only focused on the understanding of happiness and its common physical and spiritual delightful effects but the self-satisfaction through the simple life might more be appreciated? Moreover, hope would be one of the most powerful drives of human which might lead to the goal of life alongside with being optimistic and the giver. In this project, the nostalgia and the personal experiences of the researcher had played the crucial role in creating the series of painting that represented the metaphorical images of happiness paralleled with the life appreciation by observing the flowers, the fragment of floral patterns such as the petal and its forms and colors. In other words, the aesthetical effects of the flower observation might lead to the happiness and become the kind of healing among the life obstacle and eventually turn to the hope and goal of life later on. Hence, through the inspiration mentioned above, the artist produced the series of oil painting in order to interpret the metaphorical images of happiness through the use of the balanced art elements such as shapes and forms, lines, colors, and so on.

OBJECTIVE

To study and create the contemporary works of oil painting in order to interpret the metaphorical images of happiness, the symbols of positive emotion through the use of the concept, inspiration, and the techniques alongside with the significant creative forms that could reflect the attitude, imagination, and the positive emotional effects by flowers observation.

RESEARCH METHODOLOGY

This project was the applied research through the use of the review literature and the research documentary related to the background and inspiration of the creative process which the data collecting of physical basic natural forms of flowers had played the significant roles in this part in order to design the sketches. Then, the series of painting was developed representing the metaphorical images of happiness which totally 16 paintings were included. Finally, the analysis of the gained information and the evaluation of creative works were completed through its exhibitions.

RESULT AND DISCUSSION

Through the study, the finding had revealed that the series of oil painting using the forms and colors of the flowers as the symbols of happiness had played the significant role in making the artistic identity alongside with the positive emotional effects. Through the gained information, the use of hue and painting techniques such as flat color painting, the overlapping colorizing, the texturizing with palette knife and brushstroke, and the colorizing with soft materials had generated the soft and silky atmosphere of happiness which included 16 paintings. Furthermore, through the creative process's analysis, the researcher could summarize and highlight that the finding had revealed the symbols of happiness which were discovered and be divided into 8 categories for instance;

1. ***Consciousness leads to happiness***

Happiness to feel free (1)
180 X 150 cm.
Oil on canvas

Happiness to feel free (2)
150 X 180 cm.
Oil on canvas

2. ***Simplicity leads to happiness***

Happiness to let it be
180 X 150 cm.
Oil on canvas

Happiness to being simple
150 X 180 cm. (2 pieces)
Oil on canvas

3. ***Gratitude leads to happiness***

Happiness to being yourself (2)
150 X 180 cm.
Oil on canvas

Happiness to being yourself (1)
150 X 180 cm.
Oil on canvas

4. *Love leads to happiness*

Happiness to being in love (1)
150 X 180 cm.
Oil on canvas

Happiness to being in love (2)
150 X 180 cm.
Oil on canvas

5. *Self - Sufficiency leads to happiness*

Happiness in happiness (1)
100 X 100 cm.
Oil on canvas

Happiness in happiness (2)
100 X 120 cm.
Oil on canvas

6. ***Health leads to happiness***

Joyful with Happiness (1)
150 X 180 cm.
Oil on canvas

Joyful with Happiness (2)
100 X 120 cm.
Oil on canvas

7. ***Hope leads to happiness***

Happiness to being with faith (1)
150 X 180 cm.
Oil on canvas

Happiness to being with faith (2)
180 X 150 cm.
Oil on canvas

8. ***Giving leads to happiness***

Happiness to sharing (1)
180 X 250 cm.
Oil on canvas

Happiness to sharing (2)
150 X 180 cm.
Oil on canvas

This kind of applied research project could be developed further in order to find more information to interpret the metaphorical images of happiness and more importantly would be the knowledge dissemination in order to present the creative process, the artistic learning process, and the symbolism in art which might be the contribution to the art field, art students, and art practitioners later on.

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TRADITIONAL THAI STYLE COLORS: STUDYING ON COLOR TOLERENCE AND ACCEPTANCE BY THAI ARTISTS

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Keywords: Color Tolerance, Color Acceptance, Traditional Thai Color

ABSTRACT

This research aimed to determine accepted color tolerance of traditional 20 Thai color names judged by professional Thai artists from Ten Division of the Traditional Thai Crafts. The samples were prepared using colored pigments and acacia gum, main components used for Thai tempera. They were formulated to match 20 standard targets obtained from Thai color name dictionary. A tolerance sample set, coated on canvas, for individual Thai color name consisted of 2 charts: 1) the standard target in the middle and 8 samples with different CIE L^* having similar CIE C^* and hue and 2) the standard target in the middle and 8 samples with different CIE C^* having similar CIE L^* and hue. The color tolerances (CIE ΔE_{00}) of Thai colors with high chroma: *Dang Sen (4.70)*, *It (5.40), Lueam Lueang (5.10), Khiao Luk Samo (5.00), Khiao Khap (5.60)* and *Dok Tabaek (4.80)* were high compared to low chroma color: *Hong Din* (2.20). The wide tolerance in ΔL^* and ΔC^* was found in *Banyen* (5RP 5/10) and *Luk Wa* (7.5P4/6). The small one was found in *Khiao Kan Tong* (5GY6/4) and *Khiao Bai Kae* (2.5G5/4).

INTRODUCTION

Paints media used for traditional Thai mural painting is called "tempera" which is the mixture of dry powder pigment and Arabic gum. The result of mixing gives different colors and each color has unique name (Siripant, 2016). A study of Thai color name was done previously by several researchers. In 1988, 209 Thai names were identified (Siripant, 1988). Among 209 color names, 50 color names were painted by a Thai artist and matched with Munsell and CIE color systems, 159 color names were left unidentified. In 2013, Katemake et al. referred to Thai color names in Siripant's work and identified them again with different method involved 10 professional artists working in Ten Division of the Traditional Thai Crafts, the Fine Art department, ministry of culture. They could define 147 color names. However, the results obtained from Katemake and Siripant also showed somewhat color difference (Katemake & Preda, 2014; Katemake, Preda, & Hoontrakul, 2013; Siripant, 1988). The difference could be acceptable, however, defining accepted color tolerance of the identified Thai color names have not been done. This research aimed to identify ΔL^* and ΔC^* tolerance of 20 traditional Thai color names.

EXPERIMENT

The procedure for defining color tolerance of Thai color names were as follows: 1) Mixing primary tempera; 2) Preparing calibration paint panels; 3) Obtaining the spectral reflectance of the calibration panel; 4) Formulating a mixture for standard Thai color name; 5) Preparing a tolerance sample set for each standard Thai color name and 6) Determining acceptable color tolerance.

Mixing primary tempera.

The optimised formula for making pastel stick was obtained using the mixture design (Cornell, 2002). Accordingly, one of primary pigment (6.3wt%) was mixed with gum tragacanth (28.7wt%) and calcium carbonate (65.0wt%) and formed a stick. Twelve primaries were done.

Preparing calibration paint panels.

Each primary stick was grind and was mixed with white pigment and binder ($CaCO_3$: gum tragacanth = 2.5:1) into 8 levels (1.25, 2.50, 5.00, 12.50, 25.00, 50.00, 75.00 and 100wt%). Then they were coated on white canvas.

Obtaining the spectral reflectance of the calibration panel.

When the paints on calibration panels dried, the spectral reflectance were measured and stored into a color formulation software.

Formulating a mixture for standard Thai color name.

Twenty colors were chosen from ten categories; R, YR, Y, GY, G, BG, B, PB, P, and RP according to Thai color dictionary (Katemake & Preda, 2014). They were listed (translation ≈ *Thai color name* ≈ Thai color name written in Thai) as targets including "orange red ≈ *Dang Sen* ≈ แดงเสน, ochre mixed with white ≈ *Hong Din* ≈ หงดิน, yellow ochre ≈ *Din Lueang* ≈ ดินเหลือง, brown ≈ *Nam-tan* ≈ น้ำตาล, brick ≈ *It* ≈ อิฐ, Garcinia hanbury Hook.F (sap of plant) yellow ≈ *Lueang Rong* ≈ เหลืองรง, glossy yellow ≈ *Lueam Lueang* ≈ เลื่อมเหลือง, midrib of a banana leaf green ≈ *Khiao Kan Tong* ≈ เขียวก้านตอง, Myrobalan (fruit) green ≈ *Khiao Luk Samo* ≈ เขียวลูกสมอ, Agasta leaf green ≈ *Khiao Bai Kae* ≈ เขียวใบแค, River flow ≈ *Nam Lai* ≈ น้ำไหล, indigo green ≈ *Khiao Khram* ≈ เขียวคราม, bluish green ≈ *Khiao Khap* ≈ เขียวขาบ, blue ≈ *Khap* ≈ ขาบ, navy blue ≈ *Khromtha* ≈ กรมท่า, greyish cloud ≈ *Mo Mek* ≈ มอหมึก, Lagerstroemia floribunda Jack (flower) purple ≈ *Dok Tabaek* ≈ ดอกตะแบก, Syzygium cumini (l.) skeels fruit ≈ *Luk Wa* ≈ ลูกหว้า, Mimosa pudica flower ≈ *Dok Maiyarap* ≈ ดอกไมยราพ and magenta ≈ *Banyen* ≈ บานเย็น. Selected targets then were formulated and mixed to obtain the standard targets. These targets were previous identified (Katemake & Preda, 2014) and matched with matt Munsell as shown in Table 1.

Table 1: Targets provided with the matched Munsell (matt) for obtaining color tolerance.

Target	Matched Munsell patch	Target	Matched Munsell patch
Dang Sen	5R 5/12	*Nam Lai*	2.5G7/4
Hong Din	7.5R 4/6	*Khiao Khram*	5BG5/6
Din Lueang	10YR 7/8	*Khiao Khap*	10BG4/4
Nam-tan	7.5YR 6/4	*Khap*	5B4/4
It	2.5YR 6/8	*Khromtha*	5B3/2
Lueang Rong	5Y 8/10	*Mo Mek*	2.5PB7/4
Lueam Lueang	2.5Y 8/8	*Dok Tabaek*	7.5P6/8
Khiao Kan Tong	5GY6/4	*Luk Wa*	7.5P4/6
Khiao Luk Samo	2.5GY7/4	*Dok Maiyarap*	2.5RP6/8
Khiao Bai Kae	2.5G5/4	*Banyen*	5RP 5/10

Preparing a tolerance sample set for each standard Thai color name.

Eight tolerance samples (1st set), with different *CIE L** having similar *CIE C** and hue with the target, and another 8 tolerance samples (2nd set), with different *CIE C** having similar *CIE L** and hue with the target, were prepared. Sixteen tolerance samples for individual target were applied on painting canvas with the wet film thickness of 80 μm. All tolerance sample were left to dry and cut in to size of 4.5 x 4.5 cm. The tolerance samples were made with the variation only in chroma and lightness because the hue should be fixed according to the color name. The spectral reflectance of all tolerance samples were measured using X-Rite SP62, d/8 spectrophotometer and CIELAB values were calculated for illuminant D65 and the 1931 2° standard observer.

Determining acceptable color tolerance.

Ten artists with color normal vision, at the Fine Art Department, Ministry of Culture, participated in the observation, was told the Thai color name of the samples he/she was observing. The target, color that matched the name, located in the middle. They were asked to select the tolerance samples that were acceptable to be named as the target. The observations were conducted under daylight 6500K of the portable light booth and viewing geometry was 45/0.

RESULTS AND DISCUSSION

The colorimetric positions of 16 tolerance samples for each 20 Thai color name targets were measured and 3 examples of *Dang Sen* ≈ แดงเสน, *Nam-tan* ≈ น้ำตาล and *Khiao Bai Kae* ≈ เขียวใบแค are shown in Figure 1. The hue of the tolerance samples was fixed for each individual Thai color name because the hue should be specific to its color name. This resulted in non-uniform sampling showing in diagram of *ΔC** vs *ΔH** and *ΔL** vs *ΔH** compared to usual tolerance samples. The prepared tolerance samples have variation in chroma and lightness showing in the variances of *ΔL** and *ΔC** of the covariance matrix, in CIE *L*C*h* color space as seen in Figure 1. The 95% confidence ellipsoids plotted from covariance of tolerance samples for 3 targets are also presented. The covariance between *ΔL** and *ΔC** was smaller than *ΔL** and *ΔC** variances.

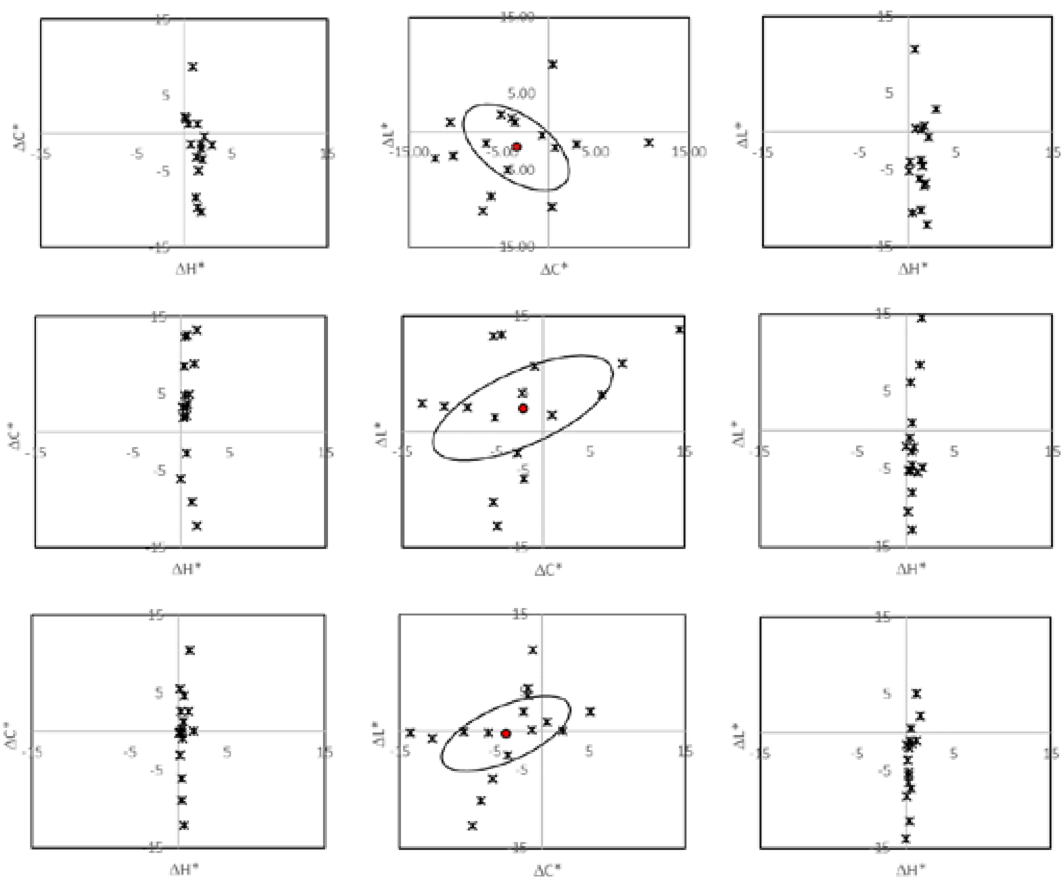

Figure 1. Example of colorimetric positions of 16 tolerance samples for 3 Thai color name targets: Dang Sen ≈ แดงเสน (top), Nam-tan ≈ น้ำตาล (middle) and Khiao Bai Kae ≈ เขียวใบแค (bottom), x-axis & y-axis: ΔC* & DH*, ΔL* & ΔC*, ΔL* & ΔH*.

Color tolerance of 20 targets

The tolerance of 20 traditional Thai style colors, using pass-fail color tolerances (Berns, 1996), including lightness difference (ΔL^*) and chroma difference (ΔC^*) are presented in Figure 2. We attempted to maintain hue of samples as the corresponding target and varied lightness and chroma, we then showed only the results of the tolerance of lightness and chroma. The deviations of the tolerance samples from the targets were prepared with the same pattern and the majority of the observers accepted the sample with the deviation of 1 step of lighter shade (ΔL^* about 1) more than 1 step of darker shade and accepted the sample with the deviation of 1 step more saturate and 1 step less saturate than the target, however, the prepared samples were not sufficiently uniform. Roughly, we found that the wide tolerance in ΔL^* and ΔC^* was in *Banyen* (5RP 5/10) and *Luk Wa* (7.5P4/6). The small tolerance in ΔL^* and ΔC^* was found in *Khiao Kan Tong* (5GY6/4) and *Khiao Bai Kae* (2.5G5/4). The plots of the smallest tolerance were separated with finer scale as in the bottom diagram of Figure 2. The cumulative responses (Berns, 1996) versus CIE ΔE_{00}, for all observers, were carried out and found that the optimized ΔE_{00} of the Thai colors, under the study, with high chroma: *Dang Sen (4.70)*, *It (5.40), Lueam Lueang (5.10), Khiao Luk Samo (5.00), Khiao Khap (5.60)* and *Dok Tabaek (4.80)* were high compared to low chroma color: *Hong Din* (2.20), bearing in mind that the samples were non-uniform as seen in Figure 1 (the hue was kept constant for all targets).

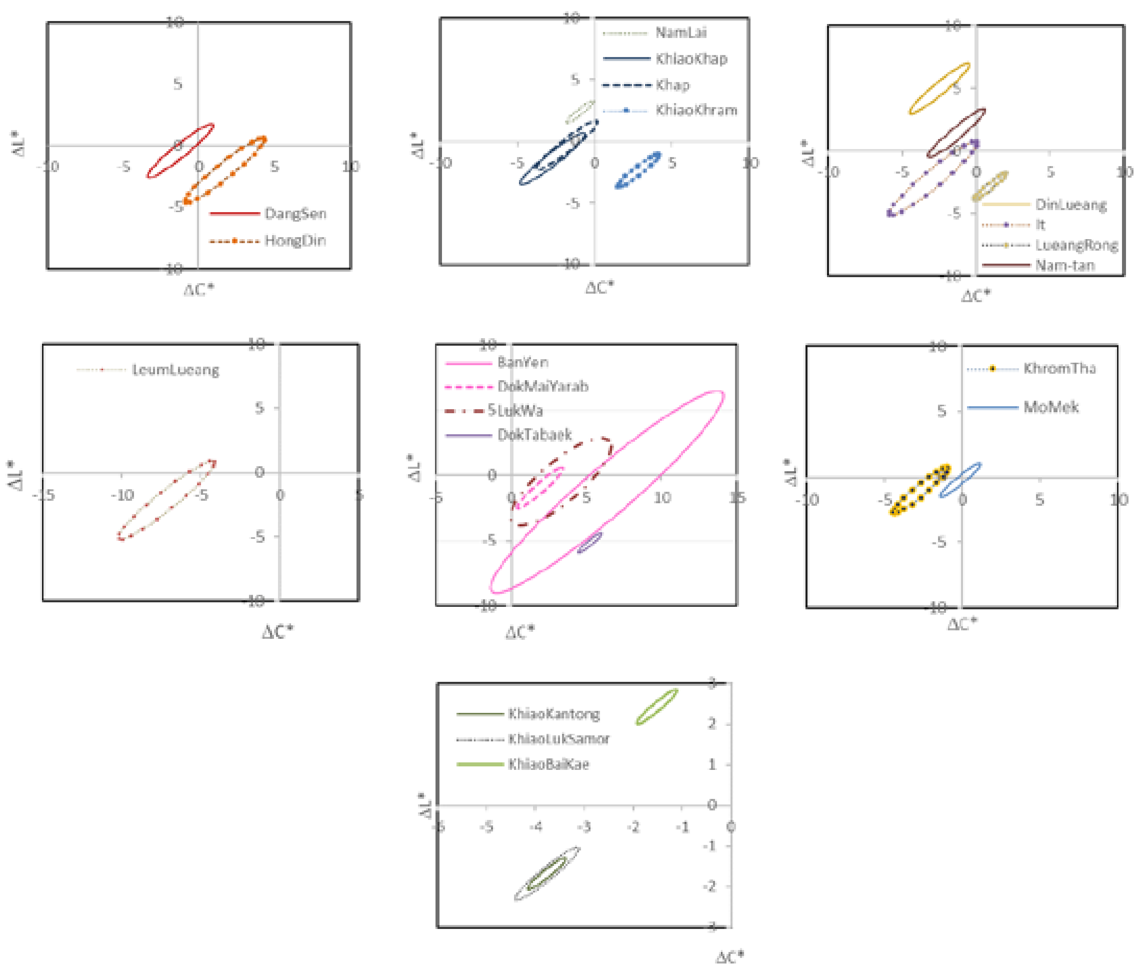

Figure 2. ΔL^* and ΔC^* Tolerance of 20 traditional Thai colors applied on canvas, judged by 10 artists under a light cabinet with daylight 6500K, 45/0 geometry.

We made the physical tolerance samples on canvas instead of presenting the samples on the monitor screen, which would be easier to obtain a uniform sample set for individual target, with the thought that the artists were more familiar and would feel more comfortable with the physical samples than the digitized ones. The suggestion for further study is using digitized tolerance samples with texture of painting paper or of canvas.

CONCLUSION

The ΔL^* and ΔC^* tolerance of 20 selected Thai colors were determined. The traditional Thai color names presenting red-purple shade gave higher ΔL^* and ΔC^* tolerance than the ones presenting green and green-yellow shades.

ACKNOWLEDGEMENT

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ORAL SESSION

PERSONALITY CHARACTERISTICS AND STABILITY OF COLOR PREERENCE

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Keywords: Color Preference, Personality Characteristic, Self-Consciousness

ABSTRACT

Questionnaire surveys were executed in order to examine relationship between participants' personality characteristics and their intrapersonal consistency (or stability) of expressed color preference. Color preference was measured by making the participants rank 12 fundamental colors, based on their preference against the target colors. Color preference measurements were repeated three times with four and 14 weeks interval, and consistencies of color preference were individually obtained by calculating rank correlation between each of the three tests. Results showed that consistency of individual color preference indicated by rank correlation was quite high (around 0.7~0.8 against a four-week interval), though it mildly decreased with increased interval, suggesting that color preference is somewhat robust against a certain range of time interval. Self-consciousness exhibited significant correlation against the stability of color preference, though there was an intersexual difference. In male participants, positive correlation was confirmed with public self-consciousness, whereas negative correlation was obtained with private self-consciousness in female participants. The results of the current survey suggested that high consciousness against a self which was considered to be monitored by other persons, not an inner self monitored by oneself, made the participants' expressed color preference more stable and consistent.

INTRODUCTION

In most cases, each of us has an individual color preference which can be internally represented and externally expressed without a specific effort. Color preference has been one of the biggest concerns in color sciences for long years, and many researchers have tried to accumulate wider knowledge about color preference in a various way. Color preference researches have revealed wider variations of preferred/hated colors as a function of genders, ages, countries and so on, by collecting data from massive group of survey participants. In these researches, it has been indicated that color preference has a certain range of robustness against a passage of time, and colors selected as preferred or hated color did not show a huge variation within a specific participant's group. Similarly, color preference also shows a certain range of stability within an individual person on average. This suggests that individual color preference would stem from a stable characteristic of the participant's personality, not affected by transient feelings varied from day by day.

Nonetheless, it has been also indicated that the intrapersonal stability/consistency of color preference would be subject to relatively large individual differences, and widely known that there would be some persons with very high stability in their color preferences, while other persons did not show a stable preference. The purpose of this investigation was to clarify reasons underlying the individual differences in the stability of color preference. Questionnaire surveys were executed in order to examine relationship between participants' personality characteristics and their intrapersonal consistency (or stability) of expressed color preference.

METHODS

Individual color preference was measured by making the participants rank 12 fundamental colors (white, black, gray, red, pink, orange, brown, purple, blue, green, yellowish green, and yellow; indicated by color names in Japanese) based on their preference against the target colors. Measurements of color preference were repeated three times with four and 10 weeks interval (TEST1, TEST2 and TEST3; TEST3 was executed 14 weeks later than TEST1). In TEST1, general personality traits and self-consciousness were also measured, using Ten Item Personality Inventory (TIPI; Gosling, et al., 2003[1]) and Self-Consciousness Scale (SCS; Fenigstein, et al., 1975[2]), respectively. Both inventories were translated into Japanese, and it was confirmed that both of them had a sufficient reliability and validity. In the former, general personality traits were comprehensively assessed based on "Big-Five personality theory" and five factors were measured, namely extraversion (tendency to seek stimulation in the company of others), agreeableness (tendency to be compassionate and cooperative), conscientiousness (tendency to be organized and dependable and act dutifully), neuroticism (tendency of emotional stability), and openness to experiences (extent to which a person is imaginative or independent). The latter scale measured private and public self-consciousness (tendency to introspect and examine one's inner feelings, and awareness of the self as it is viewed by others, respectively). In TEST2 and TEST3, only the color preference was measured using the same method employed in TEST1. At the time of TEST1, there was no announcement of repetitive measurements. In TEST2 and TEST3, it was emphasized that the participants should not try to recall the answers in the previous tests, and rank color preference based on their feelings at the moment. Thus, we believe that participants independently evaluated their color preference in each test.

Data collected from 269 undergraduate students (113 males and 156 females, ages ranged from 18 to 21 years old), who participated in all tests, were subject to a consequent analysis. On average, it took about 20 minutes to complete TEST1, and approximately 5 minutes was required for TEST2 and TEST3 in which only color preference was measured.

RESULTS AND DISCUSSION

Figure 1 indicates averaged coefficients of correlation among three tests. Correlation was remarkable high between TEST1 and TEST2 in which inter-test interval was four weeks (around 0.7 for male and 0.8 for female participants). The coefficients of correlation were slightly decreased with the intervals between the test, whereas the correlation was still enough high even with the longest interval (the inter-test interval was 14 weeks between TEST 1 and TEST3). Two-way analysis of variance (ANOVA) revealed that there was a significant main effect of the test intervals ($F(2,532)=3.41$, $p<.05$). ANOVA also indicated that the female participants exhibited significantly higher correlation than the male participants ($F(1,266)=405.4$, $p<.01$). There was no significant interaction between the two main effects ($F<1.0$). Our previous surveys have repeatedly indicated that females tended to exhibit higher stability in expressing one's color preference, and the current investigation successfully replicated the tendency. Nevertheless, the stabilities of color preference were considerably high both for males and females, and it can be concluded that color preference measured by ranking colors based on the preferential order is considerably robust against the time intervals. TEST1 and TEST2 were carried out in the same season (middle of April and middle of May, spring season in Japan). On the other hand, TEST3 was executed in the different season (beginning of August, summer). One may argue that individual color preference was susceptible by the environmental factor by a certain amount. However, the current result indicated that the robustness of color preference would be able to overcome the seasonal changes, suggesting that a color preference can be considered as a well-established personal characteristic that the environmental effect could not be hardly elicited. Correlations among three tests were highly consistent within each participant, so that three coefficients of correlation were averaged and employed as an index of intra-individual stability of color preference in the following analysis.

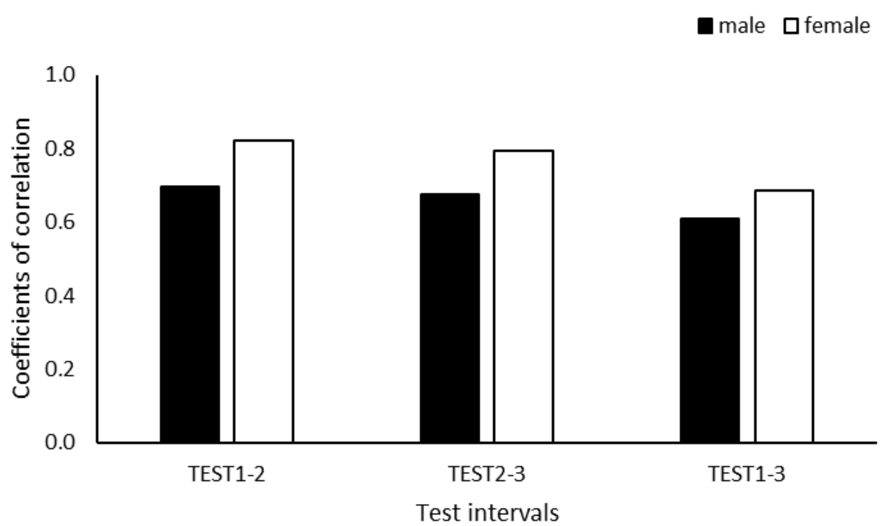

Figure1 Coefficients of correlation of color preference between the tests

Table 2 and 3 indicate Pearson's coefficients of correlation between the stability of color preference and the scores of the psychological scales concerning the participant's personalities. In the results of TIPI (Table 2), there were no significant correlations between the stability of the color preference and general personality traits for the female participants. On the other hand, the male participants exhibited significant negative correlations in "extraversion" and "openness to experiences" and significant positive correlation in "agreeableness." Due to the intersexual difference, significant correlations between the stability of the color preference and the personality traits were hardly confirmed in the total participants (except for negative correlation in "openness"). The results of this survey suggest that the male participants with tendencies of avoiding social involvement ("extraversion") and novel experience ("openness") were more stable to express their color preference. It can be speculated that those participants may depend on sensory information including color, not logical information, in every day's living, and their sensitivity to inner preference concerning sensory issues (e.g., color preference) would be more facilitated, as compared with other persons. Furthermore, significant correlation in "agreeableness" might suggest that people with less self-assertion should take precedence in being consist for every aspect of self-expression to make a better communication with others (please note that significant correlation in "agreeableness was only observed in the male participants). Anyway, in a future study, we should examine the effects of the participant's personality traits on the stability of the color preference in more details, including the explanations of the intersexual differences (in the current survey, only the male participant exhibited significant correlations).

Table2 Coefficients of correlation between the stability of the color preference and general personality traits measured by TIPI

	Extraversion	Agreeableness	Conscientiounsness	Neuroticism	Openness to experiences
Female	−0.01	−0.12	0.02	−0.02	−0.08
Male	−0.22*	0.20*	0.10	0.12	−0.19*
Total	−0.07	0.02	0.07	0.06	−0.13*

*$p < .05$

Table 3 indicates coefficients of correlation between the stability of the color preference and the scores of SCS. Intersexual differences were also observed, as well as in the results of TIPI. In the male participants, the score of the public self-consciousness showed a significant positive correlation against the stability of the color preference. Thus, men who had tendencies to be aware of the self as it was viewed by others from the outside of oneself exhibited more stable expression of their color preference. On the other hand, in the female participants, there was a significant negative correlation between the score of the private self-consciousness and the stability of the color preference. Women who are less inclinable to reflect one's own inner self tended to have more stable color preferences. The results indicated remarkable contrasts between the male and the female participants. It is suggested that peoples who care about how they are looked and thought by other peoples would be more consistent in expressing their color preference, because less private self-consciousness might make public self-consciousness be enhanced as compensation. The stability of the color preference would be affected by the awareness toward self that is looked by other persons (public self-consciousness). If it is true, it should be very interesting because the color preference would originally be considered as very private issues, and people may express one's color preference honestly according only to their inner sense. Given that color preference may also play a role in a kind of "self-expression", the results of the current survey can be consistently explained. The participants with higher public self-consciousness would like to keep a consistency concerning self-expression, and as a result, their color preference would also be stable against a passage of time in order to keep consistency in the self-expression (also refer that the stability of the color preference exhibited significant positive correlation against "agreeableness" in the male participants).

The current investigation was designed to examine a relationship between intrapersonal stability/consistency of color preference and various personality characteristics. The results suggested that the participant's public self-consciousness, not their private self-consciousness, would be a key to understand interpersonal variability of the stability, although we cannot have a clear conclusion yet because there was a huge intersexual difference. In the current survey, correlations of the color preference between the tests were considerably high even with 14 weeks intervals, and thus inter-individual differences concerning the stability of the preference, and the effects of the personality traits on it, would be hardly emerged. In the future study, we have to examine the relationship between the color preference and the participant's personality in the situation where the stability of the color preference is measured by yet different ways other than ranking the color preference (e.g., pairwise comparison, direct rating of degree of freedom using visual-analogue scale and so on).

Table3 Coefficients of correlation between the stability of the color preference and the public and private self-consciousness measured by SCS

	Public	Private
Female	−0.08	−0.24*
Male	0.21*	0.12
Total	0.08	−0.10

*p<.05

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COLOR PREFERENCE BY ELDERLIES FOR COLORED RICE

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Keywords: Rice color, Thai herbs, Elderly people, Preference

ABSTRACT

In Thailand, the number of elderly is increasing. One of problems is Thai senior citizens lost appetite resulted to their health while rice is a main dish for Thais. A previous study showed that, for the aged, blue color from Butterfly Pea Flower (called Aunchun) and yellow from Curmin were the most preferable with the number of 30 tested subjects. This research continuously investigated the preference of colored rice of more subjects. The rice was stained with Thai herbs: Butterfly Pea Flower for blue, Curmin for yellow, Roselle (Kajeab) for red and Pandan leaf (Bi-Tery) for green. To illustrate the almost same colors as real color rice, the color rice stained by the natural materials was carefully taken photographs with CS-100A Konica Minolta. The photographs were uploaded to the website and attached with five-category questionnaires using adjectives such as beautiful, appetite, safe, etc. The experiment was performed by using 9.5-inches-retina Apple iPad. The old people's caretakers were asked and returned answers online. 155 people of over-60-year-old elderlies responded. The result showed that the elderlies preferred blue color rice from Butterfly Pea the most followed by green from Pandan leaf, white original color, red from Roselle and yellow from Curmin respectively.

INTRODUCTION

Findings from the National Health Examination Survey conducted in 1991 showed that the pattern of chronic diseases among Thai elderlies was relatively similar to that in developed countries (Thailand Health Research Institute, National Health Foundation, 1996a) (Table 1). Thailand has been one of the most successful countries as the aged population has grown faster than the growth of total population. Old population in Thailand in the period of 1980-2050 has rapidly increased in the proportion of the older population which implies to a sharp increase in the size of the elderly. Thailand's total population grew by 31 percent between 1980 and 2000, increasing from 46.7 million to just over 60 million at the present. The proportion of the population in their elderly years (over 60) is anticipated to increase from 8.7 percent in 2000 to 10.8 percent in 2010, 15.2 percent in the year of 2020, and 30 percent in the year of 2050. The number of the older people will continue to rise, from approximately 5.3 million at present to 7.2 million in 2010 and will reach 11 million by 2020 (Figure 1). Based on the latest projections from the United Nations, the growth rate of the Thai older population is relatively high, over 3 percent per year. With the growth rate of 3-3.6 percent per year, the size of the older population will have doubling times of aproximately 19-23 years. Thailand will become an ageing society within the next 10 years, according to the United Nations' definition [1].

Table 1: Prevalence (%) of selected diseases among Thai older persons assessed by objective methods from the National Health Examination Survey I.

	Male			Female		
	60-64	65-69	70+	60-64	65-69	70+
Diabetes mellitus*	4.1	4.3	4.2	4.4	6.8	5.5
Hypertension**	8.1	8.2	15.7	12.6	10.8	16.5
Chronic airway Obstruction***	4.3	5.3	7.9	3.4	4.6	5.0
Coronary heart disease#	1.8	4.3	2.6	1.3	2.5	2.5
Hypercholesterolemia ##	15.1	13.9	11.8	25.5	25.1	21.4
Long-standing arthralgia@	51.9	52.5	55.7	64.5	69.4	64.9
Long-standing back pain@	49.5	53.7	50.2	52.6	52.6	54.7

** fasting plasma glucose above 140 mg/dl*
*** blood pressure above 160/95 mmHg*
**** peak flow rate below 80% of the predictive value plus historical criteria # using electrocardiogram criteria*
total serum cholesterol above 240 mg/dl
@ duration for more than 6 weeks

Source: *Thailand Health Research Institute, National Health Foundation, 1996a*

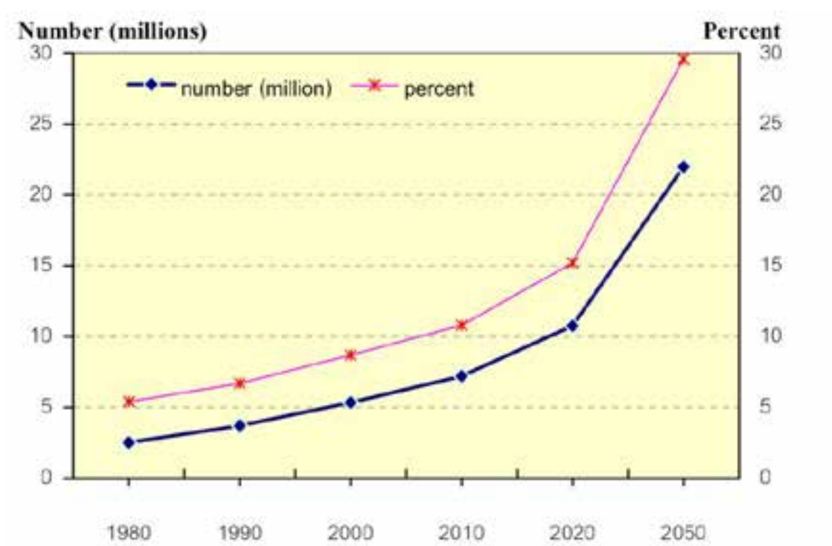


Figure 1: Linear graph of total number and percent of the older population in Thailand, 1980 - 2050.
Source: *Calculated from data provided by the United Nations, 1999b*

However, according to the survey of the research titled System Development of Disease Treatment by Rujijan Vichivanives, the herbs were used to help the elderly and the people with 32 years and above who have been interested to always take care of their health. 36 kinds of herbs were brought to help adjusting their health to normal conditions under the announcement of Primary Care

Commission in order to support ailments related to life elements of each person in the total of 250 symptoms, especially people who have earth element tend to get pain more than wind, water and fire elements.

Currently, herbs with particular colors and smells can be applied with white rice to motivate or lower the consumers' appetite. Additionally, each kind of Thai herbs has various properties. For example, Butterfly Pea is a type of herbs with blue color and helps expelling waste from body. Rosella gives red color and helps dissolving fat in blood vessels. Curmin can relieve pain and inflammatory because of arthritis, and increase body immunity. Pandan leaf can lower blood pressure and protect blood coagulation.

According to this research, there were problems as follow: 1) The elderlies do not feel appetite which affects their health 2) Rice is a main course in Thailand since the last research results showed that green and yellow colors were equally selected by the elderlies which were the most preferred colors and 3) The number of answered subjects was 30. Therefore, the research aimed to deeply investigate the preference of colored rice of Thai elderly people with more subjects.

EXPERIMENT

This research focused 4 dye colors from Anchan (Blue), Bi-Tery (Green), Ka-jeab (Red) and Curmin (yellow) as shown in Figure 2. In the Figure 3 showed rice after stained.

(a) Anchan, (b) Ka-jeab, (c) Bi-tery, (d) Curmin

Figure 2: Thai herbs

Figure 3: Colors of rice after stained.

The color of rice taken with CS-100A Konica Minolta shown in Figure 4. The circle symbols represented colors of real rice and x symbols were colors in the pictures measuring on the display (iPad). The colors of pictures were controlled similarly to the colors of real stained rice.

The online questionnaire was made with ten adjectives; 1) innovative 2) notable 3) attractive 4) clean 5) beautiful 6) safe 7) healthy 8) more appetite 9) stimulating and 10) interesting. The subjects must be 60 years old and above. 146 elderlies were participated in the experiment. The scale was divided into 1 for most dislike, -0.5 for dislike, 0 for neutral, 0.5 for like and 1 for extremely like.

The result of the previous paper showed ten adjectives from five colors shown in Table 2. Initially, for green color, the highest selected adjective was of healthy. For the yellow color, the highest adjective was healthy. Next, for blue color, the highest selected adjective was exotic. The highest selected adjective for red is exotic. The high selected adjective is safe for white color. Also, both green and yellow were selected the same adjectives which were healthy.

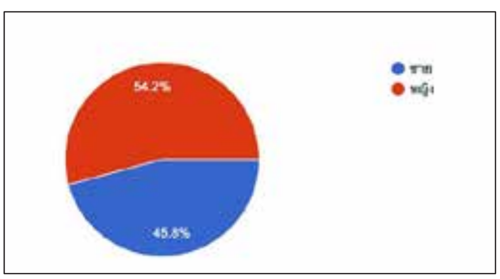
Table 2: Number of selected rice colors among Thai old people selecting adjective were healthy with methods from the Rice Colors Preferred by Thai Elderly People Survey I.

Adjective	Bitery (Green)	Cermin (Yellow)	Aunchan (Blue)	Kajeab (Red)	Normal White Rice
Exotic	12	8	14	5	0
Eye catching	11	12	10	3	0
Attractive	13	11	9	3	0
Clean	4	3	0	1	11
Beautiful	6	4	13	1	1
Safe	4	2	1	2	15
Healthy	15	14	1	5	13
Appetite	4	1	3	2	0
Stimulated	6	5	4	1	1
Interest	9	1	7	3	0

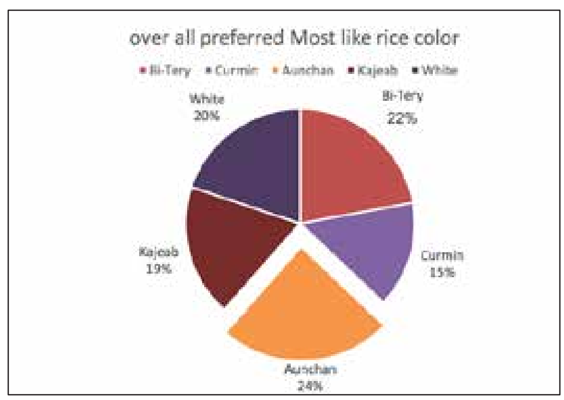
Source: *Rice Colors Preferred by Thai Elderly People, 2018*

RESULTS AND DISCUSSION

The classification of 150 elderly genders was 80 females and 70 males shown in Figure 3(a). Those subjects realized of the herbs that were used to stain rice. The overall result of preferred colors of rice showed high frequency of blue for 86 persons (24%), green for 78 persons (22%), white for 70 persons (20%), red for 66 persons (19%) and yellow for 53 persons (41.5%) respectively shown in Figure 3(b).



(a) Elderly Genders

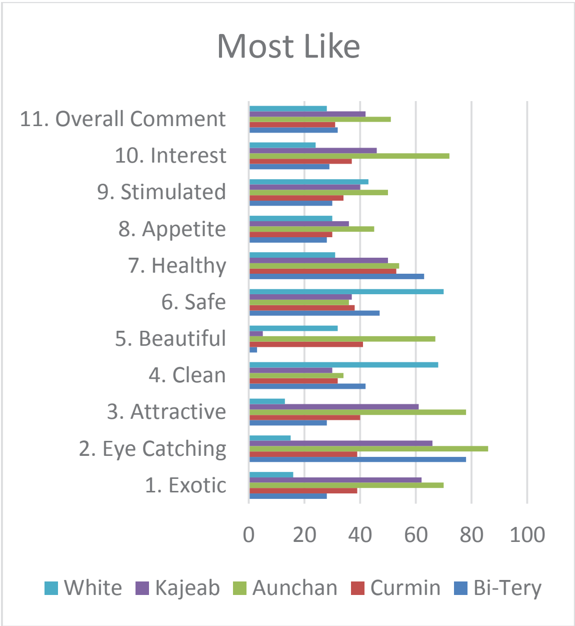


(b) Overall preferred colors of rice

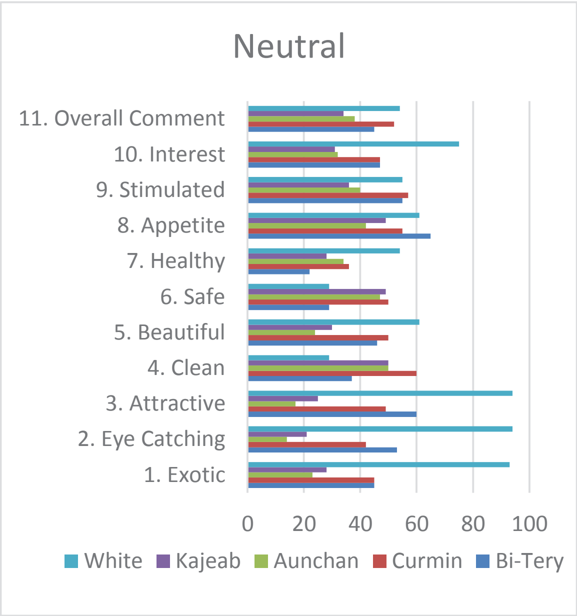
Figure 3: The overall preference of rice in 5 colors.

The result of questionnaire were 10 adjectives divided into four categories; Extremely Like (Figure 4a), Like (Figure 4b), Neutral (Figure 4c), Dislike (Figure 4d), and Extremely Dislike which did not have the number of the elderlies in this preference category.

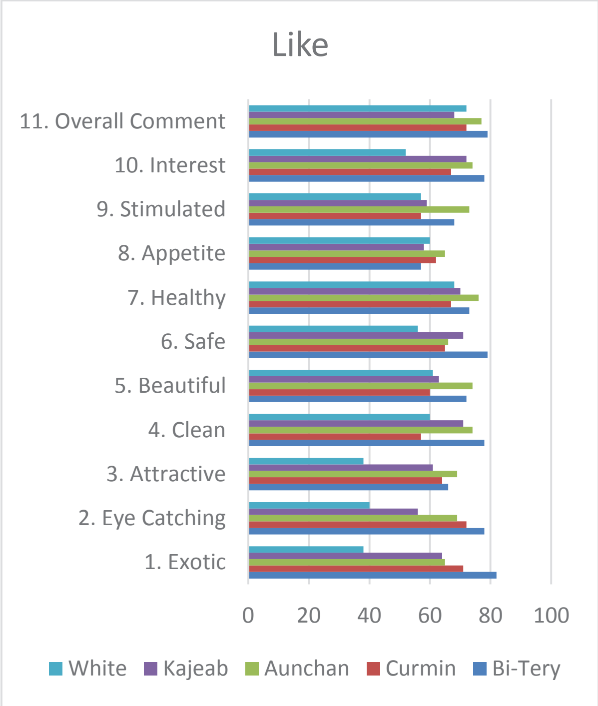
The differences of rice color preference of the elderlies could portray the most favorite rice colors which were from Bi-Tery, 82 people, followed by Aunchun, 77 people. The aged equally liked natural rice color, Krajeab and Curmin for 72 people. For the neutral feeling, 94 old people agreed to natural white rice followed by 60 for Baitoey and Curmin, and 50 for Aunchun and Krajeab respectively. The highest disliked colors were from Krajeab, white rice, Curmin and Baitoey for 12, 10, 9 and 5 respectively as seen in the Figure 5.



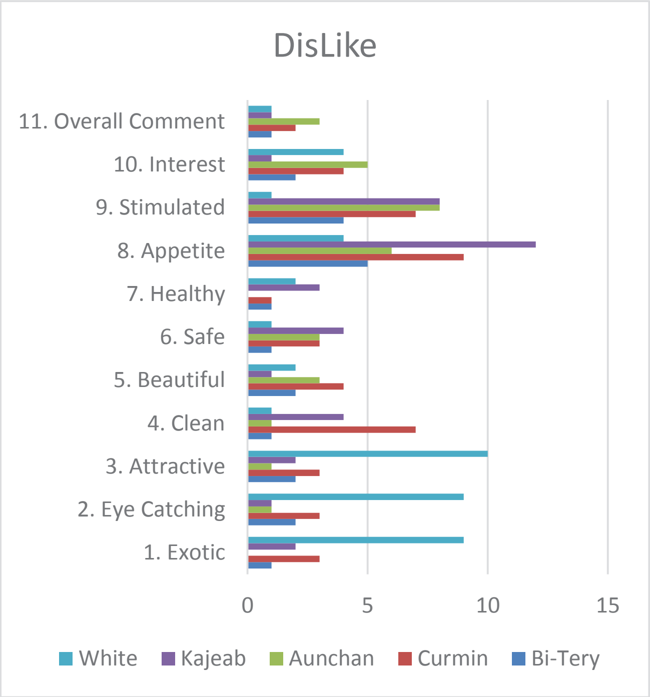
(a) Most Like Feeling of rice colors



(b) Neutral Feeling of rice colors



(d) Like Feeling of rice colors



(e) Dislike Feeling of rice colors

Figure 4: The overall preference of feelings.

When an increasing number of the aged has been associated with the different rice color preferences in the previous research and various ages of the old people could result in the rice color preference. The most important factors can be accounted to familiarity and individual appetite popularity. The research found that the elderlies aged 60-65 years old preferred to choose rice colors more than the 65-80-year-old senior citizens who were older and were mostly familiar with eating white rice as well their unclear eyesight.

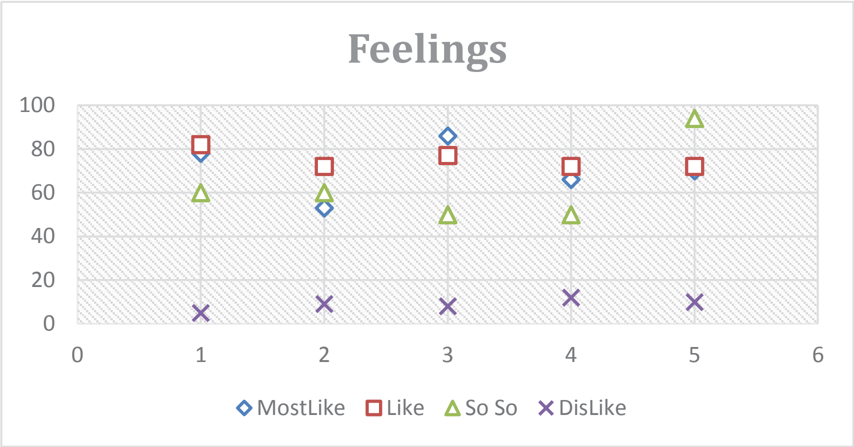


Figure 5: The overall preference of Feeling.

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COLOR BOUNDARY DETERMINED BY COMPARISON WITH 12 COLORS ON YOUNG AND ELDERLY

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Keywords: color boundary, illumination, elderly vision, color temperature

ABSTRACT

This psychophysical research aimed to investigate the color boundary determined by comparison with 12 colors on young and elderly. The viewing environment was daylight at 6500 kelvin 700 lx and incandescent light at 2800 kelvin 700 lx. 1,046 Toyo Ink color chips of variety colors across color gamut were randomly prepared to subjects so they judged each color chip under each lighting and assigned to a certain color box out of 12 predefined color names. The 12 colors are Red, Red-Yellow, Yellow, Yellow-Green, Green, Green-Blue, Blue, Blue-Purple, Purple, Purple-Red, Pink, and Brown. If decision to assign the chip to color boxes could not be decided, the chip put to "Out" box. Subjects were 30 young (25-35 years) and 15 elderly (60-70 years). Result showed that color boundary judgement for the 12 colors of elderly and young are not significantly different, either under daylight or incandescent light. From the 12 predefined names, we found average color value and a*b* color boundary of each color. Using the multivariate analysis of variance, MANOVA, we found that color boundary is more relate to the color value than the factor of age group or the lighting for color observing.

INTRODUCTION

The population of elderly in Thailand is increasing. Elderly color vision deteriorated when they are getting aged, mostly due to the increasing degree of cataract. To name colors identification correctly in our daily visual task, the database of color boundary naming for each basic color terms should be observed.

Berlin and Kay [1] proposed that there are 11 basic color terms which are Red, Orange, Yellow, Yellow-Green, Green, Blue-Green, Blue, Purple, Pink, Brown, White, Gray, and Black. The proposed color terms were commonly used in many languages which may correspond to universal perceptual color categories. Ishida [2] investigated the color identification obtained from photopic to mesopic illumination levels based on 11 basic color terms. His result shows the different color perception especially under mesopic illumination. Kawamoto [3] investigated the effect of illuminance (three levels: 10, 100, 1000 lx) on the viewing of color. The sample color chips were judged under illuminance to match the designed Munsell color chips of 11 categories. He reported that the color identification was deteriorated when either the illuminance was low (10 lx), or the lightness of the chips was low in the elderly. He also found that there were some color chips whose categorization was same regardless of observer group or illuminance in the categories of black, blue, purple and green. Sagawa [4] applied the color matching test to study the spans of categorical colors under 500 lx and 0.5 lx. He used predefined 286 color samples to match the 20 reference colors.

ORAL SESSION

The previous research has done on illumination levels investigation of white light. Some were comparing elderly and young adult observers. The quite small number of color chips aim on main and clear color, and limit the gradation of colors between main colors which are in our daily life. The judgement of fine gradation of color change will reflect more reality we face in our daily life. The investigation of colors perceived under different color temperature of light source have not when directly compared, especially when it view by different age groups.

This research aim to investigate the color boundary of young and elderly under daylight and incandescent light. The database will ascertain designer awareness of color perception difference among elderly and young, so they can design visual sign that properly suitable for elderly.

METHODOLOGY

Subjects experimented under daylight and incandescent light of 700 lx in the living atmosphere. The 1,046 printed color patches from Toyo Ink were used to represent the overall color variety throughout color gamut. The 12 basic color terms were used for target color boundary of color patches. They are Red, Red-Yellow, Yellow, Yellow-Green, Green, Green-Blue, Blue, Blue-Purple, Purple, Purple-Red, Brown, and Pink. Color patches that cannot assign into those colors were put into OUT box. There were 45 subjects participated in this research: 30 young subjects age between 25-35 years and 15 elderlies age between 60-70 years old. Subjects were recruited by testing Farnworth 100 Hue Test to screen out the color deficiency subjects. Subjects get paid for doing experiment.

The experimental room was constructed in the size of 1.8 x 1.8 meter wide and 2.3 meter high. Wall was painted dull white color. Experimental room was decorated like living room. The Panasonic LED light (HH-LC714A) was fit on the ceiling in the middle of the room. The light was adjustable for color temperature and illumination power. A table was put in the middle of the room under the light. Subject sit under the light and view color patch on the surface of table at the distance of 1.5 meter from the light. The light was adjusted for daylight of 6,500K at 700 lx in the first round of experiment, and adjusted to 2,700 K at 700 lx in the second round of experiment. The experimental setup is shown in Fig. 1

Figure 1. Experimental setup

RESULTS

The data obtained from subjects were the selected color chips with codes of Toyo Ink database. The codes were referred to the L*a*b* value of each color chip. The frequency each color chips selected by subjects were plotted in the graphs in Fig 2 and Fig 3. The CIELAB data of each selected color under each color name then calculated for average L*a*b* of that color name, and a*b* value plotted in the graph in Fig 4. Then the statistical analysis of multivariate analysis of variance (MANOVA) was done in SPSS and show the result in Table 1.

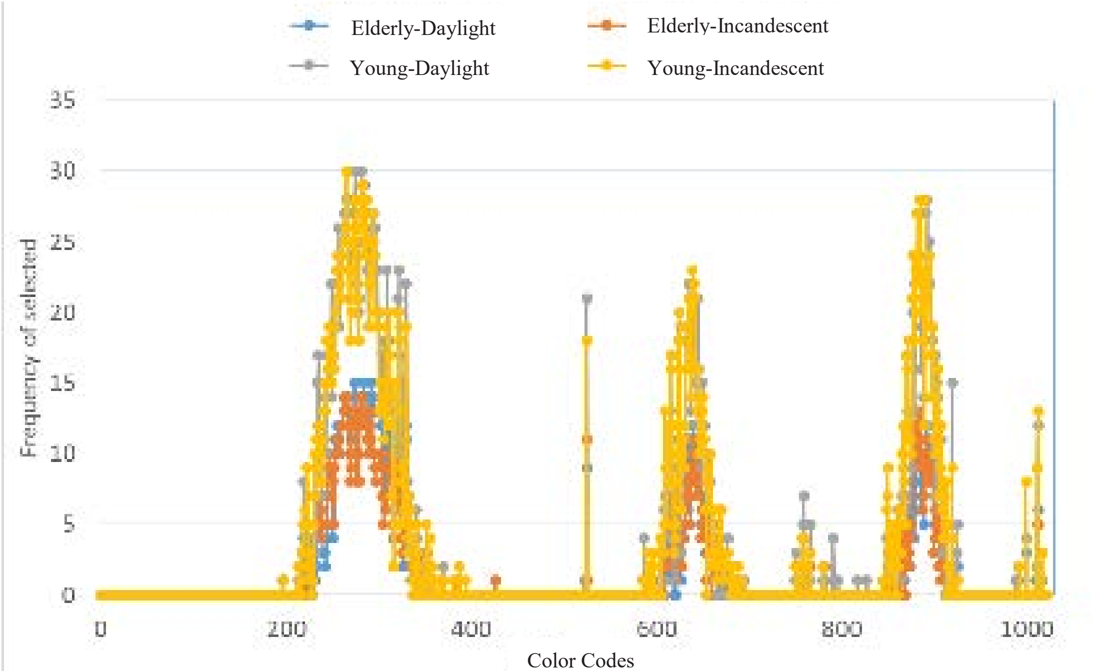

Figure 2. Frequency of selected color chip of Green color

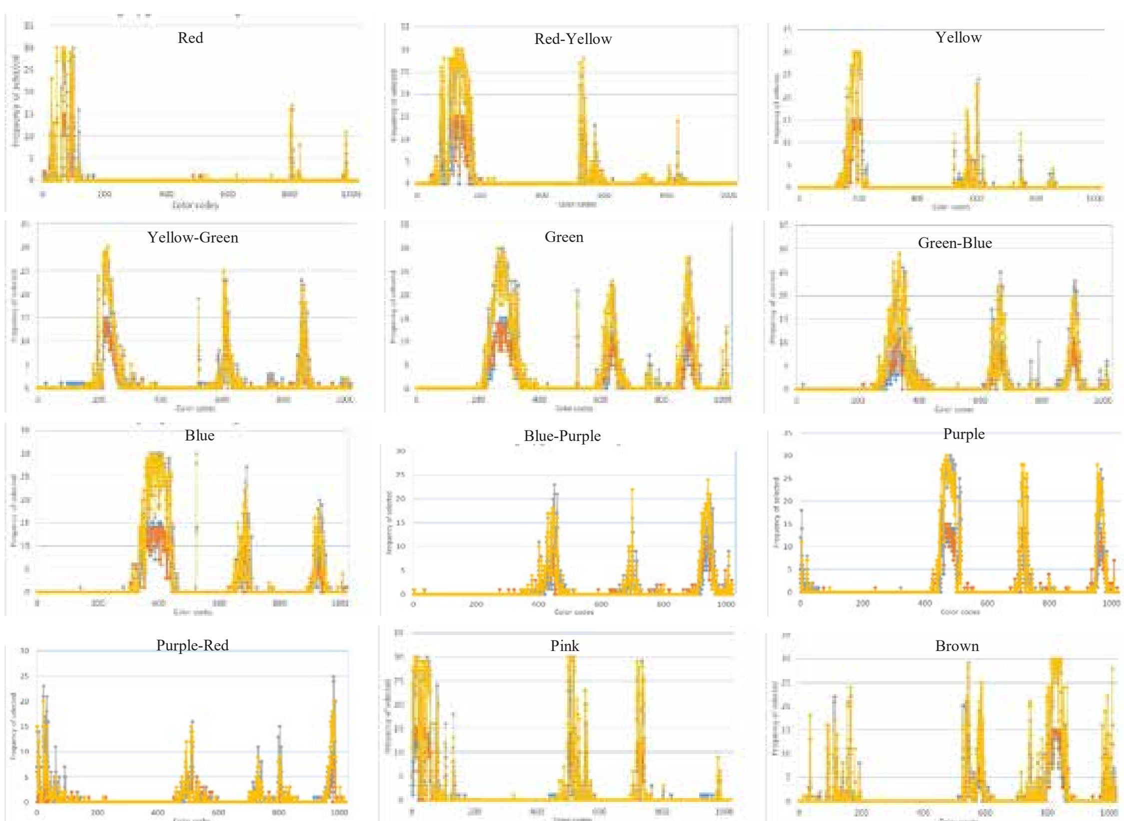

Figure 3. Frequency of selected color chip for each of 12 color names obtained from elderly and young subjects experimented under daylight and incandescent light.

ORAL SESSION

Fig. 2 shows the results of frequency for each color chip that has been chosen as Green color. The horizontal axis demonstrated the chip number from 1 to 1,046. The vertical axis is the frequency of selected as the color name. Since the number of subject for elderly and young are not the same (15:30) the base for frequency of selected are different for elderly and young. However the selection for color name of each chip are agreeable throughout the color space, as seen in graph of Elderly-Daylight, Young-Daylight, Elderly-Incandescent, Young-Incandescent. We can see that the pattern of chosen color for elderly and young, under daylight or incandescent light are in the same pattern. The decision to assign to a color boundary for each color chips based mainly on its color rather than the age group or the illumination.

Fig. 3 demonstrate the pattern of frequency distribution of all 12 colors. Each color has similar frequency pattern as explained in Fig. 2.

The color boundary of 12 color names traced from the average CIELAB color value of each color chip that has been selected as the given color name. The graph in Fig. 4 represent the a*b* coordinate of each color. The horizontal axis is the a* and vertical axis is the b*. The average color value of the 12 color names are plotted with the symbol of each color. The standard deviation of the a* and b* of each color represent the boundary of that color. Most of the colors are well distributed across the color gamut, except for the Purple-Red and Pink that are very close together.

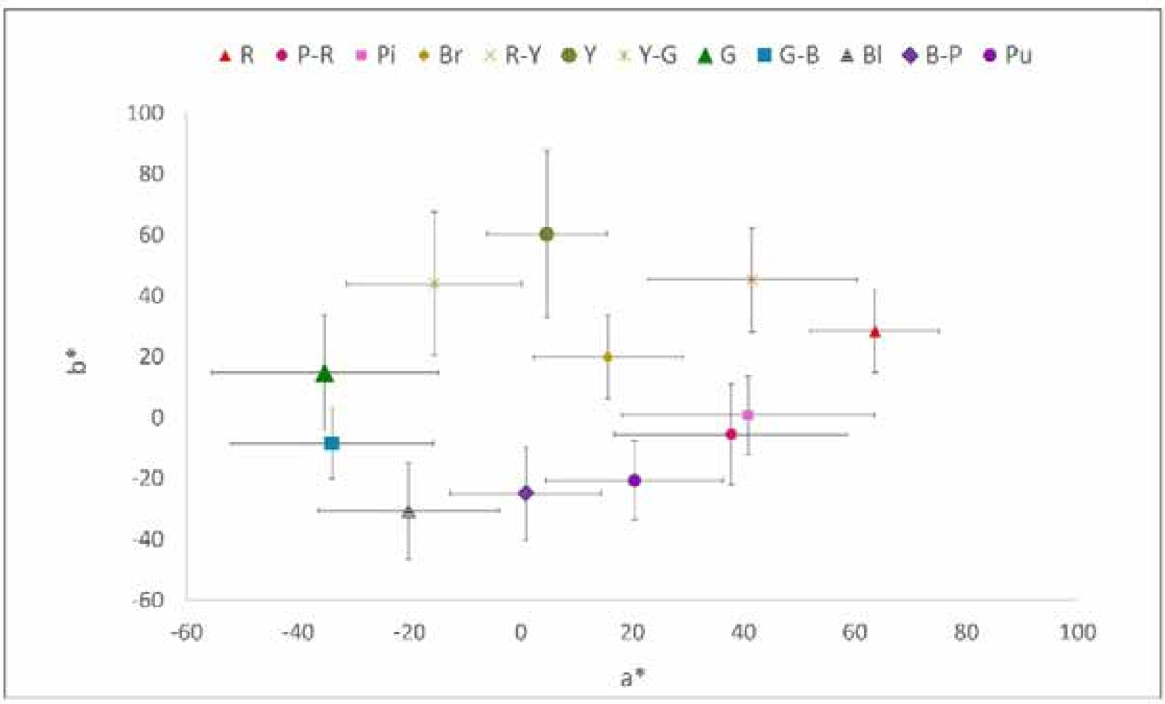

Figure 3. The a*b* value of 12 color names obtained from elderly and young subjects experimented under daylight and incandescent light.

To statistically evaluate the relation of color name and other dependent variables we run the multivariate analysis of variance (MANOVA) test in SPSS. Result shows that only color name affect the CIELAB color value (dependent variables) significantly [$F(36, 277988.315) = 11222.254$ (Wilk's Lambda) $p\text{-value}<0.001$)]. The variables of age groups and lighting illuminance not significantly affected, as shown in Table 1.

Table 1. The result of multivariate analysis of variance (MANOVA) of Lighting, Age groups, and Color names by Wilks' Lambda statistic.

Result	Wilks' Lamda statistic	F	Sig.
Intercept (cross)	.081	356352.833b	0.000
Colorname	.071	11222.254	0.000
Group (Elderly and Young)	1.000	.[b]	
Groupdetail (Elderly-Daylight, Young-Daylight, Elderly-Incandescent, Young-Incandescent)	1.000	.[b]	
Lighttype	1.000	.[b]	
colorname*Group	1.000	.[b]	
colorname*Groupdetail	1.000	.[b]	
colorname*lighttype	1.000	.[b]	
Group*Groupdetail	1.000	.[b]	
Group*lighttype	1.000	.[b]	
Groupdetail*lighttype	1.000	.[b]	
colorname*Group*Groupdetail	1.000	.[b]	
colorname*Group*lighttype	1.000	.[b]	
colorname*Groupdetail*lighttype	1.000	.[b]	
Group*Groupdetail*lighttype	1.000	.[b]	
Colorname*Group*Groupdetail*lighttype	1.000	.[b]	

b. Exact statistic

CONCLUSION

For the color boundary of 12 color names: Red, Red-Yellow, Yellow, Yellow-Green, Green, Green-Blue, Blue, Blue-Purple, Purple, Purple-Red, Brown, and Pink, result showed that color boundary judgement for elderly and young are not significantly different, either under daylight or incandescent light. The result from this study can ascertain young designer to use the 12 basic colors in the visual sign design that the given color within its boundary can be used successfully for elderly as well as the young, either under daylight or incandescent light. Look into the distribution of color names, we found that most of the colors are well distributed across the color gamut, except for the Purple-Red and Pink that quite close together. We would suggest to pick either Purple-Red or Pink but not both of them together.

The 12 color terms used in this research were derived from the concept of Berlin and Kay basic color terms. However, only chromatic colors were included, and achromatic color not included. In this research the achromatic colors were not included. Further study might include the achromatic colors as well as the colors with addition of white such as Light Blue, which actually one of the basic color for Thai people, but not define as main color by the concept of Berlin and Kay. The cross cultural color boundary also worth investigated.

ACKNOWLEDGEMENT

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COLOR MEASUREMENT AND CHARACTERISTICS ANALYSIS FOR PORCELAIN

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Keywords: Porcelain, Dominant wavelength, Color purity, Color difference

ABSTRACT

The identification of porcelain is an important means of cognizing ancient cultures. The most major ones of methods for the identification of porcelain are two kinds: the first one is the empirical identification method, which is carried out through reserving the color, texture, shape and the image on porcelain; the other is through analysis, testing, measurement and other modern scientific means to identify. The color of porcelain is the most direct external performance of porcelain, and also is an important factor that can't be ignored in the two methods of identification. This article is dedicated to find out the similarities and differences between same types of porcelains, the differences between different types of porcelains by analyzing their colors, which will provide an objective basis for the porcelain characteristics analysis such as ages, materials and so on.

Two kinds of porcelains (peacock blue and yellow glaze) from different places of origin in ancient China are studied in the article. Because the porcelain samples used are some damaged small tiles, which have the characteristics of non-flatness, small area, strong luster and so on, many instruments can't obtain their spectra. In this article, the spectroradiometer is used to measure the spectral data of each porcelain sample in the experiment. Then some chromaticity data of sample such as dominant wavelength, color purity and L*a*b* values were calculated based on the tristimulus values.

Through analyzing, some results can be got by us: the dominant wavelength and color purity of the inner and outer surface of the yellow glaze is not too different; yellow glaze has the characteristics of better hue consistency and higher color purity than peacock blue; the color distribution of porcelain based on difference of the ages (origin) on the CIELAB-a*b* chromaticity diagram has a certain regularity. These results provide more objective data support for empirical identification of porcelain.

INTRODACTION

Porcelain can show the culture and development of an era, and identification of porcelain is an important means of understanding ancient culture. At present, the identification of ancient porcelain mostly relies on the expert's visual experience to judge the ages from the color, pattern and recognition of porcelain. For example, Sun Yingzhou [1] put forward several methods to appraise the porcelain from Yuan, Ming and Qing Dynasties: (1) Color and pattern: from simple to complex, what's more, black color not exceed the early Zhengde, pastel not exceed the late Kangxi. (2) Peptide glaze: identification of peptide substance is mainly observation of bottom foot, such as in the Yuan Dynasty, the bottom foot of the vessels was rich in peptide and coarse in quality. (3) Modeling: from simple to complex, most shapes of porcelains from the Yuan Dynasty are blunt, unadorned and childish. (4) Recognition: porcelains with recognition from Yongle time are less; the recognition of porcelains from Chenghua time is rich, from Hongzhi time is elegant. Li Na [2], in the paper about the development of peacock green glaze porcelain, mentioned that the peacock green from Cizhou kiln in Song and Yuan Dynasties was very similar to that of peacock green in Ming and Qing Dynasties , but the color was bluer and darker. Because of the purity and delicacy of peptide soil in Qing Dynasty, the optimization of embryo-making technology and the mastery of firing temperature, the peacock green glaze in Qing Dynasty changed more than Ming Dynasty, such as some are thick lush and some are light and pure. Dong Aifeng [3] made a comparative study on the colors of the peacock blue in Ming Dynasty and the peacock blue restored and reappeared by new research. It was found that the brightness (L) of the new glaze was about 40 and that of the old glaze was about 25. The purity of the new glaze was higher than that of the old glaze.

Experts must have a certain historical and cultural foundation and long-term experience in visual judgment when they use experience appraisal method to appraise porcelain. In identification experience, color is the most direct external expression of porcelain. The unique glaze color and decoration of porcelain can show the specific cultural and technological characteristics of a certain era and plays an important role in the identification of visual experience. But in this process, there is often no objective quantitative data or data range for the color expression, which makes it difficult for these porcelain color classification to have a definite objective basis.

In view of the above problems, the relationship between glaze color and porcelain ages (origin) can be discussed in this paper. However, due to the particularity of porcelain luster and shape, different measurement methods can obtain uncertain color data. Therefore, the measurement method of glaze color of porcelain is explored: spectroradiometer is used to measure spectral composition of porcelain sample in our experiment. Spectral data is used to calculate the color parameters and analyzed to get color characteristics and regularity, which provide data basis and method for porcelain identification.

METHOD

Yellow glaze and peacock blue are studied in this paper. Color characteristics of porcelain of each kind color can be got by calculating and analyzing the dominant wavelength range and color purity of each kind of porcelain. The relationship between color and ages (origin) is explored based on color characteristics of porcelain.

1. *Color purity*

Color purity refers to the degree of color of the sample close to the spectral of the main wavelength. Color purity can be expressed by chromaticity coordinates.

$$p_e = \frac{x - x_n}{x_d - x_n};\ p_e = \frac{y - y_n}{y_d - y_n} \quad (1)$$

In the formula, (x, y) (x_n, y_n) (x_d, y_d) are the chromatic coordinates of the sample, white point and the spectral color (at the dominant wavelength or the complement wavelength). The calculation results of the two formulas should be the same, but if the line between the sample and the dominant wavelength tends to be parallel to the x-axis of the chromatogram, the error of the Y-type is large, the X-type should be adopted; otherwise, the Y-type should be adopted.

2. Dominant *wavelength of color*

The dominant wavelength of S1 refers to the wavelength of a monochromatic light stimulus. The monochromatic light stimulus, mixed with a prescribed colorless stimulus in a certain proportion, can match the color S1. The position of the colorless stimulus on the chromatic map is called a white spot.

$$k_d = \frac{y_d - y_n}{x_d - x_n};\ k = \frac{y - y_n}{x - x_n} \quad (2)$$

In the chromaticity diagram, three points (S_1, white spot and the main wavelength S_1 spot) should be collinear, in other words, k_d=k.

3. CIE1976 L*A*B*

CIE1976 L*a*b* color space is a kind of visual chromatic aberration uniform color space, where L* stands for brightness, a* stands for red and green, and b* stands for yellow and blue.

EXPERIMENT

1. Selection of spectrometers for measuring porcelain

The porcelains studied in this paper are some damaged porcelain tiles, as shown in Fig.1. It is not suitable for spectrophotometer, fiber optic spectrometer and PR715 Photometer to measure its spectral power distribution because of its irregular surface, certain gloss and partial damage of porcelain. In order to obtain accurate color data of porcelain, it is required that the caliber of the spectrometer is appropriate and the position of the sample is not fixed. In this paper, a spectroradiometer is used to measure the spectral data of the porcelain.

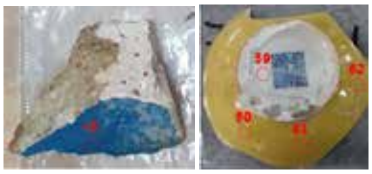


Fig. 1 Sample 10 of peacock blue and sample 7 of yellow glaze

2. Measurement of porcelain spectra

The information of porcelain (number of samples, ages, origin and so on) is shown in the table.1.

Table.1 feature of two kinds of porcelain (yellow glaze, peacock blue)

	number of samples	*peptide measurement points*	*outer surface measurement points*	*inner surface measurement points*	*total number of measurement points*	*ages information*	*Origin information*
yellow glaze	*12*	*20*	*36*	*25*	*81*	✓	
peacock blue	*12*	\	*49*	\	*49*	✓	✓

The experiment is designed to suitable for porcelain sample measurement shown in fig.2. The basic steps of the spectroscopic measurement of porcelain are as follows:

(1) Put the standard whiteboard in a standard light box and measure its spectrum with a spectroradiometer;

(2) Select the multiple measuring points of the porcelain, which can represent the color or special point of the porcelain (no damage and no stain);

(3) Place the porcelain in the light box, adjusting the position of the porcelain so that the light source is irradiated perpendicularly to the measuring point;

(4) Measure the measurement points by a spectroradiometer.

Fig.2 Measurement experiment in standard light source box

3. *Measurement results of porcelain* spectral data

Fig. 3 is the spectral reflectance of 12 yellow glazes and 12 peacock blue.

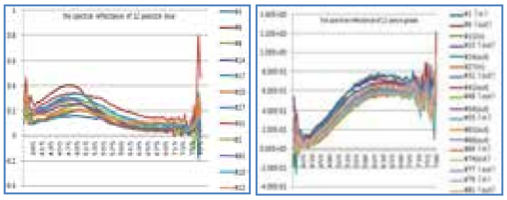
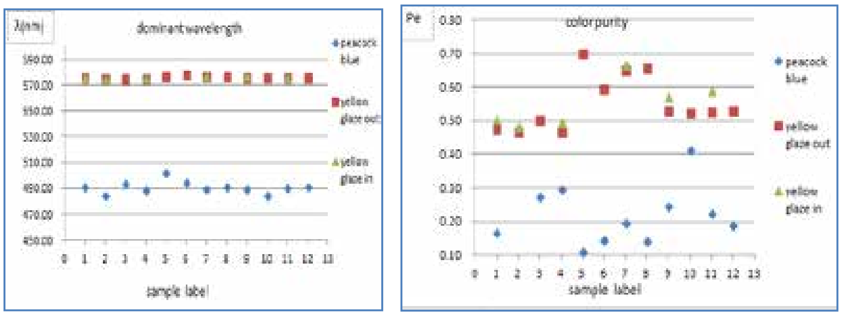


Fig. 3 Spectral reflectance of samples

RESULTS AND DISCUSSION

The color data (dominant wavelength, color purity) of each sample point was calculated by formula (1-2) based on spectral data measured by spectroradiometer. We're trying to find something common from the color data of the same age (place of origin) by analyzing the color data.

1. *Two kinds of porcelain color characteristics*

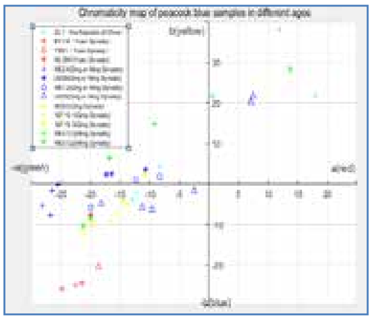


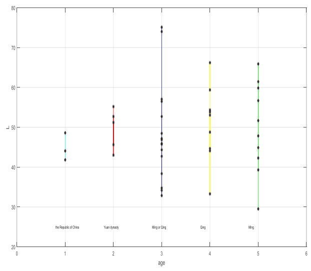
(1) Dominant wavelength (2) Color purity

Fig.4 Color characteristics of yellow glaze and peacock blue

As can be seen from fig4(1): the dominant wavelength of the inner and outer surface of the yellow glaze is not too different; the dominant wavelength range of peacock blue is wider than the yellow glaze. It can be seen from fig4(2): the color purity of the inner surface of the yellow glaze is a little bigger than the outer surface; the color purity of peacock blue is much smaller than the yellow glaze. These color information shows us the characteristics of yellow glaze as court color, such as hue consistency and high color purity.

2. *The relationship of two kinds of porcelain between color and ages (origin)*



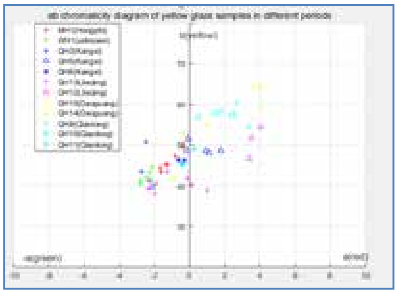


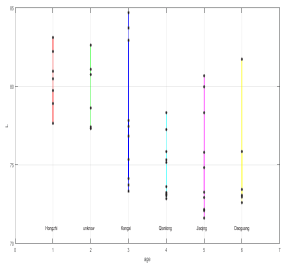
(1) a*b* chromaticity diagram (2) L luminance diagram

Fig. 5 CIELAB datas of peacock blue samples in different ages

As can be seen from fig.5(1): the color of peacock blue samples from Yuan Dynasty is more cyan; from Qing Dynasty is more green; from Ming Dynasty is yellow and green; the color of samples from Qing or Ming Dynasty(except LM25 sample) is more green. According to the above rules, the possibility, samples from Qing or Ming Dynasty is the Qing Dynasty, is relatively high (except LM25 sample).

Fig.5(2) shows that the luminance distribution of Ming Dynasty and Qing Dynasty porcelain samples is similar, the luminance distribution range of Yuan Dynasty is small, and the sample of the Republic of China is less, which is inconvenient for analysis.

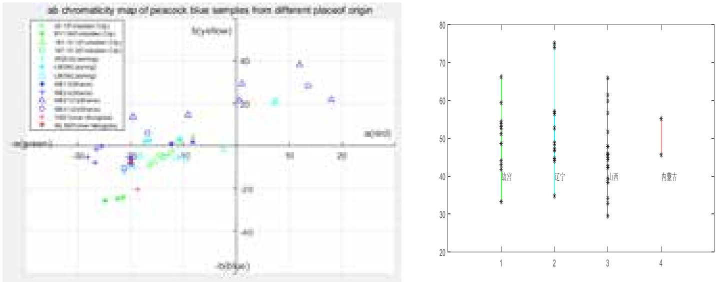




(1) a*b* chromaticity diagram (2) L luminance diagram

Fig. 6 CIELAB datas of yellow glaze samples in different periods

Fig.6(1) shows the color of yellow glaze samples from Jiaqing is more red; the saturation of samples from Kangxi is moderate; the saturation of samples from Daoguang and Qianlong can reach higher. Because porcelain is from the Qing Dynasty, the color coincidence of the samples in different periods is relatively high, but there are still characteristics of each periods. As can be seen from fig.6(2), the average luminance of the samples in the first three periods is higher than that in the last three periods. From Hongzhi to Daoguang, the minimum brightness is decreasing.



（1） a*b* chromaticity diagram (2) L luminance diagram

Fig. 7 CIELAB datas of peacock blue samples from different place of origin

Fig.7(1) shows the color of peacock blue samples from Forbidden City is more blue; from Liaoning is more green; from Shanxi is green and yellow. It can be seen from fig. 7(2) that the brightness distribution range of peacock blue samples from different place of origin is not much different, but the brightness of Shanxi porcelain is more uniform than that of Liaoning.

CONCLUSION

In this paper, the spectrums of porcelain were measured by spectroradiometer. The color data can be got by spectrum data of the porcelain. The color characteristics and the relationship between porcelain color and ages (origin) can be obtained by analyzing:

(1) the dominant wavelength and color purity of the inner and outer surface of the yellow glaze is not too different; yellow glaze has the characteristics of better hue consistency and higher color purity than peacock blue;

(2)The distribution of porcelain based on difference of the ages (origin) on the CIELAB-a*b* chromaticity diagram has a certain regularity, and there are also certain differences in the brightness, from the distribution range and uniform.

These findings provide a basis for identification of porcelain. Because each sample has not enough measurement points and samples in different ages or place of origin, the experimental results need to be further improved.

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HOM THONG BANANA RIPENING COLOR SCALE FOR INDIVIDUAL PACKAGING SELECTION IN THE RETAIL MARKET

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Keywords: Hom Thong Banana, Individual Packaging, Banana Ripening Color Scale, Retail Market

ORAL SESSION

ABSTRACT

The objective of this research is to investigate the appropriate design selection of individual packaging with material type, packaging size, the percentage of permeability for gases and water vapor (% Open air hole) by measuring Hom Thong banana ripening color scale from green to yellow color. The methodology of this research is to select a banana color scale for consumption to adapt from the CSRIO standard by using the spectrometer color measurement. The consumer's preference split from 0% to 100% by calculating the percentage of the banana ripening area. The boundaries of the area divided into five slots and the level in each slot have three scales. The result of this research found that the color of Hom Thong bananas for the retail market can be divided into banana ripening color scales from green color with the average value of u'0.1836 and v'0.5403 to yellow color with the average value of u'0.213 and v'0.538. The nine color scales set for classification which is the appropriate design selection of individual packaging to keep Hom Thong banana for the long life of storage. The comparison between the material type of packaging, it found that Polyethylene and Polypropylene material does not differ of the percentage of banana ripening color scale. The packaging size the effect, the result found that small size (14 x30 cm.) can keep a long life of storage than big size (20x30 cm.). The comparison between closed seal packaging and opening air hole packaging has different significantly in banana ripening color scale. The suitable permeability for gases and water vapor at 0.3-1% can reach to desired banana respiration rate and keep long life of storage than closed seal packaging. The contribution of this research can expand to agricultural farmers to apply the appropriate packaging for Hom Thong banana in the retail market.

INTRODUCTION

Hom Thong Banana (*Musa acuminata* AAA Group 'Gross Michel') is a significant economic fruit of domestic consumption and export to foreign countries, especially in China and Japan. Both domestic and foreign markets demand it. According to the Department of International Trade Promotion reported by Pisanwanich, A.[1] that shows The statistic of Hom Thong Banana for export about 171,000 tons. In the domestic market, Hom Thong banana is expanding from the fresh market to convenient stores and modern trade. The packed size for retail market is to pack for individual pack one piece/bag and 4-2pieces bag and fit for consumers. The banana is popular with many groups of consumers from youth, adult, and elderly groups. The main problem of Hom Thong Banana is the short life of storage and sensitive products for transportation. So there is a considerable loss only 5-7 days after harvest. This period is shorter than fruits with low respiratory rates, such as oranges, apples and hard fruits. Ripe bananas are the for its flavor, texture, and high nutritional value is popular with consumers. Because banana is a fruit in the climacteric fruit group has a high respiratory rate. The appearance of color skin is the main criteria of the customer for buying decision.

Focusing on a relation between the ripening process of banana and appropriate packaging. There are a number of relevant studies such as that by Wongs-Aree, et al.[2] to study various plastic bags for storage life extension of Emperor banana for export by keeping banana combs in sealed polyethylene bagged (PE), active polyethylene bags (AC) and ethylene absorbent bags (EA) and compare with non-bagged banana (control). All treatments were kept at 13° C for 30 days. Storage in PE bags significantly prevented weight loss and delayed the senescence of the banana by retarding peel yellow changes, firmness and an increase of total soluble solids compared to other treatments when control banana fully ripped on day 24. According to the previous studies about the ripening the process, banana undergoes significant color and textural transformations. The peel color changes from green to yellow due to the synthesis of a few pigments [3]. Consumers usually judge the quality of banana upon the first visual assessment. CSIRO [4] who conclude that color act as an important indicator of RS of banana to influences consumers acceptability. The peel color is used as a predictor of shelf-life for retail distribution. The objective of this research is to investigate the appropriate design selection of individual packaging with material type, packaging size, the percentage of permeability for gases and water vapor (% Opening air hole) by measuring Hom Thong banana ripening color scale from green to yellow color from the retail distribution to customers.

METHODOLOGY

The research adopts the methodology in Wongs-Aree, et al. [2] and modifies them to visual inspect by color [5]. The methodology of this research consists of three parts.

Part 1: Developing a packaging of individual Hom Thong banana

The researchers study various plastic bags in material type in sealed Linear Low Polyethylene bagged (LLDPE) and Polypropylene bagged (PP), Position of Opening air hole, Diameter of Opening air hole, Bagged size, the percentage of permeability for gases and water vapor (% Opening air hole) for storage life extension of Hom Thong banana for retail market by keeping one piece of banana in seal bagged and non bagged banana (control). All treatments were repeated five replicates and kept for two conditions; normal condition at 27 ± 3°C, Relative Humidity (RH) 60 ± 10% for 15 days. The condition of the experiment is illustrated in Table 1.

Table 1: Condition of Development a packaging of individual Hom Thong banana

Condition	Material Type	The position of the open-air hole	The diameter of the open-air hole (cm.)	Number of open-air holes	Bag size (cm)	Open-air hole (%)
1	LLDPE	[-/ - / -]	-	-	14x30	0
2	PP	[-/ - / -]	-	-	14x30	0
3	LLDPE	[-/ - / -]	-	-	20x30	0
4	LLDPE	[-/ - / -]	-	-	14x30	0
5	LLDPE	[- /Center/ -]	0.1	128	14x30	0.3%
6	LLDPE	[- /Center / -]	0.7	8	14x30	0.9%
7	PP	[- /Center / -]	0.7	8	14x30	0.9%
8	LLDPE	[Edge/ - Edge]	0.7	12	14x30	1.4%
9	LLDPE	[- / Center / -]	0.7	12	14x30	1.4%
10	LLDPE	[Edge/ Center /Edge]	0.7	12	14x30	1.4%
11	Non bagged banana					

Part 2: Aging condition

Simulation of Banana Storage Conditions in the retail market show as the Table 2. The experiment test in the aging condition at 29.3 ± 1 ° C, Relative Humidity 99% for eight days with wrapping with strength plastic film at the end of banana to help slow down respiration and test the direction of placing bananas in the distribution. This research compares two packed alignments;

horizontal and vertical packed orientation as the Figure 1. This is the comparison of how to effect for respiration rate of banana.

Table 2: Treatment condition

Condition	Material Type	The position of opening air hole	The diameter of the open-air hole (cm.)	Number of open-air holes	Bag size (cm)	Open-air hole (%)	Control respiration rate	Packed alignment
5	LLDPE	[- /Center/ -]	0.1	128	14x30	0.3%	Unwrapping	vertical
8	LLDPE	[Edge/ - Edge]	0.7	12	14x30	1.4%	Unwrapping	vertical
11	Non bagged banana (control)						Unwrapping	vertical
12	Non bagged banana with (control)						wrapping	vertical
13	LLDPE	[- /Center/ -]	0.1	128	14x30	0.3%	Wrapping	vertical
14	LLDPE	[Edge/ - Edge]	0.7	12	14x30	1.4%	Wrapping	vertical
15	LLDPE	[Edge/ - Edge]	0.7	12	14x30	1.4%	Wrapping	horizontal

Figure 1. Vertical and horizontal and packed alignment

Part 3: Banana ripening area Inspection

The methodology of this research is to select a banana color scale for consumption to adapt from the CSRIO standard by using a manual scale. The consumer's preference split into ten levels from 0 percent to 100 percent by calculating the percentage of the banana ripening area. The boundaries of the banana area divided into five slots and the level in each slot have three scales (0, 10, 20) as Figure 2. The Number of '0' scale means the full area of green color, the number of '10' scales mean the middle area between yellow and green color and the number of '20' scale means the full area of yellow color. The summary of the banana color scale is the percentage of the banana ripening. The jig divider for separating How Thong banana area is shown as the **Figure 2.** This research inspects the color by using the spectrometer color measurement CS-200 Konica Minolta, 1010 lux, Fluorescent three lamps, CIE standard from Color Research Center at RMUTT as the Figure 3.

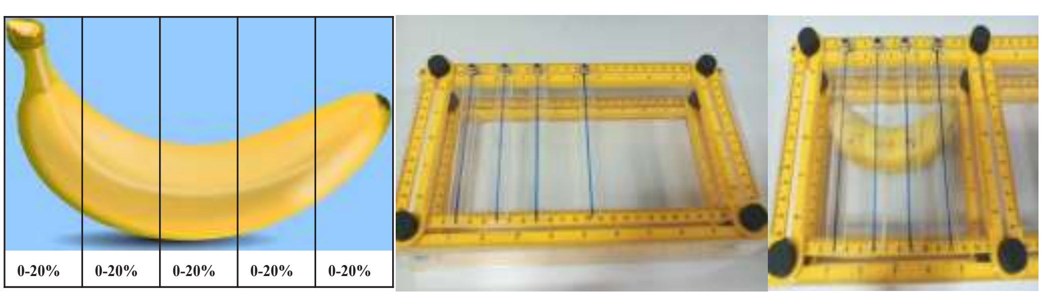

Figure 2. The boundaries of the banana area and jig divider

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Figure 3. Color inspection with spectrometer color measurement

RESULT

According to the experiment of Hom Thong banana ripening color scale for individual packaging in the retail market. The result of Part 1 is shown that the several packaging with material type in sealed Linear Low Polyethylene bagged (LLDPE) and Polypropylene bagged (PP), Position of Opening air hole, Diameter of Opening air hole, Bagged size, the percentage of permeability for gases and water vapor (% Opening air hole) for storage life extension of Hom Thong banana for retail market by keeping one piece of banana in seal bagged and non bagged banana (control). All treatments were kept for two conditions; normal condition at 27 ± 3°C, Relative Humidity 60 ± 10% for 15 days. The result is shown in Figure 4.

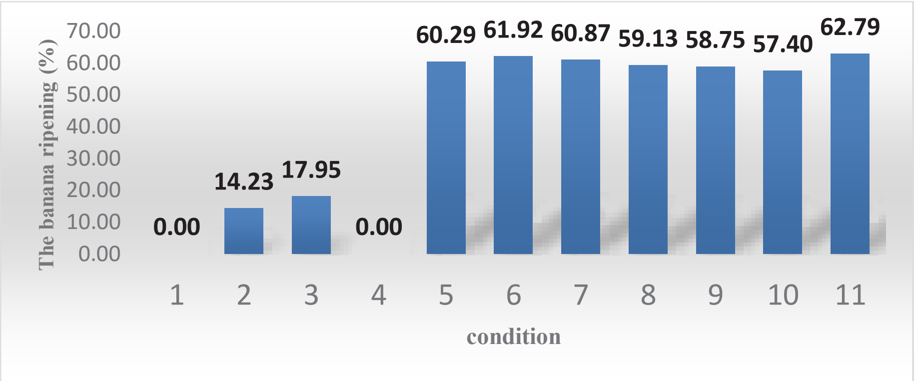


Figure 4. The percent of banana ripening in several packaging

From Figure 4 found that condition no. 10 is the lowest banaba ripening percent (57.40%). This condition is the best solution for packaging Hom Thong banana. The packaging specification is to select LLDPE material and make the open air hole in Edge/Center/Edge position. The diameter of the open-air hole is 0.7 cm. The total of the hole is 12 holes in the bagged size is 14x30 cm, the percentage of permeability for gases and water vapor is 1.4%. In the condition no.1, 2, 3 and 4 show the percentage of banana ripening is very low value but these conditions are not selected. Because three are not changed from green to yellow. The texture can not eat and when the bag is opened, there is a foul odor caused by fermentation in the state of oxygen-free breathing occurs.

The result of Part 2 Simulation of Banana Storage Conditions in the retail market at the aging condition at 29.3 ± 1°C, Relative Humidity 99% for 8 days with wrapping with strength film plastic at the end of the banana. This research compares two packed alignments; horizontal and vertical packed alignment. This is the comparison of how to effect for respiration rate of banana. The result is shown in Figure 5.

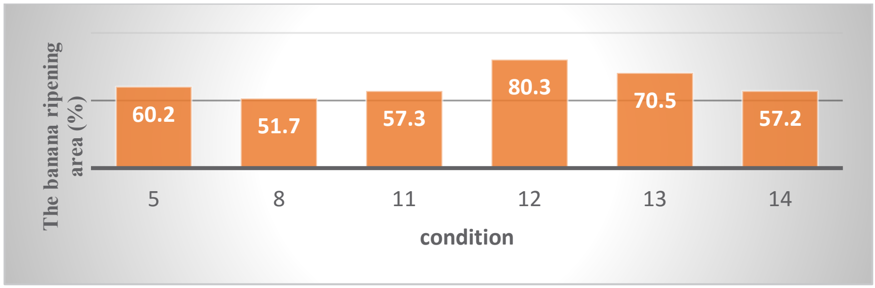


Figure 5. Simulation of Banana Storage Conditions at the aging condition

From Figure 5, the lowest percentages of banana ripening are condition no.8 (51.7% banana ripening area). The condition no.12, 13, and 14 with wrapping with strength film plastic at the end of banana cannot slow down respiration in aging condition.

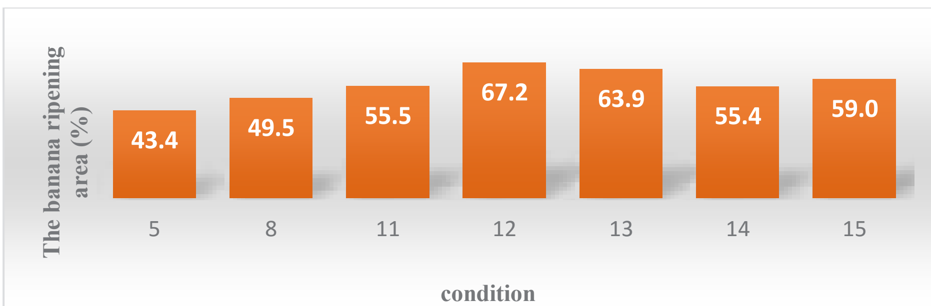


Figure 6. The comparison of packed alignments

From Figure 6, this experiment compares two packed alignments; horizontal and vertical packed alignment. From the result found that the vertical banana (a condition no. 14) is lower ripening banana 55.4% than the horizontal banana (condition no.15) with 59%. The result in Part 3 is shown that the color inspection spectrometer color measurement. The result of this research found that the color of Hom Thong bananas for the retail market can be divided into ten color scales in green color is the average value of u'0.1836 and the average value of v'0.5403 as the Table 3. The middle color green between yellow is the average value of u'0.2088 and the average value of v'0.5444 as the Table 4. The yellow color is the average value of u'0.0.213 and average value of v'0.538 as the Table 5.

Table 3: Average u' and v' value of the green banana color

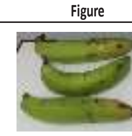
Green Banana at five points																					
No.	Code	u'	v'	Code	u'	v'	Code	u'	v'	Code	u'	v'	Code	u'	v'	Code	u'	v'	Avg u'	Avg v'	Figure
1	G*1.1	0.1881	0.5376	G*1.10	0.1888	0.5403	G*2.1	0.1876	0.538	G*2.10	0.1854	0.54	G*3.1	0.1789	0.5421	G*3.10	0.1891	0.5396	0.1863	0.5396	
2	G*1.2	0.1865	0.5354	G*1.9	0.1851	0.5414	G*2.2	0.1852	0.5364	G*2.9	0.1819	0.5418	G*3.2	0.1798	0.5365	G*3.9	0.188	0.5406	0.1844	0.5387	
3	G*1.3	0.1816	0.541	G*1.8	0.185	0.541	G*2.3	0.1831	0.541	G*2.8	0.1804	0.5414	G*3.3	0.1768	0.5428	G*3.8	0.1828	0.5421	0.1816	0.5416	
4	G*1.4	0.1834	0.5386	G*1.7	0.1834	0.5421	G*2.4	0.1821	0.5412	G*2.7	0.1788	0.5419	G*3.4	0.1825	0.5379	G*3.7	0.1827	0.5434	0.1822	0.5409	
5	G*1.5	0.1829	0.5398	G*1.6	0.1825	0.5432	G*2.5	0.1818	0.541	G*2.6	0.18	0.542	G*3.5	0.1921	0.5359	G*3.6	0.182	0.5436	0.1836	0.5409	
															Average				**0.1836**	**0.5403**	

Table 4: Average u' and v' value of middle green between yellow banana color

Green and Yellow Bananas at five points																					
No.	Code	u'	v'	Code	u'	v'	Code	u'	v'	Code	u'	v'	Code	u'	v'	Code	u'	v'	Avg u'	Avg v'	Figure
1	S*1.1	0.1871	0.5442	S*1.10	0.1883	0.5433	S*2.1	0.1991	0.5436	S*2.10	0.1998	0.5418	S*3.1	0.1869	0.5445	S*3.10	0.1888	0.5432	**0.1917**	**0.5434**	
2	S*1.2	0.2005	0.5455	S*1.9	0.2087	0.5439	S*2.2	0.2149	0.5454	S*2.9	0.2034	0.5441	S*3.2	0.2012	0.5469	S*3.9	0.2096	0.5435	**0.2064**	**0.5449**	
3	S*1.3	0.2141	0.5452	S*1.8	0.2115	0.5452	S*2.3	0.2165	0.5467	S*2.8	0.2142	0.5451	S*3.3	0.2145	0.5462	S*3.8	0.2149	0.5449	**0.2143**	**0.5456**	
4	S*1.4	0.2161	0.5447	S*1.7	0.2131	0.5448	S*2.4	0.2167	0.5461	S*2.7	0.2153	0.5428	S*3.4	0.2163	0.5446	S*3.7	0.216	0.5451	**0.2156**	**0.5447**	
5	S*1.5	0.2187	0.5436	S*1.6	0.2144	0.5438	S*2.5	0.2158	0.5453	S*2.6	0.2145	0.5412	S*3.5	0.2186	0.5433	S*3.6	0.2152	0.5441	**0.2162**	**0.5436**	
																		Average	**0.2088**	**0.5444**	

ORAL SESSION

Table 5: Average u' and v' value of the yellow banana color

Yellow Bananas at five points																					
No.	Code	u'	v'	Code	u'	v'	Code	u'	v'	Code	u'	v'	Code	u'	v'	Code	u'	v'	Avg u'	Avg v'	Figure
1	Y*1.1	0.2142	0.5397	Y*1.10	0.2147	0.5412	Y*2.1	0.2125	0.5375	Y*2.10	0.2159	0.5348	Y*3.1	0.2114	0.5372	Y*3.10	0.2127	0.5337	**0.214**	**0.537**	
2	Y*1.2	0.2144	0.5396	Y*1.9	0.213	0.5394	Y*2.2	0.2135	0.54	Y*2.9	0.2159	0.5385	Y*3.2	0.2095	0.5354	Y*3.9	0.2101	0.5333	**0.213**	**0.538**	
3	Y*1.3	0.2134	0.5403	Y*1.8	0.2122	0.537	Y*2.3	0.2137	0.54	Y*2.8	0.2112	0.5347	Y*3.3	0.2107	0.5363	Y*3.8	0.2092	0.5323	**0.212**	**0.537**	
4	Y*1.4	0.2139	0.5417	Y*1.7	0.2127	0.5388	Y*2.4	0.2153	0.5426	Y*2.7	0.2115	0.5367	Y*3.4	0.2108	0.5358	Y*3.7	0.211	0.5365	**0.213**	**0.539**	
5	Y*1.5	0.2148	0.542	Y*1.6	0.2117	0.5365	Y*2.5	0.2131	0.5407	Y*2.6	0.2092	0.533	Y*3.5	0.2107	0.5342	Y*3.6	0.2123	0.5371	**0.212**	**0.537**	
																Average			**0.213**	**0.538**	

DISCUSSION

The objective of this research is to investigate the appropriate design selection of individual packaging by measuring Hom Thong banana ripening color scale from green to yellow color from the retail distribution to customers. As the result is shown is banana ripening color scales set for classification which is the appropriate design selection of individual packaging to keep Hom Thong banana for the long life of storage. The comparison between the material type of packaging, it found that Polyethylene and Polypropylene material does not differ of the percentage of banana ripening color scale. The packaging size the effect, the result found that small area (14x30 cm) can keep a long life of storage than the big area (20x30 cm). The comparison between closed seal packaging and opening air hole packaging has different significantly in banana ripening color scale. The suitable permeability for gases and water vapor at 0.3-1% can reach to desired banana respiration rate and keep long life of storage than closed seal packaging. The contribution of this research can expand to agricultural farmers to apply the appropriate packaging for Hom Thong banana in the retail market. The banana ripening color scale can use to classify banana which is suitable for the retail market and inform the customers to make a buying decision. The limitation in banana color scale applications is only in gross Micheal banana in the area of central region Thailand. For further research will extend the scope from farm to folk by applying the color scale methodology to determine the banana harvest at the farm.

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THE COLOR AND APPEARANCE IN FUNGAL INHIBITION EFFECT OF NATURAL PACKAGING MATERIAL BY USING THAI HERB POWDER EXTRACTION

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Keywords: Fungal Inhibition, Natural Packaging Material, Thai Herb, Color and Appearance

ABSTRACT

The objective of this research is to study the types of Thai herbs that can inhibit fungal growth in natural packaging material by the results of color and appearance of Fungal Inhibition. This research study on the natural material of Water Hyacinth by using the White crane flower (Rhinacanthus nasutus; Thong Phan Chang) and Galanga (Alpinia galangal; Kha) herb powders that could inhibit the growth of fungus. The experiments classify herbal concentration from 15%, 30%, 45%, 60 and 75% weight by weight. The time of extraction varies 1,2,3, and 7 days and the time of absorption varies 30,60, and 120 minutes. The fungus studies by color and appearance by using a fungal counting jig. This is a jig for counting and checking the color and appearance of the fungus. The research found that the Rhinacanthus nasutus can inhibit fungus better than Alpinia galangal herb powder. The appropriate condition for fungal inhibition is to set at a concentration of 75% w/w at the 3days of extraction time and 120 minutes of absorption time. After testing the Young's Modulus and the Tensile strength, the result found that the highest of Young's Modulus is a concentration of 75% w/w in both of herb powders and tensile strength of natural packaging material in the herb absorption is lower 20% than pure material. However, Usability test by manual forming from 10 experts, the natural packaging material in the herb absorption was not significantly different from the pure material. The analyzed data of the fungus color and appearance were eight patterns, and birth order; White Sphere, White Spore, Black Spore, Yellow Spore, Brown Spore, Green Spore, Green Sphere, and Grey Sphere. The white Sphere and White Spore are high frequently fungus grown in every experiment condition.

INTRODUCTION

The water hyacinth is a weed that propagated quickly and mainly causes ecological impact and water transportation problems. There are several methodologies in this cluster which have been reviewed that use of water hyacinth to supply for material in the furniture industry. Moreover, many SME business owners in Thailand have made water hyacinth material handicraft, such as a hat, bag including packaging [1]. However, natural materials are more likely to cause a fungus infection that affects product quality. In mass production, they use chemical preservative substances to control fungus growth such as Sulfur dioxide and sodium benzoate [2]. However, the chemical evaporation in process released from the substance and toxic environmental acid rain and effect to the respiratory system of humans. Focusing on inhibiting fungal growth in natural packaging material [2]. There are several researchers study of natural extracts with antifungal activity such as Rhinacanthus nasutus (Thong Phan Chang) and Alpinia galangal (Kha) who combine natural material drying to inhibit the growth of fungus on water hyacinth. The objective of this research is to study the types of Thai herbs that can inhibit fungal growth in natural packaging material.

METHODOLOGY

This research adopts the methodology for herb powder extraction [2] and modifies them to visual inspection. The methodology of this research consist tree parts.

Part 1: Studying the herbal extract condition

This research select two Thai herbs by using Rhinacanthus nasutus (Thong Phan Chang: T) and Alpinia galangal (Kha: G) powder extracts that could inhibit the growth of fungus. The experiments classify herbal concentration from 15%, 30%, 45%, 60 and 75% weight by weight (w/w). The time of extraction varies 1, 2, 3, and 7 days and the time of absorption varies 30,60, and 120 minutes. All treatments were repeated five replicates and kept in accurate conditions at the temperature 30 ± 1°C, Relative Humidity (RH) under 99% for 13 days in an enclosure control box. Because the occurrence of fungus in natural materials which generally takes more than 7 months. The formulation of the experiment is shown in Table 1.

Table 1: The formulation of herbal powder extraction

Formula	% Concentration (w/w)						Time of extraction(day)					Time of absorption (min)			
	0	15	30	45	60	75	0	1	2	3	7	0	30	60	120
G15-1-30		✓						✓					✓		
G30-1-30			✓					✓					✓		
G45-1-30				✓				✓					✓		
G75-1-30						✓		✓					✓		
G15-1-60		✓						✓						✓	
G15-1-120		✓						✓							✓
G15-2-30		✓							✓				✓		
G15-2-60		✓							✓					✓	
G15-2-120		✓							✓						✓
G15-3-30		✓								✓			✓		
G15-3-60		✓								✓				✓	
G15-3-120		✓								✓					✓
G15-7-30		✓									✓		✓		
G15-7-60		✓									✓			✓	
G15-7-120		✓									✓				✓
G30-3-120			✓							✓					✓
G45-3-120				✓						✓					✓
G60-3-120					✓					✓					✓
G75-3-120						✓				✓					✓
G15-3-120-R[1]		✓								✓					✓
G15-3-120-D[2]		✓								✓					✓
W100-30	✓						✓						✓		
W100-60	✓						✓							✓	
W100-120	✓						✓								✓
T15-1-30		✓						✓					✓		
T30-1-30			✓					✓					✓		
T45-1-30				✓				✓					✓		
T75-1-30						✓		✓					✓		
T15-1-60		✓						✓						✓	
T15-1-120		✓						✓							✓
T15-2-30		✓							✓				✓		
T15-2-60		✓							✓					✓	
T15-2-120		✓							✓						✓
T15-3-30		✓								✓			✓		
T15-3-60		✓								✓				✓	
T15-3-120		✓								✓					✓
T15-7-30		✓									✓		✓		
T15-7-60		✓									✓			✓	
T15-7-120		✓									✓				✓
T30-3-120			✓							✓					✓
T45-3-120				✓						✓					✓
T60-3-120					✓					✓					✓
T75-3-120						✓				✓					✓
T15-3-120-R[1]		✓								✓					✓
T15-3-120-D[2]		✓								✓					✓
PURE	✓						✓					✓			
B	✓						✓					✓			

Part 2: Color and Appearance Inspection

The color and appearance inspection of The fungal on dried water hyacinth by using a fungus counting jig. This tool has been developed to contain 28 grids of 88 positions (100% of the frequency of fungal occurrence as the Figure 1. The length of dried water hyacinth sample is 70 cm. as the Figure2.

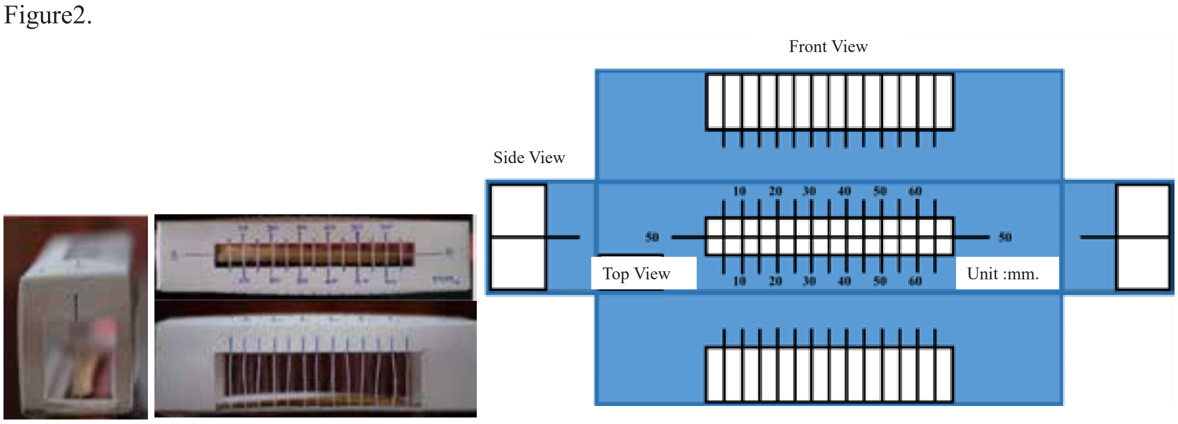

Figure 1. The fungus counting jig

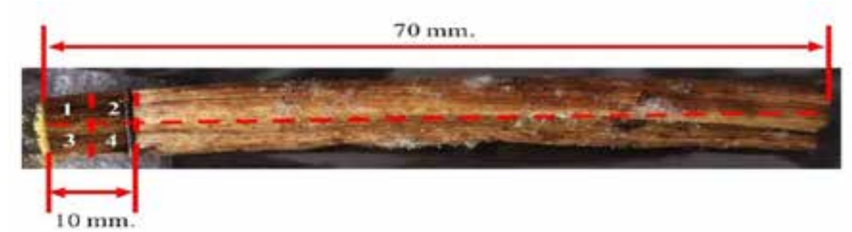

Figure 2. **The dried water hyacinth sample**

Part 3 Usability test

The research was tested with the Universal Testing Machine in term of the modulus and Tensile strength. The specification is Labthink® series XLW (EC), Speed 50 mm / min, Load cell 500 N at the laboratory of School of Science and Technology, Sukhothai Thammathirat Open University). Then, the samples were used with ten experts who produce and sell products from Water hyacinth for several sources as Ang Thong, Suphan Buri, Chai Nat, Amnat Charoen, and Buri Ram provinces.

RESULT

From the study of the percentage of concentrated herbal extraction varies 15, 30, 45, 60 and 75% w/w. The results found that the best extraction from a group of formulas was 75% w / w of concentrated herbal extraction. The comparison at the same condition, the result found that Rhinacanthus nasutus herb powder extraction is a lower percentage of fungal occurrence at than Alpinia galangal powder herb powder extraction as the Figure 3.

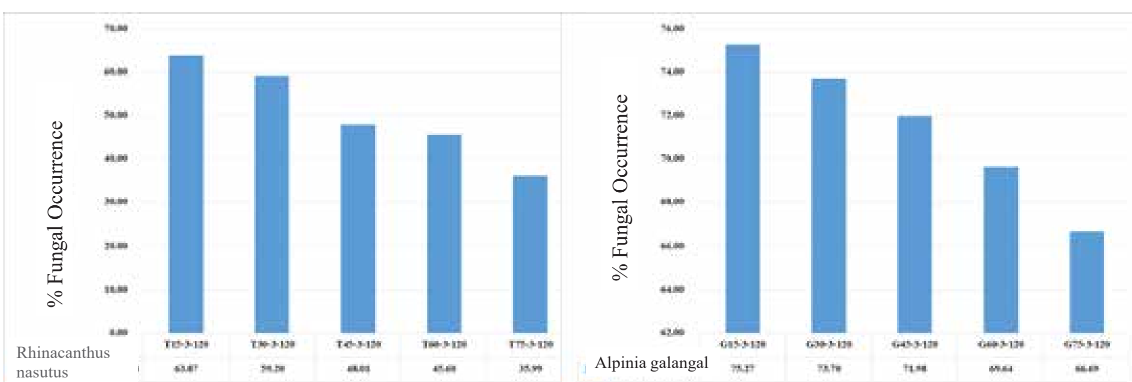

Figure 3. The percentage of fungal occurrence on dried water hyacinth at 15, 30, 45, 60 and 75% w/w concentrated herbal extraction

From the study of the time of absorption of dried water hyacinth varies at 30, 60, and 120 minutes. The result was determined at 120 minutes is the lowest of Percentage of fungal occurrence in both of Rhinacanthus nasutus and Alpinia galangal powder herb powder extraction as the Figure 4.

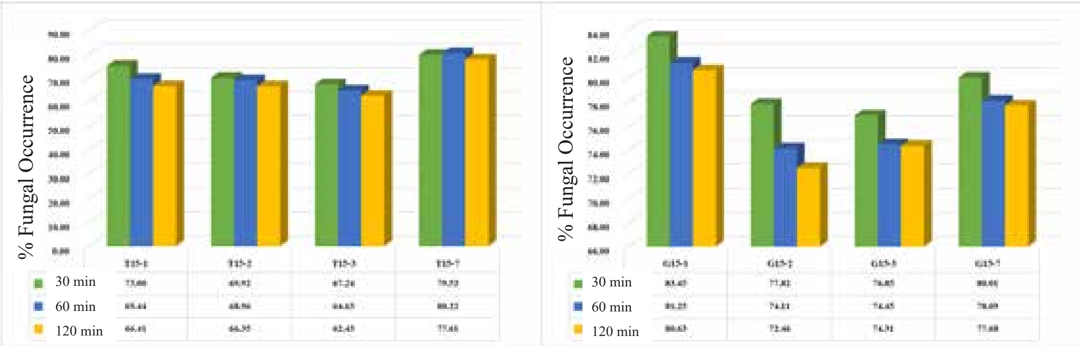

Figure 4. Percentage of fungal occurrence on dried water hyacinth at 30, 60, and 120 minutes of the time of absorption

From the study of the time of extraction of dried water hyacinth with concentrated herbal extraction varies at 1, 2, 3 and 7 days. The result was shown that at 3 days is the lowest of Percentage of fungal occurrence in Rhinacanthus nasutus herb powder extraction **(T15-7-30 and T15-7-120)** as the Table 2.

Table 2: The time of extraction of dried water hyacinth

Formula code	Fully fungal occurrence (day)	Formula code	Fully fungal occurrence (day)	Formula code	Fully fungal occurrence (day)
T15-1-30	7	T15-1-60	7	T15-1-120	7
T15-2-30	7	T15-2-60	7	T15-2-120	7
T15-3-30	8	T15-3-60	9	T15-3-120	9
T15-7-30	5	T15-7-60	6	T15-7-120	5

From usability testing, the result found that the highest of Young's modulus (MPa) is at the 75% % w/w concentrated herbal extraction, at three days of the time of extraction, and the time of absorption at 120 minutes in both of herb powder extraction. The structure of water hyacinth stalk is cellulose of the hydroxyl group (-OH) functional group, which is hydrophilic and sensitive to hydrogen bonding of water [2]. When the dried hyacinth stalks absorb in water, herb powder extraction will swell and softer. As a result, Young's Modulus value decreased, but when the time of absorption increased from 30 minutes to 60 and 120 minutes, Young's Modulus value increased as Figure 5.

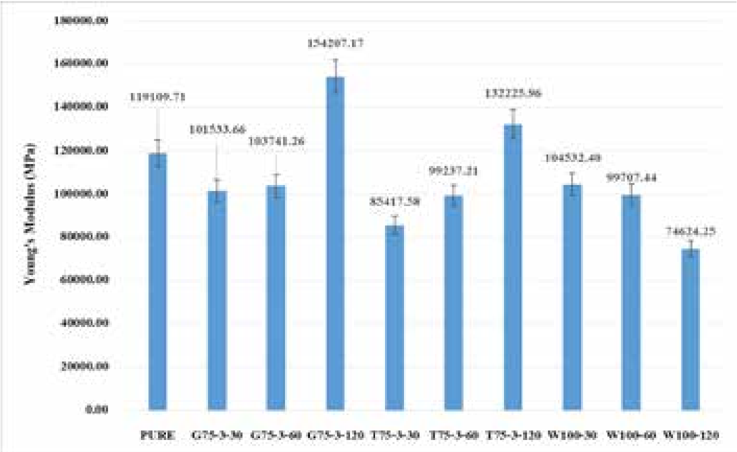

Figure 5. Young Modulus Testing of dried water hyacinth

From the tensile strength test, the result found that the dried water hyacinth in Rhinacanthus nasutus, Alpinia galangal herb powder extraction was lower 20% of tensile strength than dried water hyacinth (pure). Because the time of herb absorption effected to fiber strength of water hyacinth as Figure 6.

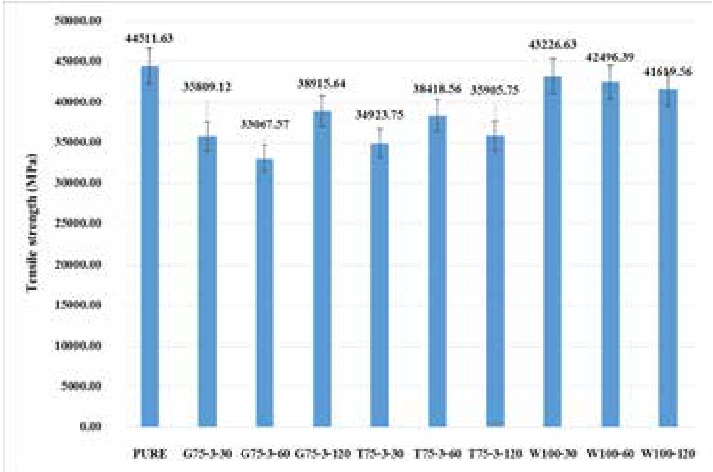

Figure 6. Tensile strength testing of dried water hyacinth

From the result of the reduction of Tensile strength of dried water hyacinth in Rhinacanthus nasutus, Alpinia galangal herb powder extraction. The samples were tested in actual conditions with ten experts who produce and sell products from Water hyacinth for several sources as Ang Thong, Suphan Buri, Chai Nat, Amnat Charoen, and Buri Ram provinces. The result is shown that 100% (10/10 persons) of the samples of water hyacinth in Rhinacanthus nasutus and Alpinia galangal herb powder extraction can use for handmade products. It concluded that the herbal powder extraction to Fungal Inhibition does not affect the manual weaving. From the samples in the experiment of176 specimens from a 44 formulation. The researcher found eight patterns of fungus occurrences with color and physical appearance ordering of birth as White Spore, White Spear, Black spore, Yellow Spore, Green Sphere, Brown Spore, Green Spore, and Gray Sphere as illustrated in Figure 7.

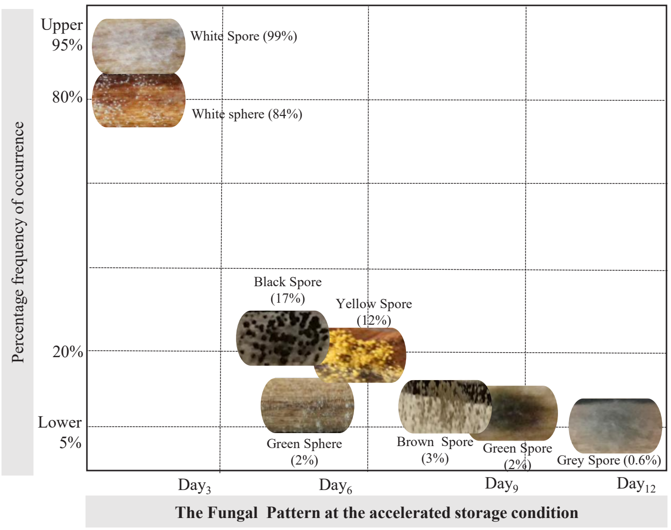

Figure 7. The relation between the patterns of the color and physical appearance and Percentage frequency of occurrence

From Figure 7, the result found that more than 80% of the frequency of occurrence in 3 days was the White Sphere and White Spore [3-4]. The fungus was found 2-20% frequency of occurrence in 6-9 days was Black Spore, Yellow Spore, Brown Spore, Green Sphere, and Gray Sphere. The rare fungus is lower than 2% frequency of occurrence in 13 days was gray spore.

DISCUSSION

The objective of this research is to study the types of Thai herbs that can inhibit fungal growth in natural packaging material by the results of color and appearance of Fungal Inhibition.

The appropriate condition for fungal inhibition is to set at a concentration of 75% w/w at the 3days of extraction time and 120 minutes of absorption time. After testing the Young's Modulus and the Tensile strength, the result found that the highest of Young's Modulus is a concentration of 75% w/w in both of herb powders and tensile strength of natural packaging material in the herb absorption is lower 20% than pure material. However, Usability test by manual forming from 10 experts, the natural packaging material in the herb absorption was not significantly different from the pure material. The analyzed data of the fungus color and appearance were eight patterns, and birth order; White Sphere, White Spore, Black Spore, Yellow Spore, Brown Spore, Green Spore, Green Sphere, and Grey Sphere. The white Sphere and White Spore are high frequently fungus grown in every experiment condition.

The contribution of this research can be applied to inhibit fungus in natural packaging materials in the sector with household production level or SME entrepreneurs. The process is not complicated, practical applications, and low-cost process. The limitation of this research simulates the emergence of fungus in accelerated conditions at 99% humidity and temperature 30.25±1.05 °C in an enclosure control box. Because the occurrence of fungus in natural materials which generally takes more than 7 months. For further research will expand on another natural material such as reed that can use in packaging and study in the details of the fungal phylum on water hyacinth.

ACKNOWLEDGEMENTS

The authors would like to gratefully acknowledge the substantial support provided by Sukhothai Thammathirat Open University (STOU) and Color Research Center at Rajamangala University of Technology Thanyaburi. The authors would like to thank for kindly experts from Ang Thong, Suphan Buri, Chai Nat, Amnat Charoen, and Buri Ram provinces at the OTOP exhibition show at IMPACT Muang Thong Thani. The authors are very appreciative to all the anonymous reviewers for their valuable comments.

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ORAL SESSION

GLOSS DISTRIBUTION MEASUREMENT OF FOODS AND THEIR VISUAL PALATABILITY EVALUATION

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Keywords: food glossiness, food appearance, perceived glossiness, specular gloss

ABSTRACT

We conducted sensory tests to determine the preference of food appearance by paying special attention to their glossiness. We prepared chicken meatloaf, cookies and fried rice samples; they were all replica foods made of plastic resin, and by painting gloss/matte varnishes, high-, medium-, and low-gloss samples were manufactured. A total of 32 subjects (16 males and 16 females, age 21-24 years old) evaluated the glossiness of foods under the daylight-color or light-bulb-color illumination. The results are as follows: (1) The gloss evaluation of the food is not affected by the color temperature of the light source. (2) Food glossiness tends to be emphasized in comparison with that of industrial products. (3) Glossy foods look like warm, fresh and tasty.

INTRODUCTION

The gloss of foods is one of the important factors for their quality. As the color does so [1-3], it provides a clue to the freshness, matureness and doneness of foods and appropriate glossiness will enhance the palatability of foods. As compared to the color, however, it is difficult to evaluate the glossiness, because the degree of gloss perceived by observers depends strongly on the observing conditions. Therefore, in this study, we conducted sensory tests to determine the perception and the preference of gloss of foods under rigorously controlled conditions.

METHODS

Samples

The food samples evaluated are as follows:
(1) High- (YH), medium- (YM) and low-gloss (YL) chicken meatloaf (*"yakitori"* in Japanese).
(2) High- (CH), medium- (CM) and low-gloss (CL) cookies.
(3) High- (RH) and low-gloss (RL) fried rice.

They were all replica foods made of plastic resin, and by painting gloss or matte varnishes on them, high-, medium- and low-gloss samples were manufactured as shown in Figure 1. We used replica foods because they are stable and their glossiness stays constant for a long time when they are stored at the appropriate condition.

The colors were almost the same in the same food category and only the degree of glossiness was made to be different. Table 1 shows the lightness L^* in the CIELAB unit (D65/2 deg.) and the 20-degree specular glossiness *Gs*(20 deg.) in gloss unit (gu) of eight samples measured by the non-contact colorimetric measuring system with dome illumination [4]. The system can obtain the two-dimensional images of color and gloss of complex shape object surfaces. See reference 4 for the details.

(1) Chicken meatloaf (*"yakitori"* in Japanese)

High-gloss **Medium-gloss** **Low-gloss**

(2) Cookies

High-gloss **Medium-gloss** **Low-gloss**

(3) Fried rice

High-gloss **Low-gloss**

Figure 1. Food samples used for the sensory test

Figure 2 shows the examples of gloss distribution of *yakitori* obtained by the system. In the figure, the degree of glossiness is represented by the pseudo colors: red=100 [gu] or higher > yellow > green > cyan > blue=0 [gu]. The values in Table 1 are the average and the standard deviation (SD) calculated from the pixels of the food parts of the two-dimensional images. The lightness of each food is almost constant in the same category and only the degree of gloss is different. Note that the resolution of the digital camera (Nikon D5100) used in the system is 6.387 pixels per mm (0.1566 mm per pixel), then the area of a pixel is 0.02452 mm².

Table 1: Measured lightness L^* and specular glossiness *G*s(20 deg.) of food samples

Food samples		Lightness L^* [-]		*Gs(20°)* [gu]	
		Average	SD	Average	SD
Yakitori	YH	49.49	6.28	31.21	31.53
	YM	50.79	5.18	13.95	18.29
	YL	51.27	4.58	8.85	12.30
Cookie	CH	68.38	2.82	19.25	14.84
	CM	69.05	2.38	9.10	9.59
	CL	69.82	2.51	4.69	5.94
Fried Rice	RH	69.62	7.98	26.22	30.20
	RL	70.53	6.50	15.51	21.58

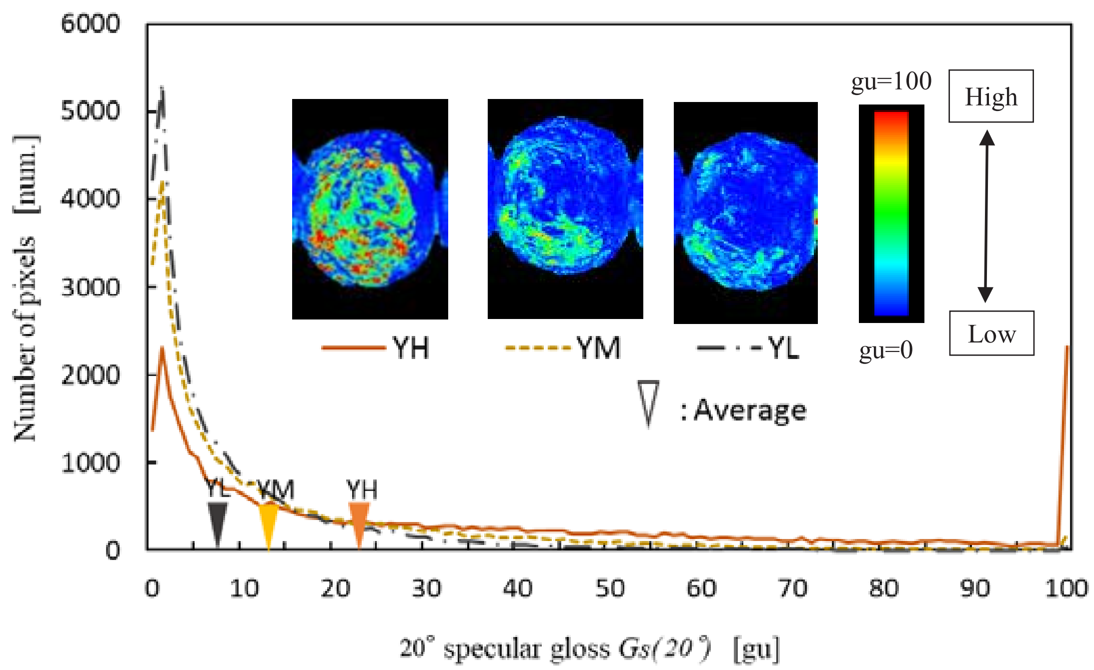
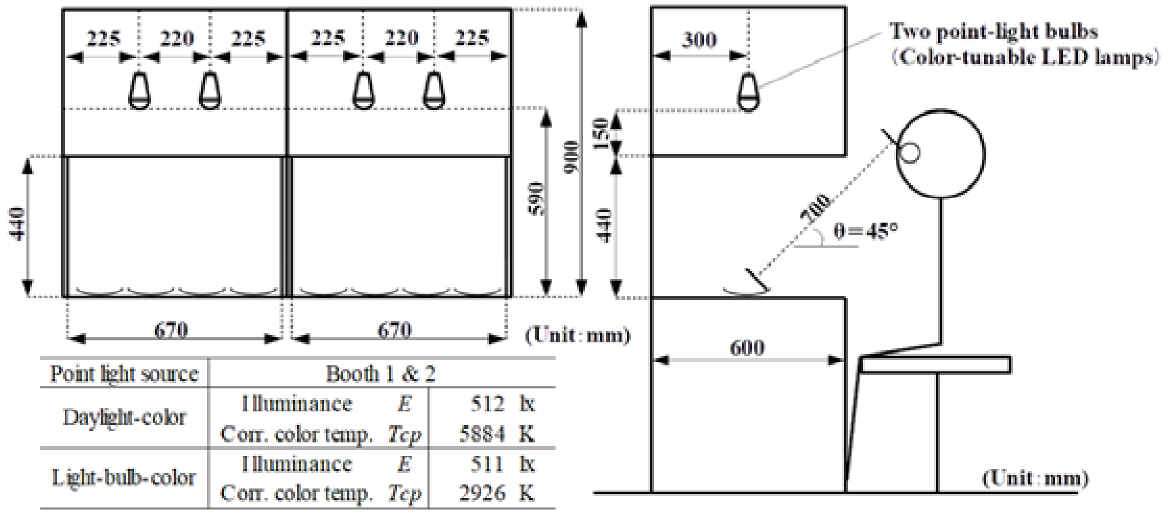


Figure 2. Examples of gloss distribution of high- (YH), medium- (YM) and low-gloss (YL) *yakitori* samples

Sensory test

Sensory test was performed by using a pair of lighting booths as shown in Figure 3. The inside of each booth was illuminated by two point-light bulbs (color-tunable LED lamps, Philips Hue) with the lamp shades to become 500 lx on its floor. Illumination color of the booths was set at the daylight-color (T_{cp} is about 5,800 K) and at the light-bulb-color (about 2,900 K). The inside walls and floor of the booths were matte gray (about N5). Each food sample to be evaluated was placed one by one on a white paper plate and the four plates were presented to observers at the same time in one booth, that is, eight at the same time in two booths.



Point light source	Booth 1 & 2	
Daylight-color	Illuminance *E*	512 lx
	Corr. color temp. *Tcp*	5884 K
Light-bulb-color	Illuminance *E*	511 lx
	Corr. color temp. *Tcp*	2926 K

Figure 3. Setup of the lighting booths

An observer was seated in front of the booth and viewed binocularly the food samples in the booth at an angle of 45-degree above with a viewing distance of 700 mm. First, the observer was asked to evaluate the glossiness of eight food samples on a 5-point scale from very-high-gloss (point 5) to no-gloss (point 1). Then, in the second test, he or she was asked which was softer, warmer, fresher, and tastier looking between high-gloss and low-gloss *yakitori* and fried rice samples. (High- and low-gloss samples were presented side by side in one booth for the second test.) These two sensory tests were performed under the daylight-color illumination and under the light-bulb-color illumination. Participants were 32 (16 males and 16 females, age 21-24 years old); Half of them performed the test under the daylight-color first, then under the light-bulb-color, and another half performed in reverse order so that the order effect would canceled out.

RESULTS AND DISCUSSION

The results of the degree of gloss of the food in the 5-point scale (5: very-high-gloss, 1: no-gloss) by 32 observes are shown in Table 2. A paired t-test ($p < 0.05$) on the MS-Excel revealed that there is no significant difference between the results under the daylight-color illumination and those of under the light-bulb-color illumination, except for the low-gloss cookies (CL). The same is true for the results in the second test (that is, which is softer, warmer, fresher, and tastier looking between high-gloss and low-gloss samples). Although the light-bulb-color lights are preferably used for the lighting at restaurants and the like, it seems that there is little effect on the evaluation of gloss. Therefore, the results under two illumination colors are merged in the following discussions.

Figure 4 shows the relationship between the perceived glossiness evaluated by 32 observers (Table 2) and the measured specular gloss (Table 1) for eight food samples (Figure 1). Figure 4 shows that the perceived glossiness and the measured specular gloss have a high correlation, and the value R^2 (adjusted coefficient of determination) between them is 0.6038. It is said that the perceived glossiness can be explained by the average of their specular gloss, though their glossiness are not uniform (i.e., standard deviations of specular gloss are large) as was shown in Table 1 and in Figure 2.

Table 2: Results of gloss evaluation of eight food samples (32 observers)

Food samples		*Yakitori*			Cookie			Rice	
		YH	YM	YL	CH	CM	CL	RH	RL
Daylight-color	Average	4.34	1.75	1.41	4.44	3.31	1.66	4.97	3.13
	Max	5	3	3	5	4	3	5	4
	Min	2	1	1	4	2	1	4	1
	SD	0.65	0.76	0.56	0.50	0.64	0.70	0.18	0.87
Light-bulb-color	Average	4.28	1.78	1.59	4.44	3.38	2.06	4.91	3.16
	Max	5	4	3	5	5	4	5	5
	Min	3	1	1	2	2	1	3	2
	SD	0.63	0.75	0.67	0.72	0.79	0.84	0.39	0.77
Daylight- + Light-bulb-color	Average	4.31	1.77	1.50	4.44	3.34	1.86	4.94	3.14
	Max	5	4	3	5	5	4	5	5
	Min	2	1	1	2	2	1	3	1
	SD	0.64	0.75	0.62	0.61	0.72	0.79	0.30	0.81

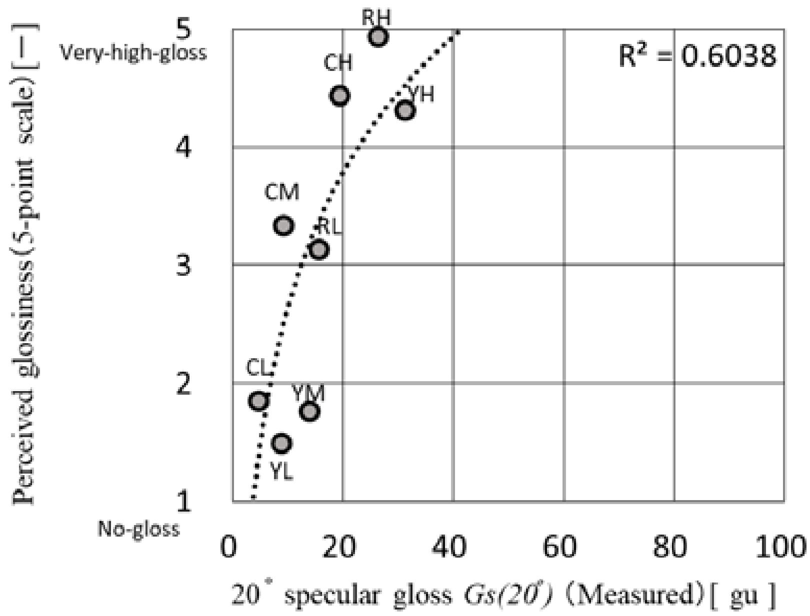


Figure 4. Relationship between the perceived glossiness and the measured specular gloss

More precisely, however, *yakitori* samples tend to be located the lower side of the fitted curve (dotted curve in Figure 4). On the other hand, cookies tend to be located the upper side of the curve. These tendencies can be explained by the fact that there are visible irregularities on the *yakitori* surfaces, and the cookie surfaces are more or less smooth with few visible irregularities. These macroscopic irregularities do not affect the measured specular gloss in average, but, would affect the glossiness perceived by observers.

Next, let us discus the absolute value in Figure 4. The specular gloss of high-gloss samples (indicated by H) are about 20 to 30 in gloss unit [gu] for *yakitori*, cookies, and fried rice. They are all in the low or medium gloss region on the industrial specular gloss scale in which a clean and flat glass surface has 100 [gu]. In spite of that, these food samples were evaluated as very-high-gloss (point 5) or high-gloss (point 4) by the observers. The reason why the samples in the low or medium gloss region are perceived high gloss is unclear. A possible explanation is that the criteria for gloss judgment depend on the sample categories. Even in the low or medium gloss region, "high-gloss" food samples are relatively high gloss as it is named in the food category, then, they are perceived high gloss. Another possible explanation is the "high-gloss" food samples have very high gloss (over 100 [gu]) parts, as shown in Figure 2, and these parts glint and appeal to observers. That is, observers evaluate sample glossiness not by the average, but by parts.

In this study, only three kinds of foods were evaluated and it is difficult to identify the cause. We would like to clarify the cause in the future study.

Finally, the results are shown for the second test, that is, which is softer, warmer, fresher, and tastier looking between high-gloss and low-gloss samples. Figure 5 shows the result for *yakitori* samples, and Figure 6 for fried rice samples. Observers felt that the glossier *yakitori* is softer, warmer, fresher and tastier, and that glossier fried rice is harder, warmer, fresher and tastier. The effect was opposite on the soft/hard feeling for *yakitori* and fried rice, but it was not so strong. On the other hand, the effect on the feelings of warm/cold, fresh/stale, tasty/insipid was clear and observers felt the glossier *yakitori* and fried rice are warmer, fresher and tastier.

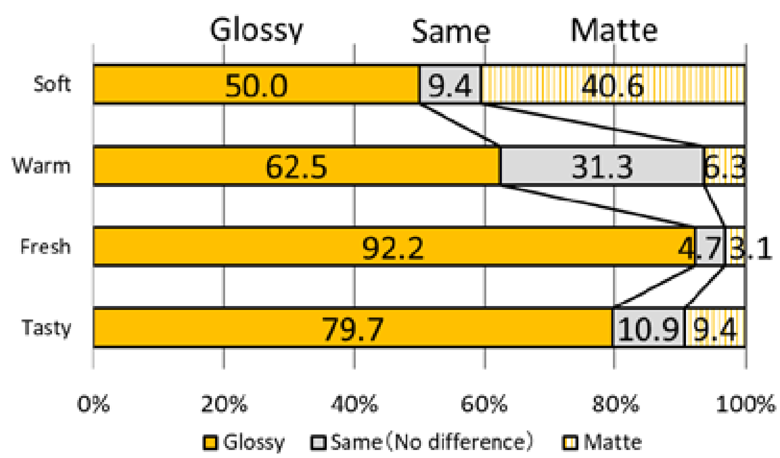


Figure 5. The results of the gloss effect on the feelings for *yakitori* samples

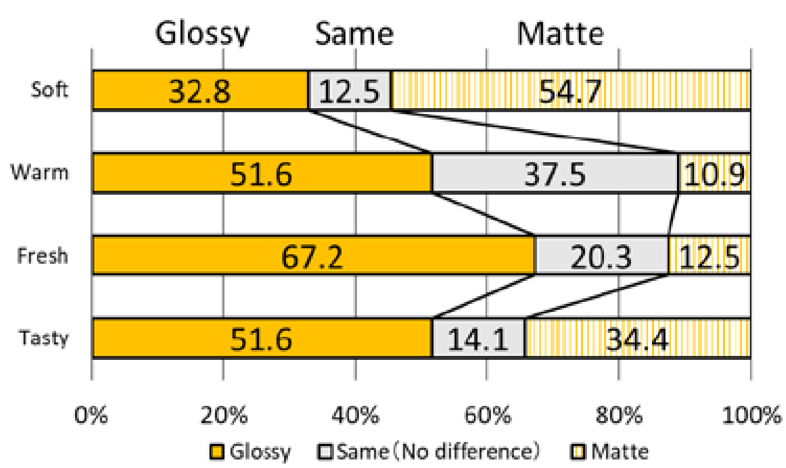


Figure 6. The results of the gloss effect on the feelings for fried rice samples

CONCLUSIONS

The findings obtained in this study are as follows:
(1) The gloss evaluation of the food is not affected by the color temperature of the light source.
(2) Food glossiness tends to be emphasized in comparison with that of an industrial product.
(3) Glossy foods look like warm, fresh and tasty.

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ORAL SESSION

EVALUATION OF SURFACE COLOR OF STEAM-COOKED MANJU THROUGH NON-CONTACT COLORIMETRIC MEASUREMENT USING DOME ILLUMINATION: EFFECT OF PROCESSING CONDITIONS

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Keywords: Food processing, Non-contact Measurement, Colorimetry, Steaming, Color distribution

ABSTRACT

This paper outlines the results of experimental measurement of the colors of two types of steamed buns (mugwort manju and brown sugar manju) that were steamed using a continuous steamer, typically used in a food factory. A precise color information was achieved and the effect of the amount of air mixed in the steamer on the color and gloss of the baked food was investigated. It was established that the value of lightness, L^*, increased with steaming, and, as the aeration amount decreased or the humidity in the steamer increased, this value also increased. In addition, it was found that the value of glossiness, $Gs(20°)$, decreased with heating and tended to decrease further with increasing humidity in the steamer. The results indicated that the glossiness of the steamed mugwort manju was higher than that of the brown sugar manju.

INTRODUCTION

The color of food provides vital information about the quality of food. Therefore, it is important and necessary to understand how cooking conditions can affect the color of finished products in order to produce high-quality food. This paper focuses on the effect of the steaming condition, produced using a belt-conveyor-type steamer, on the color and glossiness of steamed buns ("*manju*" in Japanese). The steamer handled during this experiment is usually used to mass-produce steamed buns in a food factory.

EXPERIMENT

Materials

The two types of steamed buns (brown sugar manju and mugwort manju), steamed under three different conditions, were used. The dough of both buns was made using weak flour, superfine sugar, water, and baking powder. In addition, brown sugar was added to the dough of brown sugar bun (approximately 80 mm diameter, 40 mm height, 90 g weight) and mugwort was added to the dough of mugwort bun (approximately 70 mm diameter, 40 mm height, 90 g weight). The filling consisted of the bean paste that was wrapped by stretching the dough around.

Steamer and conditions

A belt-conveyor-type steamer, shown in Figure 1, was used to carry out the process of steaming. The steamer consists of five sections along its length [1]. The food placed on the belt conveyor was steamed for about 12 minutes. The steamer forcibly supplies air inwards from the inlet (Fig. 2) to adjust the steaming process (distribution of humidity inside the device). The experiment was performed under three conditions in which the air supply amount was first set to (1) 0 L/min (no supply), then to (2) 415 L/min (optimum condition), and finally to (3) 560 L/min (excess supply). The air supply lowered the heat and humidity, and produced fine water droplets in the inlet of a steamer. After heating, the food was kept in refrigerator for 3 hours to cool down. Each bun was then put in a packet and transported at normal temperature.

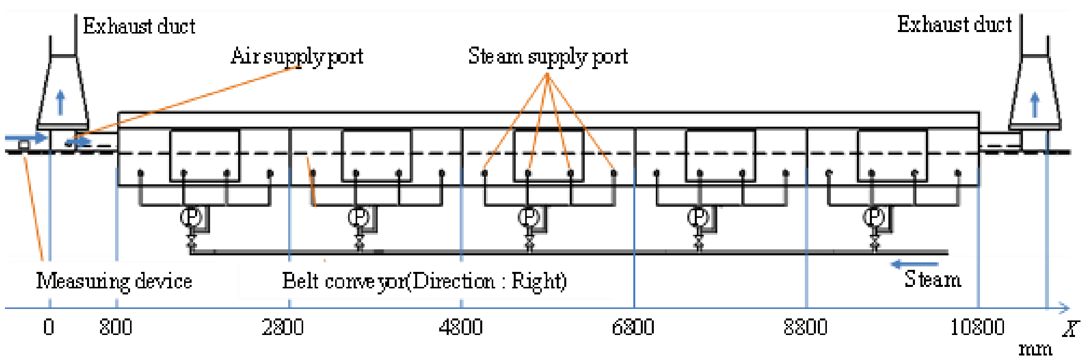


Figure 1. Belt-conveyor-type steamer

Figure 2. Inlet of a steamer

Non-contact colorimetric measurement

The two-dimensional images of buns were obtained using a non-contact colorimetric measurement system (Fig. 3) after 20 hours of the completion of the experiment [2][3]. For the measurement, buns were placed on the sample stand inside the dome, and photographed with reference to color charts

(X - Rite Color Checker Passport 24 colors) while changing the position of the light trap. Then, the color of the entire image was compensated on the basis of the specification of color charts, and the SCE (Specular Component Excluded) / SCI (Specular Component Included) images were obtained by composing the compensated images [4].

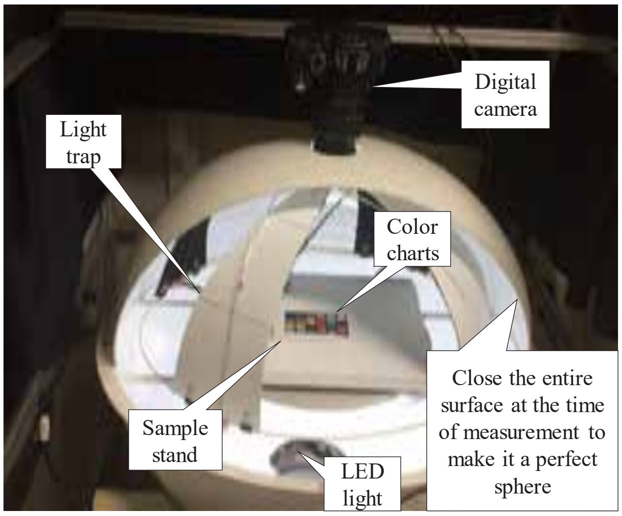
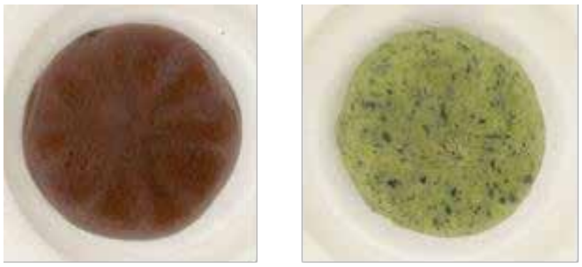


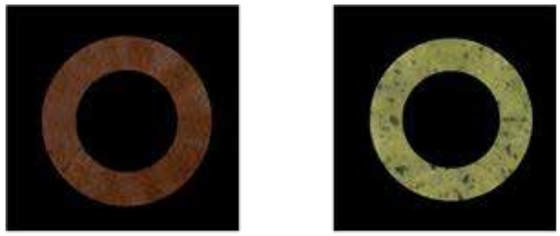
Figure 3. The non-contact colorimetric measurement system

RESULTS

Figures 4 (a) and 4 (b) show the SCE images of a brown sugar bun and a mugwort bun, respectively, and Figures 4 (c) and 4 (d) show the areas of these buns, which were considered for analysis. As evident from Figures 4 (c) and 4 (d), a region with an inner diameter of 15 mm and an outer diameter of 25 mm was extracted from the center of the SCE and SCI images of each bun, and was used for analysis. Tables 1 and 2 show the results of the $L^*a^*b^*$ values (D65 / 2° visual field) of brown sugar manju and mugwort manju, respectively, converted from sRGB values of the analysis regions (this color was compensated on the basis of the specification of color charts photographed at the same time). The 20° specular gloss value $Gs(20°)$ was calculated from the lightness difference between both images, by assuming that lightness difference between the SCE and SCI images occurred as a result of the mirror reflected component.



(a) Brown sugar manju **(b) Mugwort manju**



(c) Brown sugar manju (analysis area) (d) Mugwort manju (analysis area)

Figure 4. Examples of analysis images

(Brown sugar bun, mugwort bun, condition (2), SCE images)

Table 1: Measurement result of brown sugar manju

Heated condition (air supply amount: L/min)	SCE images			SCI images			*Gs*(20°)
	*L**	*a**	*b**	*L**	*a**	*b**	
(1) 0	30.6	13.1	19.3	38.5	10.3	14.0	43.8
(2)415	26.4	14.6	20.7	39.0	10.1	11.4	95.5
(3)560	24.3	14.4	20.3	36.3	10.4	11.3	82.3
Unheated	13.1	5.3	6.5	30.4	3.6	3.5	126.2

Table 2: Measurement result of mugwort manju

Heated condition (air supply amount: L/min)	SCE images			SCI images			*Gs*(20°)
	*L**	*a**	*b**	*L**	*a**	*b**	
(1)0	60.5	-9.5	29.1	63.6	-9.3	27.4	14.6
(2)415	53.8	-9.3	29.7	58.4	-9.6	27.9	27.5
(3)560	50.4	-9.7	28.5	55.3	-9.8	26.7	27.9
Unheated	41.3	-11.9	21.2	48.6	-10.0	16.6	48.3

It was observed that the L^* value of both the brown sugar manju (Table 1) and the mugwort manju (Table 2) decreased with the increase in the air supply amount. On the other hand, the gloss value *Gs*(20°) increased with the increase in the air supply amount. In addition, it was found that the L^* value increased and the glossiness *Gs*(20°) decreased due to steaming when compared with the unheated ones. It was also concluded that the glossiness of steamed mugwort manju was higher than that of brown sugar manju.

EXAMINATION

Figures 5 and 6 show the relationship between the air supply amount and the L^* value of brown sugar manju and mugwort manju. Figure 6 also shows the measured values obtained from the SCI image of mugwort manju reported in the previous study [4]. As shown in Figures 5 and 6, a linear relation between L^* and air supply amount was obtained. Therefore, from the approximate equations shown in these figures, it was observed that the L^* value of the manju could be predicted from the air supply amount. Likewise, the glossiness could also be predicted from the air supply amount. Furthermore, compared to the past data as shown in Figure 6, the values were nearly identical under the same raw material and steaming condition. Therefore, we were able to confirm the reproducibility of this experiment. In terms of a^*b^* values, changes were seen in steamed buns when compared to the unheated ones. However, the air supply amount did not make a big difference as the L^* value did. In brief, the change in humidity mainly influenced the L^* value.

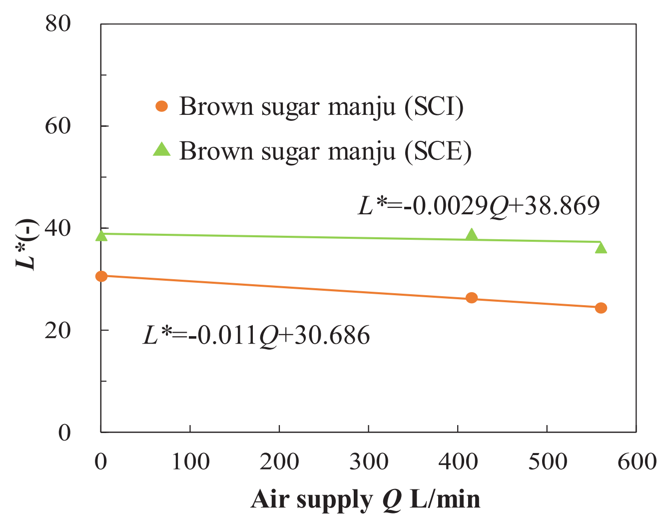


Figure 5. The relationship between the air supply amount and the L^* value of brown sugar manju

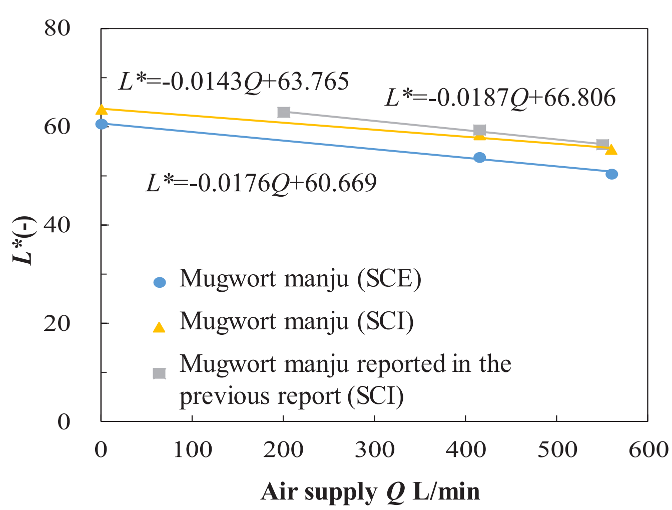


Figure 6. The relationship between the air supply amount and the L^* value of mugwort manju

CONCLUSIONS

The surface color distribution of brown sugar manju and mugwort manju was analyzed, and the relation between the steaming conditions and the color and glossiness of the finished products was elucidated.

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ORAL SESSION

STANDARD MEASUREMENT APPARATUS OF COTTON COLOR WITH XENON LAMP

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Keywords: cotton color, xenon lamp, spectral reflectance, degree of reflectance (Rd), yellowness (+b)

ABSTRACT

Reflectance Rd and yellowness +b are indices to indicate cotton color. National Institute of Metrology and China Fiber Inspection Bureau developed a standard apparatus for cotton color, in which samples illuminated by xenon lamp, the reflected light detected by CCD spectrometer, spectral reflectance of samples are measured and trace to the 45°:0° standard facility.

6 sets of ceramic tiles with nominal value from USDA were measured to evaluate repeatability and Agreement.

INTRODUCTION

Color is one of the main parameters for cotton quality. Cotton color is influenced by Rainfall amount, freezing, pest attack, mould, pollution and other factors.

Nikerson-Hunter color system has been the specification and evaluation method commonly used in cotton color for about one hundred years. The index of *Rd* and +*b* see Eq. (1):

$$Rd = Y$$
$$+b = 70 f_y (Y - 0.847Z) \qquad (1)$$

Where

Rd —degree of reflectance

$+b$ —yellowness,

$f_y = 0.51[(21+20Y)/(1+20Y)]$

Y —one of the tristimulus(X, Y, Z)

λ ——wavelength,

$S_C(\lambda)$——relative spectral power distribution of CIE illuminant C

$\bar{x}(\lambda)$、$\bar{y}(\lambda)$、$\bar{z}(\lambda)$——the CIE 1931 standard colorimetric observer

$\rho(\lambda)$——reflectance of measured sample

$\Delta\lambda$——wavelength interval

K——normalized factor， $K = 100 \Big/ \sum_{\lambda} S(\lambda)\bar{y}(\lambda)\Delta\lambda$

ORAL SESSION

CONSTRUCTURE

Standard cotton color apparatus includes xenon lamp, CCD spectrometer, Synchronous control unit, optical fiber and so on. The sample is illuminated at 45° to the normal, and vertically detected, as shown in the figure 1.

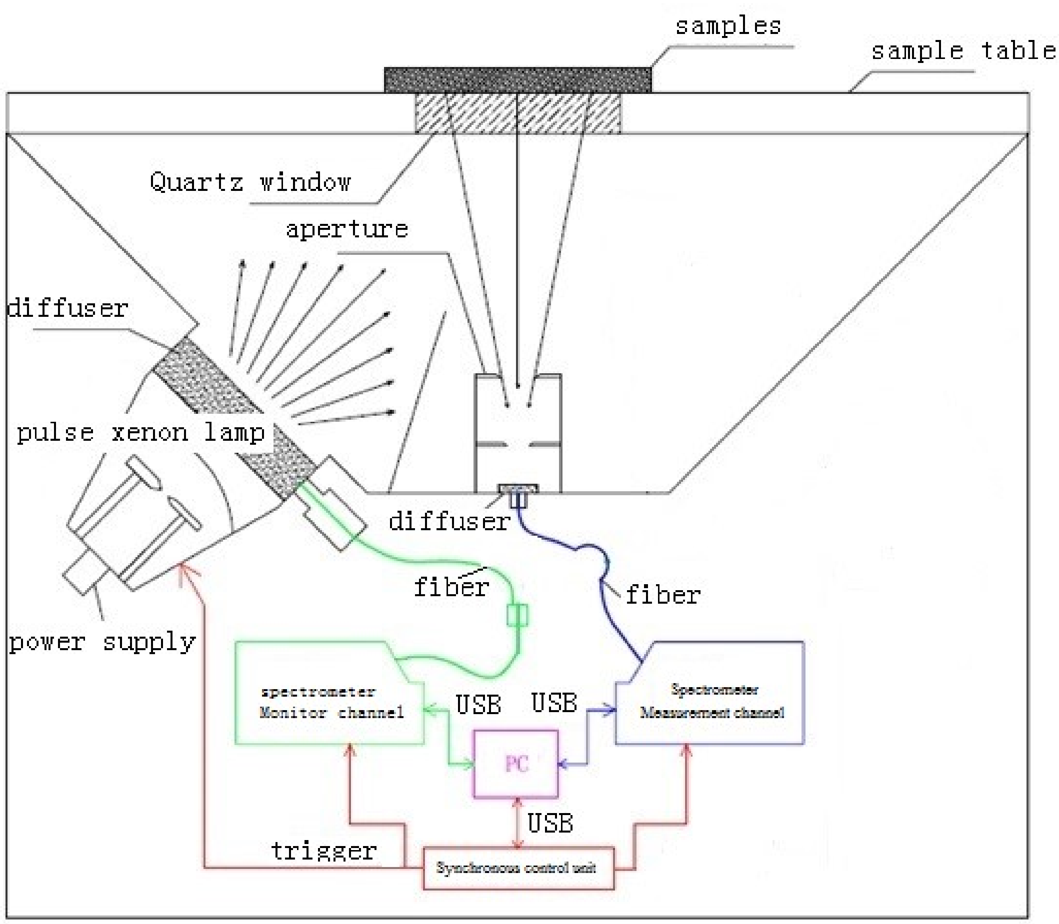

Figure 1. Schematic diagram of cotton color apparatus

TRACEABILITY

The apparatus is calibrated by five ceramic tiles which spectral reflectances are measured and trace to the 45°:0° standard facility in NIM (National Institute of Metrology, P.R.China).
The traceability chart is shown in figure 2.

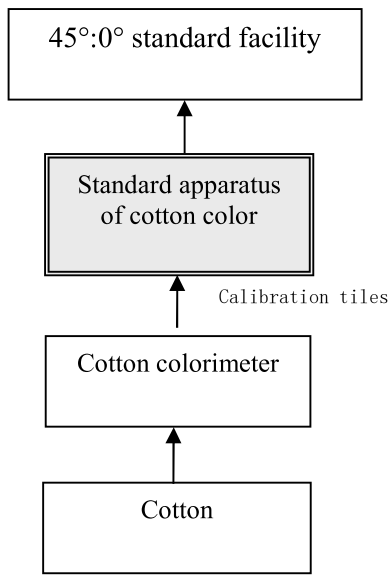

Figure 2. The traceability chart of the value of cotton color

SYNCHRONOUS SAMPLING

For the flash time of xenon lamp is very short, synchronous control unit is applied to ensure the CCD detector work at the same time to get the reflectance light signal when the xenon pulse lamp flash.
The internal structure of synchrocontrol unit see fig.3.

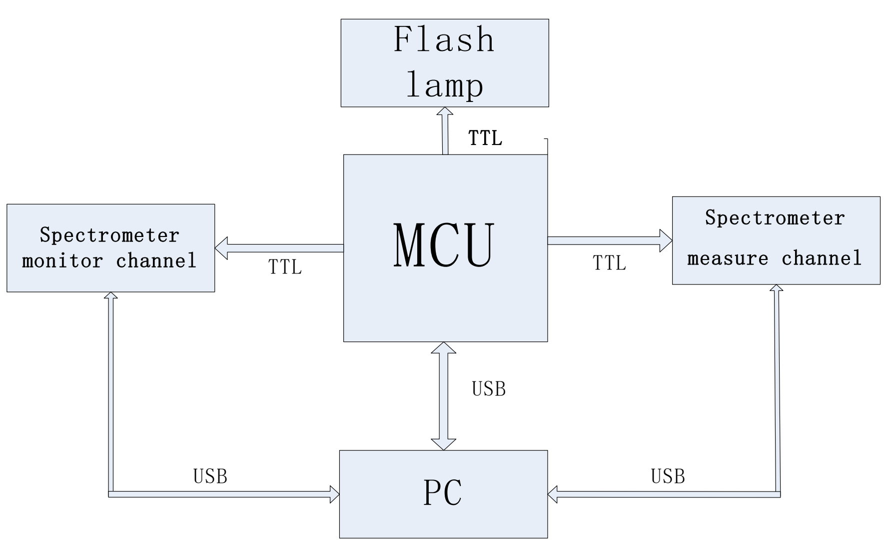

Figure 3. Internal structure of synchrocontrol unit

SOURCE INSTABILITY COMPENSATION

Comparing with tungsten lamp, the intensity of pulse xenon lamp change much larger in different flash during measurement, sometimes it can be reached to nearly 2%. Synchronous sampling mode is used to make compensation of the instability in which two spectrometers are applied, one is for measurement of reflected light of samples and the other is for monitor of xenon source.
The signal level of pulse xenon source in calibration measurement is recorded, and the change of the source in succeeding measurement can be corrected according to the recorded source level. The method reduced the inconsistency of different measurements to less than 0.3% for the same sample.

MEASUREMENT RESULTS

Repeatability

A set of ceramic color tiles from USDA which include white, brown, yellow, grey, central are measured, and the results see table 1.

Table 1: The Repeatability of the cotton color apparatus

Ceramic tile	Index	Measurement times					Standard deviation
		1	2	3	4	5	
WHITE	*Rd*	84.2	84.1	84.1	84.1	84.0	0.1
	+b	3.8	3.8	3.8	3.8	3.9	0.0
BROWN	*Rd*	63.6	63.4	63.5	63.6	63.6	0.1
	+b	8.9	8.9	8.9	8.9	8.9	0.0
YELLOW	*Rd*	83.3	83.4	83.2	83.2	83.2	0.1
	+b	13.7	13.6	13.6	13.7	13.7	0.1
GREY	*Rd*	55.6	55.6	55.6	55.6	55.7	0.0
	+b	2.2	2.2	2.2	2.2	2.2	0.0
CENTRAL	*Rd*	75.3	75.3	75.3	75.4	75.4	0.1
	+b	8.4	8.5	8.4	8.5	8.5	0.1

The repeatability of measurement results is s(Rd)=0.1, s(+b)=0.1。

Agreement

6 sets of ceramic tiles were prepared which nominal value from The United States Department of Agriculture (USDA), and one set is used to calibrate the apparatus and the others are measured. The measurement results are shown in table 2.

Table 2: The Agreement with the nominal value

Ceramic tiles	No.1		No.2		No.3		No.4		No.5	
	Δ(*Rd*)	Δ(+*b*)	Δ(*Rd*)	Δ(+*b*)	Δ(*Rd*)	Δ(+*b*)	Δ(*Rd*)	Δ(+*b*)	Δ(*Rd*)	Δ(+*b*)
WHITE	0.4	0.0	0.1	0.2	0.4	0.0	0.0	0.2	-0.1	0.1
BROWN	0.1	0.3	-0.2	0.3	0.1	0.1	-0.2	0.3	-0.1	0.2
YELLOW	-0.1	0.1	0.2	0.3	0.4	0.1	-0.3	0.2	-0.1	0.1
GRAY	0.4	0.3	0.1	0.4	0.2	0.2	-0.3	0.2	0.3	0.2
CENTRAL	0.3	0.2	0.1	0.3	0.1	0.1	-0.2	0.2	-0.2	0.2

As shown in table 2, the agreement with the nominal value of the apparatus is △Rd≤±0.4，△+b ≤±0.4.

CONCLUSION

The standard measurement apparatus of cotton color with xenon lamp is applied to measure the calibration ceramic tiles for cotton colorimeters. Spectral reflectance of tiles are measured and trace to the 45°:0° standard facility in NIM. The measurement repeatability is: s(Rd)=0.1, s(+b)=0.1, and the agreement with the nominal value is: △Rd≤±0.4，△+b≤±0.4.

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NON-CONTACT COLORIMETRIC MEASUREMENT USING DOME ILLUMINATION FOR COMPLEX SHAPE OBJECTS

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Keywords: specular component excluded, specular component included, non-contact colorimetry.

ABSTRACT

We have proposed an integrating sphere with a movable light-trapping plate for illumination to measure color and gloss distributions of complex shape objects. It is a spherical dome whose inner surface was painted white, and large enough for samples to be placed on the stage in the middle of the dome; an illuminating light source was placed below the sample stage so that samples could be illuminated only by the indirect diffuse light. This dome illumination makes it possible to get an unshaded image of rough surfaces. Note that, without a light trap, the unshaded images are specular component-included (SCI) ones. With a light trap in one position, a part of the image becomes specular component-excluded (SCE) one. When the light trap is moved to another position, another part of the image becomes SCE one. Then, after moving the light trap all over the upper inner surface of the dome, all parts of SCE image are obtained and can be merged into a complete SCE image. In addition, the gloss distribution can be derived by comparing the SCI and SCE images because their difference is caused by the glossiness of a sample surface.

INTRODUCTION

A method is discussed to measure the color distributions of complex shape objects such as rocks, woods, foods in the SCE (Specular Component Excluded) and SCI (Specular Component Included) modes. Commercially available colorimeters are usually contact-type and work perfectly right out of the box for flat and uniform surfaces. However, they are not used for rough and/or non-uniform surfaces of complex shape objects. For such surfaces, non-contact measurements are required and users have to set up the illumination and the colorimeter separately. These operations are not easy; for example, improper illuminations may cause shades on the sample surfaces.

To solve this problem, we have developed an integrating sphere (called "dome illumination") with a movable light-trapping plate for illumination. It is a spherical dome whose inner surface was painted white, and large enough for samples to be placed on the stage in the middle of the dome; an illuminating light source was placed below the sample stage so that samples could be illuminated only by the indirect diffuse light. This dome illumination makes it possible to get an unshaded image of rough surfaces when observed from the top of the dome. Moreover, the movable light trap works as a switch of specular components to obtain the colorimetric images in both SCI and SCE modes. In addition, the gloss distribution can be derived by comparing the SCI and SCE images because their difference is caused by the specular gloss of a sample surface.

This paper outlines the colorimetric system with dome illumination and movable light traps we developed. Also, the procedure is described to derive the gloss distribution of rough surfaces by comparing the SCI and SCE images.

METHODS

The structure of the non-contact colorimetric measuring system is shown in Figure 1. It consists of a dome illumination and movable light traps. As explained in the INTRODUCTION, the dome illumination, i.e. the hemispherical diffuse illumination, makes it possible to get an image of rough surfaces. To record the image, one can use a 2-dimentional spectroradiometer or a well-calibrated digital camera. Note that, without a light trap, the unshaded images are specular component-included ones (i.e., in the SCI mode). With a light trap in one position, a part of the image becomes specular component-excluded one (i.e., in the SCE mode). When the light trap is moved to another position, another part of the image becomes SCE one. Then, after moving the light trap all over the upper inner surface of the dome, all parts of SCE image are obtained and can be merged into a complete SCE image. In this way, the colorimetric images are obtained in both SCI and SCE modes.

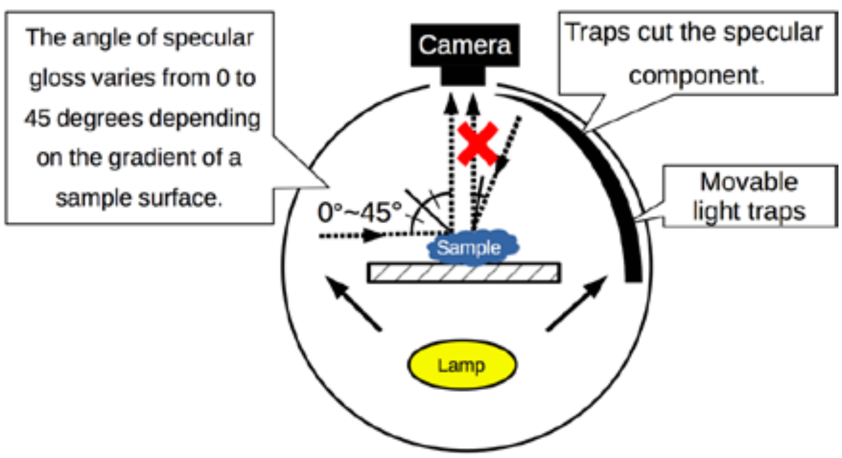

Figure 1. The structure of the colorimetric system

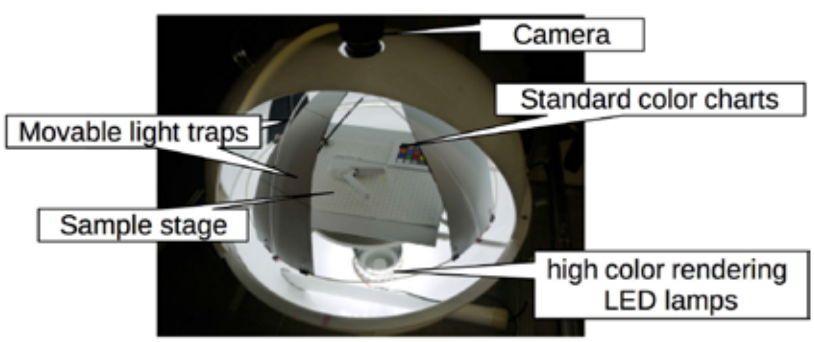

Figure 2. Prototype of the colorimetric system
The opening (near side) is closed during measurement.

In this paper, we report the measured results by using the prototype as shown in Figure 2. Its specifications are as follows:

Dome size: 600 mm in diameter
Sample stage area: 300 mm × 300 mm
Light source: the daylight-color LED lamps (high color rendering index, Ra=93)
Image recorder: a digital single-lens reflex camera Nikon D5100 with a 18mm lens.

We recorded several images by changing the position of the light traps step by step. Each image contains SCI and SCE parts. Then, these parts are merged into a single SCI and SCE images. In order to obtain the colorimetric images, we adopt the image correction method, in which samples are recorded (i.e., photographed) with some standard color charts side by side in one image, and the recorded images are color-corrected using the colorimetric data of the standard color charts as references. X-Rite ColorCheker 24 colors were used as the standard in this paper.

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RESULTS

Figure 3 shows the three recorded images at different light trap positions, the merged SCI/SCE images, and the calculated gloss distribution image for a black plastic stapler. The upper half of the stapler's grip is high gloss finish and that part looks white in the SCI image. However, it was recorded as intrinsic black in the SCE image. This clearly shows that the colorimetric system with dome illumination and movable light traps can measure the color distributions of curved surfaces in the SCI and SCE mode. The color difference between the SCI and the SCE images is caused by the glossiness.

The dichromatic reflection models suggest that the reflected lights from the surfaces of plastics, ceramics, woods, glass, etc. can be well-described by a linear combination of diffuse and specular components. For such materials, the difference between SCI and SCE corresponds directly to the specular gloss.

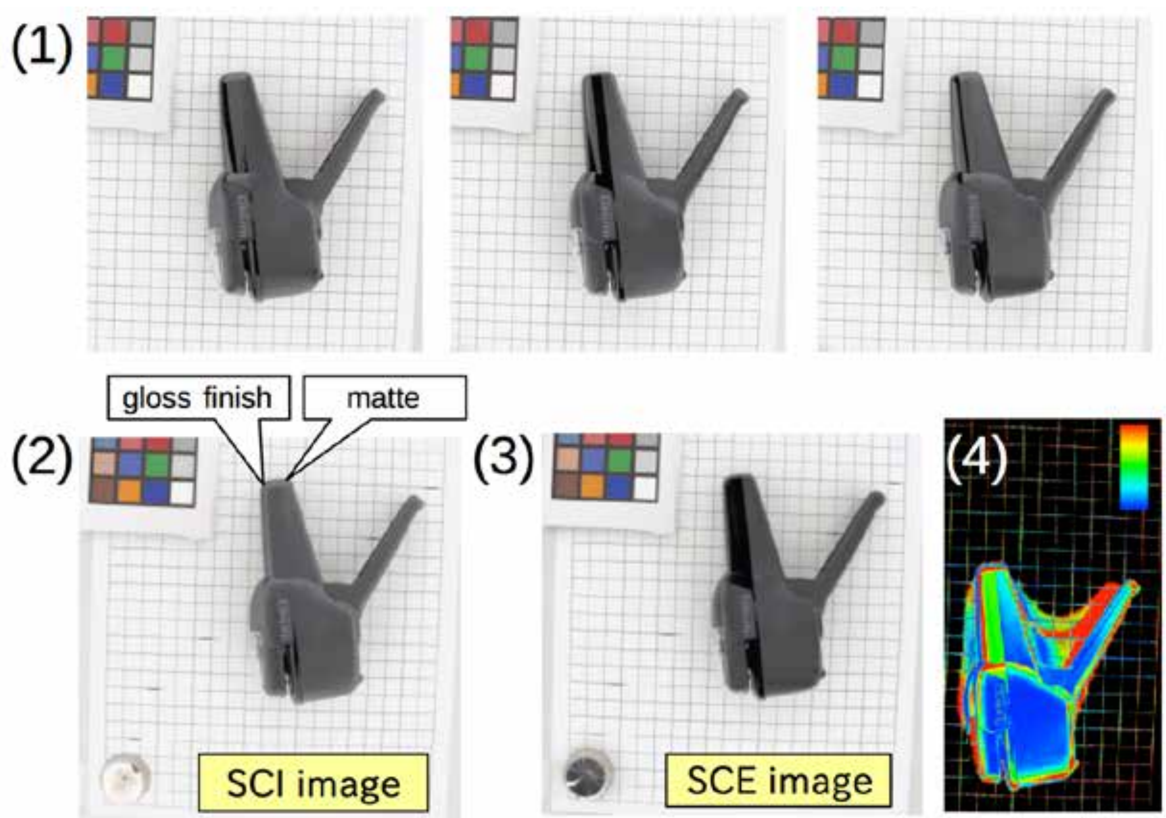

Figure 3. Examples of images recorded by the system

(1) Three images recorded at different light trap positions. (2) the merged SCI image. (3) the merged SCE image. (4) the calculated gloss distribution image represented by the pseudo colors: red=100 [gu] or higher > yellow > green > cyan > blue=0 [gu].

Based on these considerations, we derived the following equations to calculate the specular gloss (Gs) from the lightness in the SCI image (L^*_{SCI}) and that in the SCE image (L^*_{SCE}) for samples whose L^*_{SCE} is less than 80.

$$Gs = k \times (L^*_{SCI} - L^*_{SCE})^2 , \qquad \text{for } L^*_{SCE} < 80, \qquad (1)$$

$$\log_{10} k = 0.027499 \times L^*_{SCE} - 1.224980 . \qquad (2)$$

These equations were derived experimentally by using samples whose specular gloss are known. The restriction L^*_{SCE} <80 came from the fact that the magnitude of lightness differences (L^*_{SCI} - L^*_{SCE}) for the whitish samples ($L^*_{SCE} \geq 80$) are small and comparable to that of the errors of lightness measurements. Therefore, it is difficult to derive the gloss reproducibility. We would like to propose another way for whitish samples in the future.

Figure 3(4) shows the gloss distribution image calculated from the SCI and SCE images using Eqs.(1) and (2). Note that the angle of specular gloss at each part varies from 0 degree to 45 degrees depending on the angle of surface gradient as explained in Figure 1. In this study, however, to prevent the analysis from becoming complicated, the angle of specular gloss measured is regarded as 20 degrees (i.e., 20-degree specular gloss).

CONCLUSIONS

We have proposed the colorimetric system with dome illumination and movable light traps. The dome illumination (hemispherical diffuse illumination) prevents the samples from being shaded, and movable light traps work as a switch of specular components. These two functions make it possible for the system to obtain the colorimetric images in both SCI and SCE modes for rough and/or non-uniform surfaces of complex shape objects.

ACKNOWLEDGEMENTS

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APPLICATION OF AI TECHNOLOGY ON THE COLOR TREND RESEARCH IN TEXTILE AND APPAREL INDUSTRY

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Keywords: Four major fashion weeks, Color, Artificial Intelligence, Convolutional Neural Network

ABSTRACT

The clothes displayed at the four major international fashion weeks are very important materials for color prediction at present. In the prediction, the background, knowledge structure, color preference, experience and preference of color experts have a great influence on the objectivity and accuracy of the prediction results. China Textile Information Center has cooperated with Malong Technologies to develop the algorithm for color extraction and analyze the color application of the four international fashion weeks by using the convolutional neural network technology. Artificial intelligence improves the efficiency, objectivity and accuracy of color research in the fashion show, and enables color experts to capture popular color information from the rapidly changing market more quickly for trend research and customer service.

1. TRADITIONAL METHODS FOR FASHION COLOR RESEARCH

There are two kinds of fashion color prediction methods: intuitive prediction and research prediction.

Intuitive prediction can also be called "expert prediction". It is a method in which the color experts rely on their own profession and intuition to predict the color trend. The prediction results and the objective accuracy of the prediction will be greatly influenced by the background, knowledge structure, color preference, experience and preference of the color experts.

Research prediction is also called "market statistical prediction". It is mainly based on market research information. After collecting a large amount of market information and consumer information, statistical analysis is used to find a certain rule of fashion color change, and predict the future fashion color. The prediction and analysis of popular color from the perspective of consumers has greater reliability and accuracy. The research prediction mainly includes the market prediction method and the intelligence prediction method. The market prediction method is mainly represented by Japan, focusing on the research of market information, analyzing, investigating and making statistics on the color market, studying consumers' color preference and color demand, and analyzing and processing the data with the help of computer to obtain the prediction results. This method reduces the negative influence of subjective factors on the result of color prediction, and has relatively strong practical influence. The intelligence prediction method, represented by the United States, collects fashion color information, mainly including three modes: (1) Professional agencies collect European and local clothing color consumption information, conduct comprehensive analysis, and estimate and judge the trend of fashion color in the future. (2) Based on the theory of fashion communication, the time difference of fashion information acquisition among consumers of different levels is investigated and predicted, so that the fashion color can be observed and analyzed in order to meet the consumption demand. (3) Direct survey of consumers' attitudes in the form of telephone is used as the basis for prediction. Pay attention to the research of consumer psychology and behavior, and follow closely the market performance and reaction of the fashion color.

With the increasing influence of designer brands on future fashion trends, the changing trend of the color in the show fields has become an important part of the prediction for fashion colors. Each season, more than 20,000 clothes are displayed in the four major international fashion weeks. If all colors are analyzed by manpower alone, a lot of workforce and time will be needed. China Textile Information Center / China Textiles Development Center and Malong Technologies have conducted in-depth cooperation from the two dimensions of professional color research and artificial intelligence, and developed the artificial intelligence technology that can be applied to the show color research. The technology can extract colors from a large number of show's pictures, and then calculate the most frequently used show colors from different dimensions through statistical analysis, helping designers to put more time and energy into the research without wasting time in the color extraction process.

2. AI APPLICATION IN SHOW COLOR RESEARCH

The whole analysis process is seen as below Figure 1:

Figure 1. Analysis process

2.1 Image acquisition

When the show is over, web crawler technology is used to collect the corresponding costume pictures from the public website and store them to the local computer.

2.2 Image semantic segmentation

Image segmentation is a typical computer vision task which is the process of partitioning an image into multiple segments of pixels.

One of the difficulties in color extraction is to separate and extract the pixel of clothing. Traditional image segmentation mainly extracts low-level features of images by means of N-Cut [1], Grab-cut [2] etc. However, the traditional way is unable to understand the semantic information of the image, so it needs human intervention or preprocessing to segment the clothing correctly. In particular, when the clothing texture is more complex with multiple nesting, or the models are close to each other, the result of traditional segmentation is often unsatisfactory.

In 2014, Jonathan Long put forward the Fully Convolutional Networks (FCN) [3], in which deep learning was first time applied to image semantic segmentation tasks. It replaces the fully connected layer in the traditional classification network with the convolution layer. After many convolution and pooling operations, the deep features contain more semantic information than the shallow ones, but less the visual details.

The demand for segmentation granularity and semantic understanding of apparel images is very high, especially for the high-end fashion show clothes. Compared with people's daily wear, show clothes may need more exquisite workmanship with more complicated accessories and more complex and unconventional fabric textures. We refer to the popular segmentation algorithm in recent years, and design the following network structure showed in Figure 2 by combining the difficulties in show clothes images:

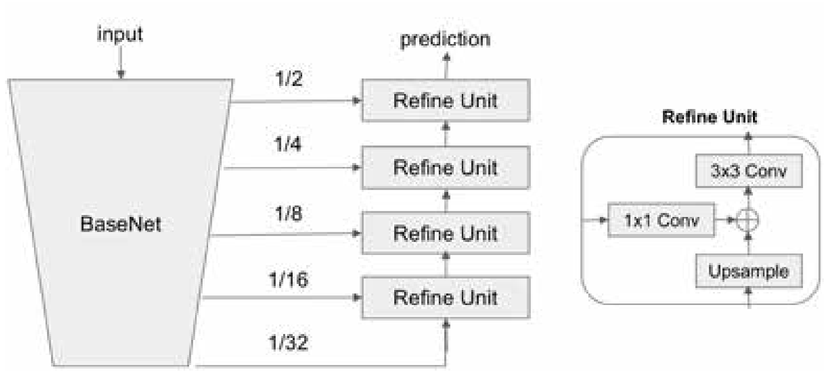

Figure 2. Network structure

In line with the idea of FCN, the input image is sampled through layers of CNN, and the features of the original size 1/2N are obtained, N=1, 2... 5. In order to retain the abstract semantic information of high-level features and the concrete visual details of low-level features at the same time, we propose the Refine Unit to fuse various resolution features recursively. Specifically, every bottom feature is upsampled and merged into its top one, then a convolution operation is performed to smooth the fused feature in each refinement stage. The fused feature will be fed into next refinement stage as the new bottom feature. The lightweight decoder design allows encoder to learn more compact deep features and run on a GPU in real time. The actual training results are shown in Figure 3:

Figure 3. Training results

2.3 Color extraction

Due to the influence of fabric, fold, lighting, etc., the clothing area with the same color on the vision may have a large difference in RGB values. Therefore, we map the pixel points from the RGB space to the L*a*b space. By the method of flood-fill, the "color gap" between each pixel point and its neighbor pixel is calculated. If the distance is less than the threshold value, the pixels are marked as “same color”; otherwise, pixels are divided into different color blocks. Take the mean value of each color block as its “color value”; merge color blocks of similar color and calculate the proportion of each color; map the statistical color values from real number space to the naming space, and output the color scheme, human-friendly names and their proportions. The actual color extraction results are shown in Figure 4:

Figure 4. Actual color extraction results

3. APPLICATION

Take the data of 2018/19 autumn and winter international fashion weeks as an example to introduce the application results of the above technologies.

An overview of all designer brands and clothing at the four 2018/19 AW fashion weeks is shown in Table 1 below:

Table 1. Data overview of the four 2018/19AW fashion weeks

Show venue	Brands	Clothes
London	105	3365
New York	174	5534
Paris	141	6181
Milan	108	4823
Total	528	19903

The above artificial intelligence technologies are used to extract colors from nearly 20,000 show pictures. One color extracted by artificial intelligence is one RGB value. Each value will be corresponding to a color number through the COLORO color system [4] by using relevant algorithm, which is a basis to carry out the follow-up color statistical analysis.

With the help of the above processing, a total of 3102 colors were extracted from nearly 20,000 garments displayed at 2018/19 AW fashion weeks.

3.1 Key colors at 2018/19 AW shows

A statistical analysis was conducted among all the colors displayed at the four 2018/19 AW fashion weeks, excluding the colors of black, white and grey, as well as those of low brightness and low color (visually very close to colored grey). The results are shown in the following Figure 5:

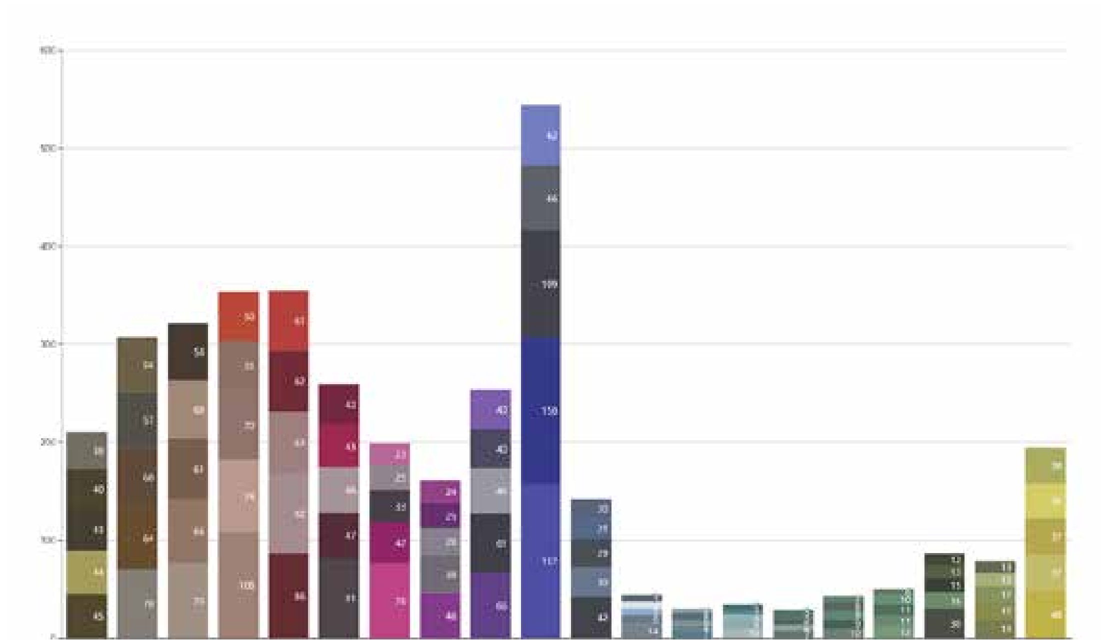

Figure 5. Key colors at 2018/19 AW shows

3.2 Analysis on 2018/19 AW famous brand colors

Now we choose Louis Vuitton, Chanel and Dior Homme as an example. The color application in 2018/19 AW international fashion weeks from the three dimensions of hue, brightness and saturation is shown in Figure 6 below:

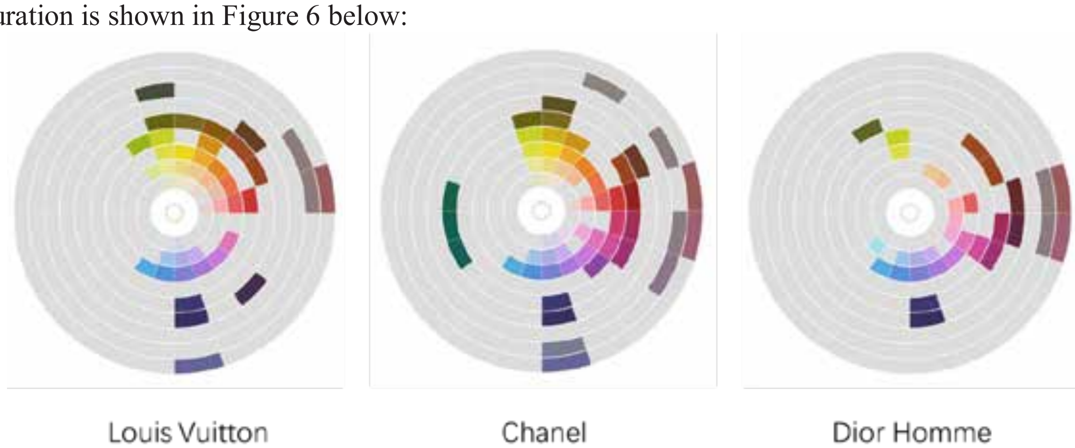

Figure 6. gamut of colors used by Louis Vuitton, Chanel and Dior Homme at 2018/19 AW international fashion weeks

In Figure 6, the circular direction of the pie chart is divided into 20 pieces, representing 20 different hues. The diameter direction is divided into 9 parts, representing the comprehensive factors of different brightness and saturation. The setting is all based on the COLORO color system. It can be seen from Figure 6 that the three brands all used blue and purple colors. Chanel used green of medium brightness and medium saturation, while Louis Vuitton and Dior Homme did not. Louis Vuitton and Chanel had more application in the two shades of prasinous and rose red, while Dior Homme had fewer application these two color gamut.

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4. Summary

As far as we can see, the application of artificial intelligence technology in the study of fashion color trend has a very profound significance and practical effect, but there are some problems that need to be further studied and resolved.

1. Artificial intelligence can greatly improve the efficiency of fashion color research. Take 2018/19 AW for example. There are about 20,000 images in total. In the case of color extraction mainly done by manpower, it would take about 21 days (8 hours per day) for 10 people to work at the same time before finishing the processing of such a large amount of image data. For each picture, it would take 5 minutes to open the software, collect the color, save the color and close pictures. By contrast, it takes only 1 second to process each image by artificial intelligence and 5.6 hours to complete all images.
2. Artificial intelligence can reduce the subjective factors in color research. In traditional color prediction, the knowledge structure, color preference, experience and preference of color experts have great influence on the prediction results, while artificial intelligence is immune to the preference.
3. There might be color difference in the process of color extraction from some pictures by artificial intelligence. Although artificial intelligence has no emotions or preference, the computer may also produce deviation results due to the impact of the folds and shadows that can be seen in the pictures to be processed.
4. Artificial intelligence may confuse the background color and the models' skin with the color of clothes. In reality, the background and the models' skin in the show pictures are often bright-colored. Although the current algorithm has tried to exclude the disturbing factors as much as possible, it is still inevitable to extract the colors of background and models' skin sometimes due to complex shooting conditions and scenes.
5. The recognition of gradient and color mixing needs to be further improved.

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VARIATIONS IN HUMAN COLOR VISION BEYOND PERCEPTUAL DIFFERENCES

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Keywords: Color vision variation, opsin gene, gaze, art appreciation

ABSTRACT

Genetic polymorphism in color vision is ubiquitous in human populations. While the majority of people possess trichromatic vision, a small percentage have minor color vision such as dichromatic vision. Although perceptual differences among different color vision types are well studied, it remains unclear how color vision variations bring about differences beyond perception, e.g., attention and impression of complex images. This study investigated how individuals with different color vision types appreciate artistic paintings. Analyses of gaze during art appreciation and impression of paintings suggest that individuals with each color vision type acquire adaptive ways of observing complex images during long-term experiences in their own color space.

INTRODUCTION

In humans, color vision variations exist mainly due to polymorphism of the L/M opsin genes, tandemly repeated on the X-chromosome. Several amino acid differences in the first and second genes of the L/M-opsin are responsible for the sensitivities of M and L cone photoreceptors [1]. About 30 nm separation in maximal sensitivity of the M and L cones at long wavelength results in common trichromatic vision along with S cone sensitive to short wavelength. Possessing one of M or L cone and S cone results in dichromatic visions, minor color vision types appeared in a few percentages of a population, mainly men. Their color perception relies on the blue-yellow color-opponent axis and ignores red-green differences. Among trichromats, polymorphism at amino acid site 180 of the first L/M opsin gene is reported to induce slight differences in red-green perception [2]. In contrast to the abundant knowledge on perceptual differences among color vision types for simple colors, little is known about how color vision differences affect aspects of vision beyond perception.

EXPERIMENTAL METHOD

Color vision types of participants were determined via an anomaloscope, the Ishihara pseudo-isochromatic plates, Farnsworth Munsell 100 Hue Test, and sequencing of the first and second L/M opsin genes. Participants with dichromatic vision and those with trichromatic vision were requested to observe 24 artistic painting images for 30 seconds each, and answer questions on their impressions of the images by rating 23 adjective pairs. The gaze during art appreciation was tracked. To compare long-term and short-term experiences of dichromatic color vision, half of the participants with common trichromatic vision observed simulated dichromatic images.

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RESULTS

The fixation patterns during the first 5 seconds for images with a certain color configuration tended to be different between trichromats and trichromats who observed simulated dichromatic images. In contrast, dichromats showed similar patterns to trichromats (Figure 1). Impressions of paintings differed greatly between trichromats and short-term experience of dichromacy in trichromats. In the genetic analysis, a large polymorphism at amino acid site 180 of the first L/M opsin gene was observed in participants with trichromatic vision. However, this difference was not related to the differences in esthetic impression.

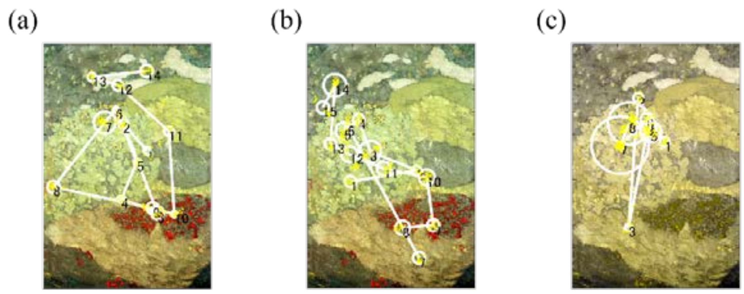

Figure 1. Example of fixation patterns during the first 5 seconds of appreciation.
(a): a trichromat, (b): a dichromat, (c): a trichromat observing simulated dichromatic images

DISCUSSION

Bottom-up attention and impressions of dichromats tended to be between those of trichromats and trichromats who briefly experienced dichromatic vision. These results suggest that the way of observing complex images was influenced by the participants' long-term experiences in their own color spaces. This indicates that the short-term experience of other color vision types via simulated images may differ greatly from the long-term experience of innate color vision.

CONCLUSION

Individuals with each color vision type acquire adaptive ways of observing complex images during long-term experiences in their own color space.

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Chromatic Adaptation Transform and Properties for Symmetry and Transitivity

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Keywords: Chromatic Adaptation Transform, von Kries transform, CAT02, CMCCAT2000, Symmetry and Transitivity Laws

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ABSTRACT

All viable modern chromatic adaptation (CAT) models such as CAT16, CAT02, CMCCAT2000 and CMCCAT97 can trace their roots, both conceptually and mathematically, to a simple model formulated from the hypotheses of Johannes von Kries in1902, now known as von Kries transform/model, hence they are considered as a generalization of the von Kries model. However, the von Kries model satisfies the symmetry and transitivity properties, but most of the modern CATs do not satisfy the two properties. In this sense, they cannot be considered as a generalization of the von Kries model. In this paper, a generalized von Kries transform is proposed and it is shown the proposed model not only satisfies the symmetry and transitivity properties, but also improves the fit to most available experimental visual datasets on corresponding colours.

INTRODUCTION

A chromatic adaptation transform (CAT) is capable of predicting corresponding colours. A pair of corresponding colours consists of a colour observed under one illuminant (say, D65) and another colour that has the same appearance when observed under a different illuminant (say, A). CAT is part of the Colour Appearance Model (CAM) [1-3] and is important for many industrial applications. This research topic has been extensively studied over several decades. The work of Johannes von Kries [4] in 1902 laid down the foundation for modeling the chromatic adaptation. He did not give a specific set of equations for the modeling, instead, he simply outlined his hypothesis in words and described the potential impact of his ideas. Based on his hypothesis, chromatic adaptation in visual system is considered to be only the independent changes in responsivity of the three types of cone photoreceptors. In order to present the von Kries hypothesis in terms of a chromatic adaptation model , we need a 3 by 3 matrix M, which transforms the tristimulus values (TSV) $X_\beta, Y_\beta, Z_\beta$ under an illuminant named as β to the cone-like or sharper sensor space R, G, B or L, M, S space. Here, we use R, G, B notation. Thus, we have:

$$\begin{pmatrix} R_\beta \\ G_\beta \\ B_\beta \end{pmatrix} = M \begin{pmatrix} X_\beta \\ Y_\beta \\ Z_\beta \end{pmatrix} \tag{1}$$

The matrix M can be the well-known HPE matrix [1] or the CAT02 matrix [2], or the CAT16 matrix [3]. All the chromatic adaptation is completed in the R, G, B space. The signal $R_\beta, G_\beta, B_\beta$ are considered as the initial cone responses. The von Kries post-adaptation signals $R_{a,\beta}, G_{a,\beta}, B_{a,\beta}$ are, according to the the von Kries proportionality law, given by:

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$$\begin{pmatrix} R_{a,\beta} \\ G_{a,\beta} \\ B_{a,\beta} \end{pmatrix} = \begin{pmatrix} k_{R,\beta}R_\beta \\ k_{G,\beta}G_\beta \\ k_{B,\beta}B_\beta \end{pmatrix} \quad (2)$$

where, subscript 'a' represents adaptation, 'β' represents the illuminant, and "R", "G", "B" represent different channels. The adaptation factors or coefficients $k_{R,\beta}, k_{G,\beta}, k_{B,\beta}$ are independent of each other and are given by

$$k_{R,\beta} = \frac{1}{R_{w,\beta}}, \qquad k_{G,\beta} = \frac{1}{G_{w,\beta}}, \qquad k_{B,\beta} = \frac{1}{B_{w,\beta}} \quad (3)$$

Here, the subscript "w" means the relevant signals transformed from the TSVs of the illuminant, i.e., for example,

$$\begin{pmatrix} R_{w,\beta} \\ G_{w,\beta} \\ B_{w,\beta} \end{pmatrix} = M \begin{pmatrix} X_{w,\beta} \\ Y_{w,\beta} \\ Z_{w,\beta} \end{pmatrix} \quad (4)$$

Here, $X_{w,\beta}, Y_{w,\beta}, Z_{w,\beta}$ are the TSVs of the illuminant β. Thus, if two stimuli s_β and s_δ are viewed under illuminants β and δ respectively and if they are perceived as the same appearance, then we must have:

$$\begin{pmatrix} R_{a,\beta} \\ G_{a,\beta} \\ B_{a,\beta} \end{pmatrix} = \begin{pmatrix} R_{a,\delta} \\ G_{a,\delta} \\ B_{a,\delta} \end{pmatrix} \text{ or } \begin{pmatrix} k_{R,\beta}R_\beta \\ k_{G,\beta}G_\beta \\ k_{B,\beta}B_\beta \end{pmatrix} = \begin{pmatrix} k_{R,\delta}R_\delta \\ k_{G,\delta}G_\delta \\ k_{B,\delta}B_\delta \end{pmatrix} \quad (5)$$

When Eq. (5) holds, the two stimuli are called the corresponding colours.

Before we go further, we note that when we say stimulus s_β in TSV space, we mean that s_β is a column vector formed by TSVs: $X_\beta, Y_\beta, Z_\beta$. If we say stimulus s_β in cone-like space, we mean that s_β is a column vector formed by cone response signals: $R_\beta, G_\beta, B_\beta$ transformed using Eq. 1. If we let $\mathrm{daig}(a, b, c)$ be a 3 by 3 diagonal matrix and we set

$$\overline{\Lambda}_{\delta,\beta} = \mathrm{diag}\begin{pmatrix} \frac{k_{R,\beta}}{k_{R,\delta}} & \frac{k_{G,\beta}}{k_{G,\delta}} & \frac{k_{B,\beta}}{k_{B,\delta}} \end{pmatrix} = \mathrm{diag}\begin{pmatrix} \frac{R_{w,\delta}}{R_{w,\beta}} & \frac{G_{w,\delta}}{G_{w,\beta}} & \frac{B_{w,\delta}}{B_{w,\beta}} \end{pmatrix} \quad (6)$$

then, we have:

The von Kries transform in the cone-like space from stimulus s_β to stimulus s_δ:

$$\Gamma_{\delta,\beta,vK} = \overline{\Lambda}_{\delta,\beta} \quad (7)$$

$$\begin{pmatrix} R_\delta \\ G_\delta \\ B_\delta \end{pmatrix} = \Gamma_{\delta,\beta,vK} \begin{pmatrix} R_\beta \\ G_\beta \\ B_\beta \end{pmatrix} \quad (8)$$

Note that the order of the symbols: δ, β, vK in the subscript of the von Kries transform $\Gamma_{\delta,\beta,vK}$. vK means the von Kries transform. δ, β mean that the von Kries transform maps stimulus s_β under illuminant β to stimulus s_δ under illuminant δ. Similarly, transform $\Gamma_{\beta,\delta,vK}$ maps stimulus s_δ under illuminant δ to stimulus s_β under illuminant β.

Note also that if two stimuli s_β and s_δ are corresponding colours, then s_δ and s_β are also corresponding colours, which is named as symmetry. Thus, we expect the von Kries transform satisfy this property. In fact, it can be verified that

$$\Gamma_{\delta,\beta,vK} * \Gamma_{\beta,\delta,vK} = I_3 \quad (9)$$

Here I_3 is a 3 by 3 identity matrix. Eq. 9 shows that the von Kries transform has the nice symmetry property. Besides, if s_β and s_δ are corresponding colours, s_γ and s_δ are corresponding colours, then s_γ and s_β are corresponding colours too, which is named as transitivity. Similarly we also expect von Kries transform has the transitivity property. Fortunately, it is indeed the case since

$$\Gamma_{\gamma,\delta,vK} * \Gamma_{\delta,\beta,vK} = \Gamma_{\gamma,\beta,vK} \tag{10}$$

In 2000, Li et al. [5] gave a linearized CAT named as CMCCAT2000 which was shown to be better than non-linear transforms: the CMCCAT97 [6] , Bradford Transform [7] and the linear von Kries transform in predicting the visual data. In order to give expression for the CMCCAT2000, we need to update the von Kries adaptation factors in Eq. (3). The new factors are given in the following:

$$k'_{R,\beta} = \frac{Y_{w,\beta}}{R_{w,\beta}}, \qquad k'_{G,\beta} = \frac{Y_{w,\beta}}{G_{w,\beta}}, \qquad k'_{B,\beta} = \frac{Y_{w,\beta}}{B_{w,\beta}} \tag{11}$$

The necessity of introducing the $Y_{w,\beta}$ value of the illuminant was first introduced by Li et al. [5] and was further discussed by Hunt et al. [8]. Let

$$\bar{\Lambda}'_{\delta,\beta} = \mathrm{diag}\left(\frac{k'_{R,\beta}}{k'_{R,\delta}} \quad \frac{k'_{G,\beta}}{k'_{G,\delta}} \quad \frac{k'_{B,\beta}}{k'_{B,\delta}}\right) = \mathrm{diag}\left(\frac{R_{w,\delta}}{R_{w,\beta}} \cdot \frac{Y_{w,\beta}}{Y_{w,\delta}} \quad \frac{R_{w,\delta}}{R_{w,\beta}} \cdot \frac{Y_{w,\beta}}{Y_{w,\delta}} \quad \frac{B_{w,\delta}}{B_{w,\beta}} \cdot \frac{Y_{w,\beta}}{Y_{w,\delta}}\right) \tag{12}$$

then the CMCCAT2000 in cone-like space is given by:

CMCCAT2000 [5] in the cone-like space from stimulus s_β to stimulus s_δ

$$\Gamma_{\delta,\beta,CAT00} = D_{00}\bar{\Lambda}'_{\delta,\beta} + (1 - D_{00})I_3 \tag{13}$$

$$\begin{pmatrix} R_\delta \\ G_\delta \\ B_\delta \end{pmatrix} = \Gamma_{\delta,\beta,CMC00} \begin{pmatrix} R_\beta \\ G_\beta \\ B_\beta \end{pmatrix} \tag{14}$$

D_{00} is the adaptation factor D [5] in the above method depending on the luminance levels of both illuminants β and δ, is between 0 and 1. Again, CAT00 in the subscript in $\Gamma_{\delta,\beta,CMC00}$ means the CMCCAT200.

It can be verified that

$$\Gamma_{\delta,\beta,CAT00} * \Gamma_{\beta,\delta,CAT00} \neq I_3 \tag{15}$$

and

$$\Gamma_{\gamma,\delta,CAT00} * \Gamma_{\delta,\beta,CAT00} \neq \Gamma_{\gamma,\beta,CAT00} \tag{16}$$

unless $D_{00} = 1$. Thus, though the CMCCAT2000 predicts visual datasets better than von Kries transform, it does not have the properties of symmetry and transitivity.

Note that the CAT02 [2] and CAT16[3] in cone-like space are the same as CMCCAT2000 in cone-like space except they use a different adaptation factor D [2] named as D_{02} here. Hence both of them do not have the properties of symmetry and transitivity unless $D_{02} = 1$.

GENERALIZED von Kries (GvK) TRANSFORM

All the above linear extensions including the CMCCAT2000, CAT02 and CAT16 fits the visual data [7,9-16] better than the von Kries transform. But the Symmetric and Transitivity Laws are spoilt unless the D factor equals to 1. Now the question is can we not only generalize von Kries transform so that the generalization has a better performance in predicting the visual datasets, but also it satisfies the Symmetric and Transitivity Laws? The answer is yes. To this end, we start from the von Kries post-adaptation Eq. (2), but with a more general scaling factors given by Eq. (11), i.e. now we consider the new von Kries post-adaptation signals $R_{a,\beta}$, $G_{a,\beta}$, $B_{a,\beta}$ defined by

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$$\begin{pmatrix} R_{a,\beta} \\ G_{a,\beta} \\ B_{a,\beta} \end{pmatrix} = \begin{pmatrix} k'_{R,\beta} R_\beta \\ k'_{G,\beta} G_\beta \\ k'_{B,\beta} B_\beta \end{pmatrix} \tag{17}$$

Also a D factor named as D_β can be introduced into the above Eq. (17), resulting in:

$$\begin{pmatrix} R_{a,\beta} \\ G_{a,\beta} \\ B_{a,\beta} \end{pmatrix} = \begin{pmatrix} [D_\beta k'_{R,\beta} + (1 - D_\beta)] R_\beta \\ [D_\beta k'_{G,\beta} + (1 - D_\beta)] G_\beta \\ [D_\beta k'_{B,\beta} + (1 - D_\beta)] B_\beta \end{pmatrix} \tag{18}$$

It is clear that when $D_\beta = 1$, Eq. (18) becomes Eq. (17), which means it has a full adaptation based on the von Kries law. While when $D_\beta = 0$, Eq. (18) becomes

$$\begin{pmatrix} R_{a,\beta} \\ G_{a,\beta} \\ B_{a,\beta} \end{pmatrix} = \begin{pmatrix} R_\beta \\ G_\beta \\ B_\beta \end{pmatrix} \tag{19}$$

which means no adaptation at all. Hence, D_β in Eq. (18) between 0 and 1 means an incomplete adaptation. Thus, if two stimuli s_β and s_δ are viewed under illuminants β and δ respectively and if they are perceived as the same appearance, then we must have:

$$\begin{pmatrix} R_{a,\delta} \\ G_{a,\delta} \\ B_{a,\delta} \end{pmatrix} = \begin{pmatrix} R_{a,\beta} \\ G_{a,\beta} \\ B_{a,\beta} \end{pmatrix}, \quad \text{or} \quad \begin{pmatrix} [D_\delta k'_{R,\delta} + (1 - D_\delta)] R_\delta \\ [D_\delta k'_{G,\delta} + (1 - D_\delta)] G_\delta \\ [D_\delta k'_{B,\delta} + (1 - D_\delta)] B_\delta \end{pmatrix} = \begin{pmatrix} [D_\beta k'_{R,\beta} + (1 - D_\beta)] R_\beta \\ [D_\beta k'_{G,\beta} + (1 - D_\beta)] G_\beta \\ [D_\beta k'_{B,\beta} + (1 - D_\beta)] B_\beta \end{pmatrix} \tag{20}$$

Thus, we have the generalized von Kries transform in cone-like space:

The generalized von Kries (GvK) transform in cone-like space:

$$\Gamma_{\delta,\beta,GvK} = \text{diag}\left(\frac{D_\beta k'_{R,\beta} + (1-D_\beta)}{D_\delta k'_{R,\delta} + (1-D_\delta)} \quad \frac{D_\beta k'_{G,\beta} + (1-D_\beta)}{D_\delta k'_{G,\delta} + (1-D_\delta)} \quad \frac{D_\beta k'_{B,\beta} + (1-D_\beta)}{D_\delta k'_{B,\delta} + (1-D_\delta)} \right) \tag{21}$$

$$\begin{pmatrix} R_\delta \\ G_\delta \\ B_\delta \end{pmatrix} = \Gamma_{\delta,\beta,GvK} \begin{pmatrix} R_\beta \\ G_\beta \\ B_\beta \end{pmatrix} \tag{22}$$

Note that the adaptation factor D_β can be the D_{00} or D_{02}, or any better formula. Now one can easily show:

$$\Gamma_{\delta,\beta,GvK} * \Gamma_{\beta,\delta,GvK} = I_3 \tag{23}$$

and

$$\Gamma_{\gamma,\delta,GvK} * \Gamma_{\delta,\beta,GvK} = \Gamma_{\gamma,\beta,GvK} \tag{24}$$

Thus, the GvK indeed satisfies the properties of symmetry and transitivity. Note also that the GvK has two adaptation factors D_β and D_δ. When the luminance levels of the two illuminants are the same, D_β and D_δ are the same since they depend only on the luminance level.

Note also that when we consider the GvK in TSV space, we need a matrix *M* to map TSV of the stimulus to the cone-like space (see Eq. 4). Then the adaptation is completed in the con-like space. Finally, the adapted signal istransformed back to TSV space using the inverse of the matrix.

PERFORMANCE OF THE PROPOSED GvK TRANSFORM

Performance of the proposed von Kries transform (GvK) with the CAT02 matrix against the CAT02 is tested using the available corresponding colour datasets [7, 9-16] which were used for developing the CAT02 and CAT16. The D factor formula is chosen as the D formula used for the CAT02 and CAT16. Results are listed in the third and forth columns of Table 1. The values in the

Table are mean CIELAB colour differences between the predicted and visual observed TSVs for each pair of corresponding colours in the same dataset. The value in the second last row is the overall mean of the mean colour differences for each dataset and the value in the last row is the weighted mean clour difference and the weight for each dataset is the ratio of the number of pairs in this dataset and the total number of pairs in all the datasets. The proposed von Kries transform (GvK) with the CAT16 matrix against the CAT16 is also tested, and the results are listed in the last two columns of Table 1. In each case, the proposed GvK method performs equally well or slightly better than the corresponding CAT02 or CAT16.

Table 1: The performance of CAT02, CAT16 and the proposed GvK transform in terms of mean and weighted mean CIELAB colour differences. NSP means number of sample pairs

Dataset	NSP	CAT02 Matrix		CAT16 Matrix	
		CAT02	GvK	CAT16	GvK
CSAJ	87	4.0	4.0	4.3	4.3
Kuo	40	5.0	4.9	5.8	5.7
Kuo	41	3.5	3.5	3.8	3.8
Lam	58	4.4	4.4	4.9	4.9
Helson	59	4.9	5.0	5.2	5.2
LUTCHI	43	5.7	5.6	**5.6**	5.5
LUTCHI	44	6.6	6.7	6.6	6.7
LUTCHI	41	7.0	6.9	7.0	7.0
Breneman(1)	12	7.7	7.7	7.7	7.7
Breneman(2)	12	5.1	5.2	**4.7**	4.8
Breneman(3)	12	8.2	8.3	**7.9**	8.0
Breneman(4)	11	9.8	9.5	**9.6**	9.3
Breneman(6)	12	7.5	7.5	**6.4**	6.5
Breneman(8)	12	8.8	8.5	**8.7**	8.4
Breneman(9)	12	14.2	13.8	**13.9**	13.6
Breneman(11)	12	6.6	6.3	**6.1**	6.0
Breneman(12)	12	7.2	6.7	**6.4**	6.0
Braun & Fairchild(1)	17	3.2	3.2	3.3	3.4
Braun & Fairchild(2)	16	5.1	5.1	**5.0**	5.0
Braun & Fairchild(3)	17	3.7	3.8	4.4	4.5
Braun & Fairchild(4)	14	3.8	3.6	4.0	3.9
Mean		6.3	6.2	6.3	6.2
Weighted Mean		5.5	5.5	5.6	5.6

CONCLUSION

In this paper, von Kries transform and its directly related linear generalizations were firstly reviewed. It was found that all the generalizations do not satisfy the Symmetric and Transitivity Laws unless the involved adaptation D factor equals to 1. Then we proposed a generalization to the von Kries transform named as GvK. It has been shown the proposed GvK method satisfies both the Symmetric and Transitivity Laws. Furthermore, test results have shown that the proposed method performs equally well as or better than the CAT02 and CAT16.

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COLOR APPEARANCE OF OBJECTS UNDER VIVID COLORED LED LIGHTS

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ABSTRACT

Human color perception changes according to the color of ambient lighting. To investigate the perceived color of the objects under vivid colored LED lights twenty-four color chips were assessed by five subjects using the elementary color naming method. Ten lights with the increasing saturation of red; D65, R1, R2, …, and R9, where R9 is a pure red LED, were used as the room lighting. Data of eleven color chips covering hue were selected to plot on the polar diagram for analysis of the amount of chromaticness and the hue change. The results showed the changes of color appearance in a way that the color constancy decreased for more vivid red color of LED light.

INTRODUCTION

LED lighting became common as interior lighting of resident and offices. Because of its properties of energy saving, long lifetime, a variety of colors, and adjustable intensity, it has developed to replace the traditional lighting technology. Vivid colored LED lights could break a property of the color constancy. We often experience very vivid colored LED lights in our daily life and sometimes we got confused about the color of the objects that were illuminated under the vivid colored lights.

To investigate the color appearance of objects under vivid LED lights, C. Pipornpong, et al.[1)] employed twenty-four color chips taken from the Color Checker and measured their color appearance by the elementary color naming method under 10 different colors of illumination. They found that the color constancy decreased for more vivid color of illumination for all the four colors of illumination, red, yellow, green, and blue. It was pointed out that smaller steps of color difference for changing illumination color was necessary to understand where the color constancy begins to break down. In this report we employ small steps of color change of illumination so that we can get points of breakdown of the color constancy accurately.

METHODOLOGY

Apparatus

We used the same experimental room as C. Pipornpong, et al.'s room which was decorated by painting, books, flowers and other to simulate a normal living room in daily life as shown in Fig. 1. The room was illuminated by LED composed of three colors, red, green, and blue. Their spectral power distribution SPD to simulate D65 is shown in Fig. 2. We employed only red color for the illumination but 9 different vividness by changing the purity. Theyir chromaticity coordinates are shown in Fig. 3 by black dots, the leftmost dot shows D65. To the white the red light was gradually added to produce 9 lights and they were denoted R1, R2, R3, R4, R5, R6, R7, R8, and R9, which are shown by successive dots. Next to D65 is R1 and the next R2 and so on. Beyond R3 an almost equal interval on the CIEu'v' diagram was taken to get the next light. The illuminance was kept at about 100 lx for all lights.

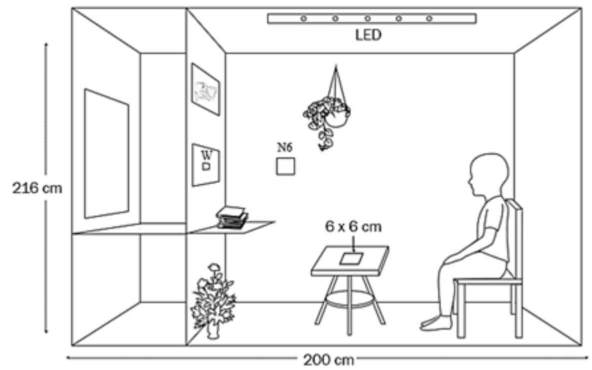

Figure 1. Schematic diagram of experimental room

The color chip was placed on a stool with a gray background in front of the subject and h/she judged the color appearance of the chip by the elementary color naming method. 24 chips were investigated in a random order, but eleven color chips were employed for the analysis and their chromaticities under respective colored lights were measured with Konica Minolta Luminometer CS100 and they are shown by red lines in Fig. 3. The chromaticity points are not shown to avoid confusion but only the connecting lines of those points are shown by dotted back line for D65 and red solid lines for red lights. The contour gradually shrank for more vivid color of illumination and it had no area at all at R9.

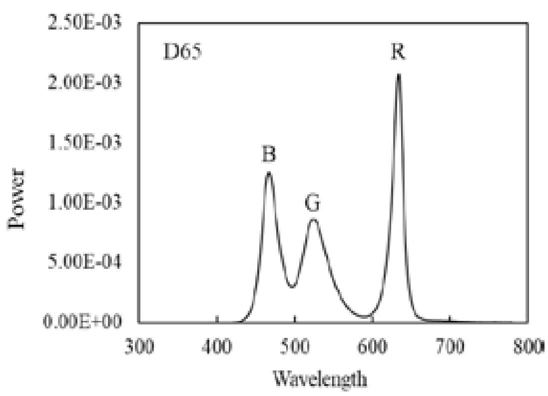

Figure 2. The spectral power distribution SPD to simulate D65

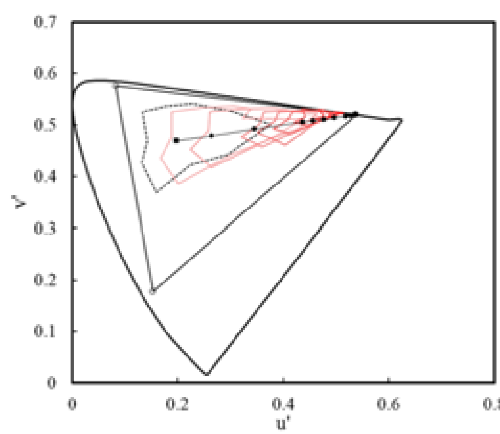

Figure 3. The interval of colored lights and the physical measurement of eleven color chips under each light.

Procedure

Five subjects who have experience in elementary color naming; CP, KT, MI, NP, and PC participated. In the experiment each subject entered the room and adapted to each light for two minutes then each color chip was randomly placed one by one on the stool. Subject was asked to assess the color appearance of the chip by answering the amounts of chromaticness, whiteness, and blackness in percentage, and the apparent hue by unique red, yellow, green, and blue in percentage. Each subject repeated three times for each light.

Beside the measurement of the color chips we measured the color of illuminations. Subjects assessed the color of achromatic patch N6 placed in the subject room by looking it through a small window W from the test room.

RESULTS AND DISCISSION

Data of 11 chips covering hue were selected to plot on the polar diagram used in the opponent color theory for analysis. Figure 4 show examples of the results after taking the average of five subjects for D65, R3, R6, and R9. Along the horizontal axis the amounts of red and green were taken and along the vertical axis the amounts of yellow and blue were taken. The amount of chromaticness was taken along the radius giving 0 % at the origin and 100 % at the circumference of the polar diagram. A contour made by 11 points showed a large contour with D65 light (the top left figure) implying all the color chips appeared colorful. Small points indicate individual data of five subjects and large points are their averages. The contour of D65 is replotted for other illuminations; R3, R6, and R9 by dotted lines to indicates the effect of color of illumination for the color appearance of chips. The contour gradually decreased for more vivid color of light. Under R3 the contour shrank, particularly in the side of green while color appearance remained similar to that under D65 at the side of red. Under R6the contour became further small. Especially under the extremely red illumination R9, the contour almost become a line on the yellow-red quadrant with a small area indicating the color appearance of all color chips became reddish yellow. In other words, all the color chips appeared same hue of orange but with different saturation. No color constancy existed. Fig. 5 shows trend of chroma contour area changes from D65 for more vivid colored lights in term of their physical measurement on u'v' diagram and the color appearance judged by the observers. Both show the same trends of decline; the area gradually decreases for more vivid colored lights. Notably, even the physical of all color patches became completely red and there is no area under R9 illumination, but for human perception there is still a bit of the area left. This indicates that subjects still perceive some colors of the patches even the physical color became completely red. This may be able to explain the adaptation mechanisms of human perception.

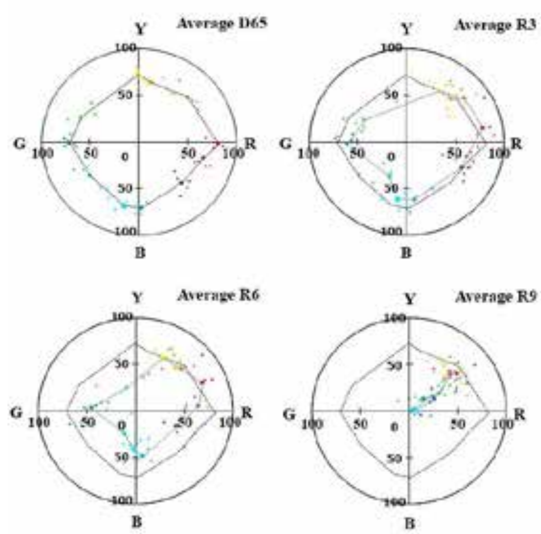

Figure 4. Color appearance of eleven objects plotted on polar diagrams for D65, R3, R6, and R9. The blue line indicated each light compare to D65 which represented by dashes line.

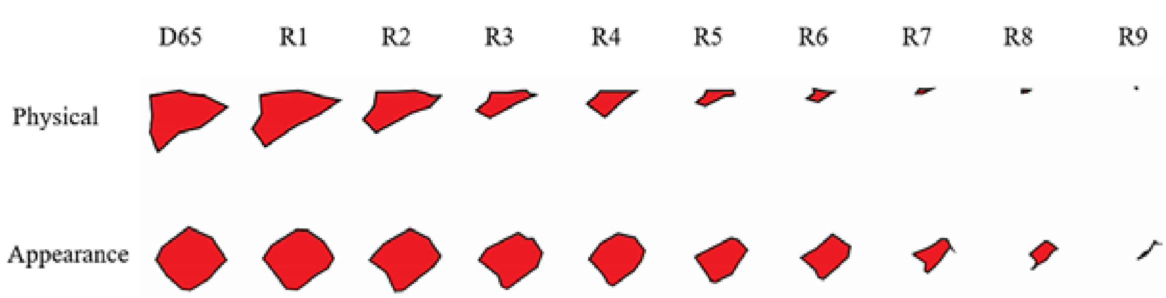

Figure 5. Trend of chroma contour changes from D65 for more vivid colored lights in term of their physical measurement and human perception.

To assess the color appearance decrease according to the vividness of LED lights the area of a contour was calculated and the ratio of the area of a light to the area of D65 for both physical contours (upper line of Fig. 5) and perceptual contour (lower line of Fig. 5) and it was plotted for the distance of each light from D65 on the u'v' diagram as shown in Fig. 6 and 7, respectively. The physical measurement shows almost linear decrease with the distance but perceptual measurement shows that the ratio remained rather large for a while up to R4 but beyond R4 it started to decrease sharply especially over the lights of R6, implying worsening of color perception with increase of red color vividness of lighting.

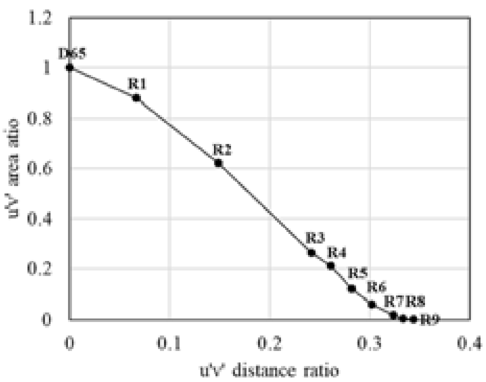

Figure 6. The correlation between appearance ratio obtain from the observers and illuminations distance ratio on the u'v' diagram.

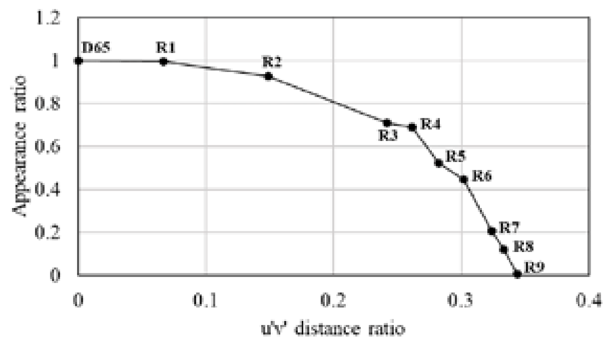

Figure 7. The correlation between physical measurement and illuminations distance on u'v' diagram.

Beside the amount of chromaticness the apparent hue change is another factor in considering the color perception ability. Fig. 8(a) shows how the color appearance of each chip changed when the illumination changed from D65 to R9. The contour of 11 color chips under the extremely vivid illumination R9 is shown by a red dashed line. It almost became a line passing through the yellow-red quadrant. In the other word, the color appearance of all chips converged to orange with different saturation. The color appearance of the illumination is shown by black dotted line in the same figure. We see here that the color of the illumination is almost unique red with different saturation, but the color of test chips appeared orange. In Fig. 8(b) we plotted the change of the psychophysical color a* and b* of chips. The colors converged to a solid line which is a regression line of a*b* under R9. In other words, color appearance of all stimuli just exhibits the psychophysical color, which is nothing but the light color appearance and not the object color. The fact all the color appearance approached a line indicates the color appearance change gradually from object color to the light color as the illuminating light becomes more vivid.

To see amount of hue shift, we calculated hue angle, which is the angle of a data point on the polar diagram measured from the red axis. The hue angle of each color chip was obtained and the average of 11 chips was calculated. The root mean square of those averages to the hue angle average obtained for D65 is plotted for the distance of illumination from D65 on u'v' diagram in Fig. 9. The RMS increased rather rapidly after R6. To show deterioration of the color appearance of test chips.

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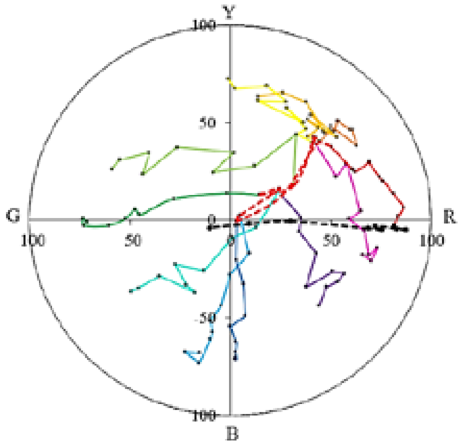

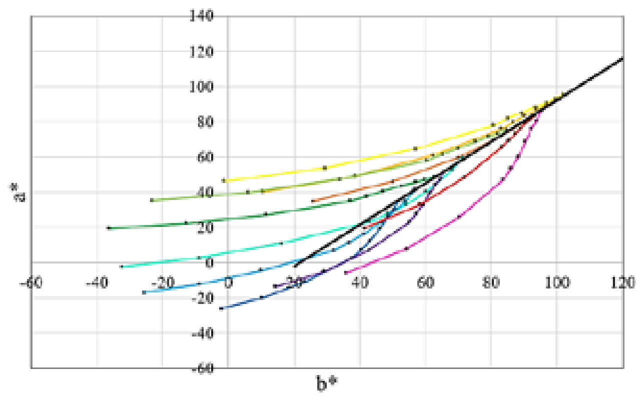

Figure 8. The color appearance changes of each color ship for the change of illumination from D65 to R9 (a) and the corresponding psychophysical color change plotted on a*b* diagram (b).

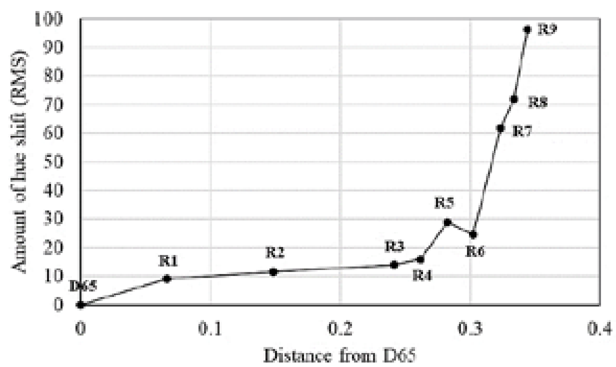

Figure 9. The correlation between the amount of hue shift (the root mean square error) and illuminations distance on u'v' diagram.

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AGING EFFECT OF OBSERVER METAMERISM FOR WIDE COLOR GAMUT DISPLAYS

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Keywords: color matching, observer metamerism, cone fundamentals, aging effect, wide color gamut

ABSTRACT

We employed age dependent cone fundamentals to simulate a color match between the color chip illuminated with LED lamps and the color presented in the displays, which have different wide color gamut, in turn, a laser display, an AdobeRGB LCD and sRGB CRT display. Simulation results show that the chromaticity coordinates of a laser display for aged observers are more bluish than those of color chips. It means that the wider color gamut display looks yellowish, so the more blue stimulus value are needed to make a color match. We also carried out color matching experiments with actual observers of different ages to examine the simulation results. Although individual differences among observers exist, the most part of experimental results are similar to the simulation applied with the CIE 2006 age dependent cone fundamentals

INTRODUCTION

Along with the progress of display technology, super high-definition (SHD), super high dynamic range (SHDR) and super wide color gamut (SWCG) become recent trends for image reproduction of display. Among them, in order to achieve a wide color gamut, the spectral power distribution of the display primaries have to be narrow spectral bands. The tristimulus value of the color stimulus mixed with the narrow band primaries is apt to be sensitive to a variation of color matching functions. Some problems might take place due to the observer metamerism, in which a pair of color stimuli of different spectral power distributions but looks the same color for an observer, called metamers for this observer, would look different for another observer. In 2006, CIE published the Technical Report[1] in which the spectral sensitivity functions of cones for various aged observers, called cone fundamentals of an age dependent observer, are generalized. The cone sensitivities of short wavelength regions decrease with age due to the increase of the optical density of the lens. We employed the age dependent cone fundamentals to simulate a color match between the color chip illuminated with an LED lamp and the color presented on the displays with different sizes of color gamut. We also conducted the color matching experiment of which different age observers participated.

EXPERIMENTAL METHOD

We carried out the color matching between a stimulus on display and a color chip illuminated with LED sources. The experimental apparatus consists of two viewing booths covered by gray papers of N 6.3. A color chip was illuminated with a 5000 K LED lamp (NNN 21607K, National) in one booth. In the other booth, a color presented on a display located behind the booth was viewed through a window of the same size as the color chip. We employed three displays; a laser display (LASERVUE 75-LT1, MITSUBISHI) whose RGB primaries were 637 nm, 532 nm, and 442 nm of wavelength, respectively, an AdobeRGB LCD (EIZO ColorEdge CS2420) and an sRGB CRT (SONY CPD15FS9) display. 27 test colors chips were used. The background of test color was the medium gray of N 6.4 surrounded by the white of N 9.1. The field size of the window was 2.7º. Figure 1 shows the spectral radiance of test color chips illuminated with an LED lamp. Figure 2 shows the spectral radiance of the stimuli of which chromaticity is the same as the color chips, on the displays, (a) Laser Display, (b) LCD, and (c) CRT Display. The observer's task was to adjust the luminance and chromaticity of displayed color stimulus to match color chips with a wireless mouse. Four normal trichromats whose ages were 22, 36, 52 and 67 years participated the color matching experiments.

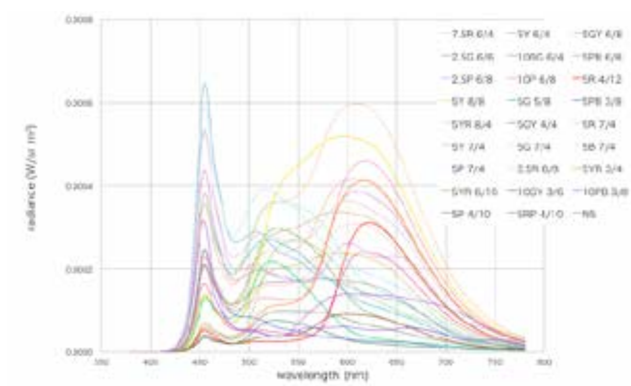
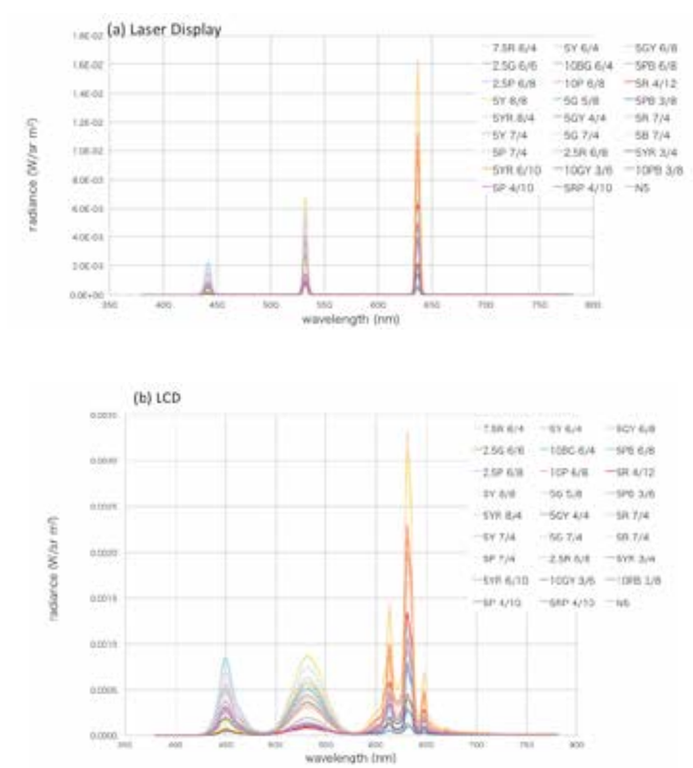


Figure 1. Spectral radiance of the color chips illuminated with an LED lamp.



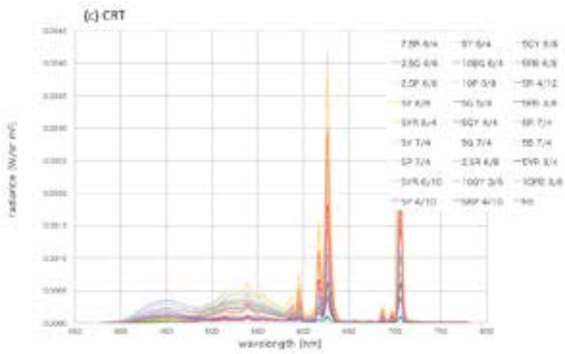


Figure 2. Spectral radiance of the stimuli on displays; (a) Laser Display, (b) LCD, and (c) CRT Display.

SIMULATION METHOD

When the color-match conditions are satisfied for two stimuli with different spectral radiant power distribution, the two stimuli are called metameric stimuli. Metameric stimuli should have the same cone excitations. So, a color matching between a stimulus on the display and a color chip illuminated with a light source is described with the following equations,

$$\int E_{\mathrm{i}}(\lambda)\,\bar{l}_{\mathrm{A}}(\lambda)\mathrm{d}\lambda = R_{\mathrm{i}}\int E_{\mathrm{R}}(\lambda)\,\bar{l}_{\mathrm{A}}(\lambda)\mathrm{d}\lambda + G_{\mathrm{i}}\int E_{\mathrm{G}}(\lambda)\,\bar{l}_{\mathrm{A}}(\lambda)\mathrm{d}\lambda + B_{\mathrm{i}}\int E_{\mathrm{B}}(\lambda)\,\bar{l}_{\mathrm{A}}(\lambda)\mathrm{d}\lambda, \quad (1)$$

$$\int E_{\mathrm{i}}(\lambda)\,\bar{m}_{\mathrm{A}}(\lambda)\mathrm{d}\lambda = R_{\mathrm{i}}\int E_{\mathrm{R}}(\lambda)\,\bar{m}_{\mathrm{A}}(\lambda)\mathrm{d}\lambda + G_{\mathrm{i}}\int E_{\mathrm{G}}(\lambda)\,\bar{m}_{\mathrm{A}}(\lambda)\mathrm{d}\lambda + B_{\mathrm{i}}\int E_{\mathrm{B}}(\lambda)\,\bar{m}_{\mathrm{A}}(\lambda)\mathrm{d}\lambda, \quad (2)$$

$$\int E_{\mathrm{i}}(\lambda)\,\bar{s}_{\mathrm{A}}(\lambda)\mathrm{d}\lambda = R_{\mathrm{i}}\int E_{\mathrm{R}}(\lambda)\,\bar{s}_{\mathrm{A}}(\lambda)\mathrm{d}\lambda + G_{\mathrm{i}}\int E_{\mathrm{G}}(\lambda)\,\bar{s}_{\mathrm{A}}(\lambda)\mathrm{d}\lambda + B_{\mathrm{i}}\int E_{\mathrm{B}}(\lambda)\,\bar{s}_{\mathrm{A}}(\lambda)\mathrm{d}\lambda, \quad (3)$$

where $E_{\mathrm{i}}(\lambda)$ is spectral radiance of a color chip numbered i, $E_{\mathrm{R}}(\lambda)$, $E_{\mathrm{G}}(\lambda)$, $E_{\mathrm{B}}(\lambda)$ is the relative radiant of each primary stimulus of a display, and $\bar{l}_{\mathrm{A}}(\lambda)$, $\bar{m}_{\mathrm{A}}(\lambda)$, and $\bar{s}_{\mathrm{A}}(\lambda)$ is the spectral sensitivity function so called the cone fundamental of the L-, M-, and S-cone of an observer aged A years. We used the age dependent cone fundamentals published as the CIE 170-1 [1]. From Eqs. (1), (2), and (3), the relative intensity of each primary, so called tristimulus values, are obtained as follows,

$$\begin{bmatrix} R_i \\ G_i \\ B_i \end{bmatrix} = \begin{bmatrix} \int E_R(\lambda)\bar{l}_{\mathrm{A}}(\lambda)d\lambda & \int E_G(\lambda)\bar{l}_{\mathrm{A}}(\lambda)d\lambda & \int E_B(\lambda)\bar{l}_{\mathrm{A}}(\lambda)d\lambda \\ \int E_R(\lambda)\bar{m}_{\mathrm{A}}(\lambda)d\lambda & \int E_G(\lambda)\bar{m}_{\mathrm{A}}(\lambda)\lambda & \int E_B(\lambda)\bar{m}_{\mathrm{A}}(\lambda)d\lambda \\ \int E_R(\lambda)\bar{s}_{\mathrm{A}}(\lambda)d\lambda & \int E_G(\lambda)\bar{s}_{\mathrm{A}}(\lambda)d\lambda & \int E_B(\lambda)\bar{s}_{\mathrm{A}}(\lambda)d\lambda \end{bmatrix}^{-1} \begin{bmatrix} \int E_i(\lambda)\bar{l}_{\mathrm{A}}(\lambda)d\lambda \\ \int E_i(\lambda)\bar{m}_{\mathrm{A}}(\lambda)\lambda \\ \int E_i(\lambda)\bar{s}_{\mathrm{A}}(\lambda)d\lambda \end{bmatrix}. \quad (4)$$

Then, the cone tristimulus values are calculated with the CIE 2006 cone fundamentals for 2º as follows,

$$L_i = R_i\int E_R(\lambda)\bar{l}(\lambda)d\lambda + G_i\int E_G(\lambda)\bar{l}(\lambda)d\lambda + B_i\int E_B(\lambda)\bar{l}(\lambda)d\lambda, \quad (5)$$

$$M_i = R_i\int E_R(\lambda)\bar{m}(\lambda)d\lambda + G_i\int E_G(\lambda)\bar{m}(\lambda)d\lambda + B_i\int E_B(\lambda)\bar{m}(\lambda)d\lambda, \quad (6)$$

$$S_i = R_i\int E_R(\lambda)\bar{s}(\lambda)d\lambda + G_i\int E_G(\lambda)\bar{s}(\lambda)d\lambda + B_i\int E_B(\lambda)\bar{s}(\lambda)d\lambda, \quad (7)$$

where $\bar{l}(\lambda)$, $\bar{m}(\lambda)$ and $\bar{s}(\lambda)$ is the CIE 2006 cone fundamental of the L-, M-, and S-cone, respectively, of the average observer 32 years and for 2° field. The XYZ tristimulus values are derived according to the CIE 170-2 [2] as follow,

$$\begin{bmatrix} X_F \\ Y_F \\ Z_F \end{bmatrix} = \begin{bmatrix} 1.94735469 & -1.41445123 & 0.36476327 \\ 0.69890272 & 0.34832189 & 0.0 \\ 0.0 & 0.0 & 1.93485343 \end{bmatrix} \begin{bmatrix} L_i \\ M_i \\ S_i \end{bmatrix}. \quad (8)$$

Figure 3 shows the simulation results of color matching points of 27 test colors on three displays for 22, 52, and 67 years old with an average observer of CIE2006, 32 years in the CIE2015 (x_F, y_F) chromaticity diagram. Color matching points of display shift toward short dominant wavelength direction with increase of the age. It means that the color of the display stimulus with the same chromaticity as a color chip looks longer dominant wavelength hue compared with the hue of the color chip. This tendency appears most conspicuously in a laser display.

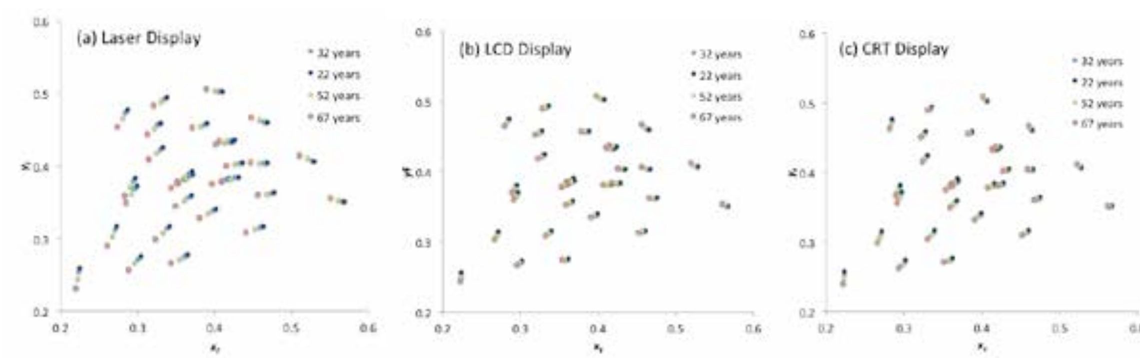


Figure 3. Color matching points for four age group observers. (a) Laser display, (b) LCD, and (c) CRT Display.

RESULTS AND DISCUSSIONS

Figure 4 shows color shifts of from color chips to the color matching points of the three different displays; (a) Laser Display, (b) LCD, and (c) CRT Display for 67 years old observer, HY. These experimental results show that the chromaticity coordinates of all displays are plotted more bluish region than those of color chips, particularly in the blue color region. It means that the color of the display stimulus with the same chromaticity as a color chip looks less bluish compared with the color chip, so more blue stimulus value are needed to make a color match.

Figure 5 shows color shifts of from color chips to the color matching points of the display for three different aged observers. The results from the youngest observer AT aged 22 years (a) shows small or opposite color shift in the blue region compared with those of older observers, SK 36 years (b) and SS 52 years (c). There is a tendency that matching points shift towards high chroma directions, particularly, for an observer (b).

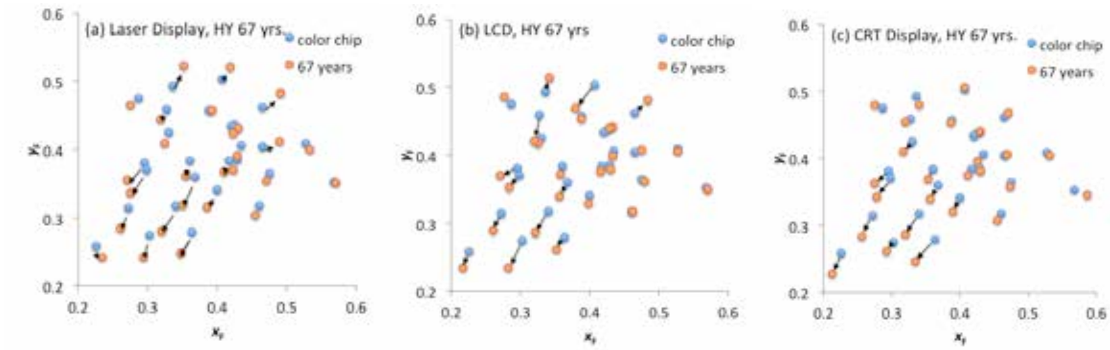


Figure 4. Shifts of color matching points from color chips to the stimuli on the display for 67 years old observer, HY. (a) Laser display, (b) LCD, and (c) CRT Display.

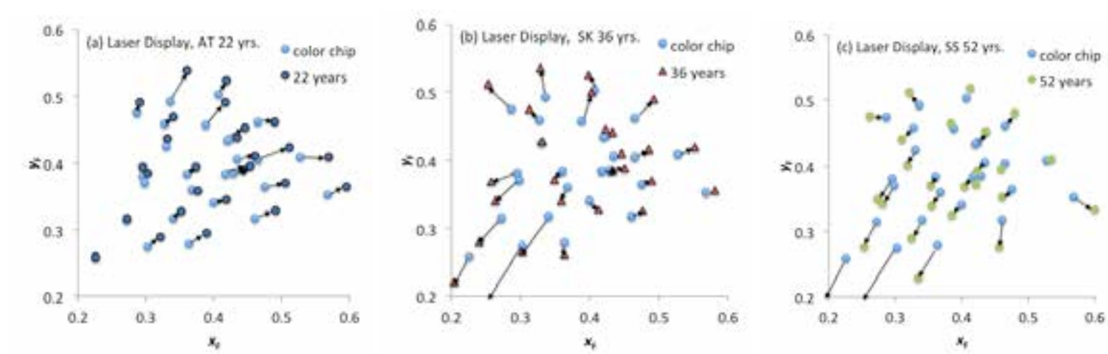


Figure 5. Shifts of color matching points from color chips to the stimuli on the Laser Display for three observers AT, SK and SS, aged (a) 22 years, (b) 36 years, and (c) 52 years old, respectively.

CONCLUSION

We conducted the color matching between color chips and the stimuli on the display for various age group observers. Although individual differences among observers exist, the most part of experimental results are well predicted by the model of color match applied with the CIE 2006 age dependent cone fundamentals [1].

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ACKNOWLEDGEMENT

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ORAL SESSION

INDIVIDUAL DIFFERENCES OF IPRGC'S CONTRIBUTION IN BRIGHTNESS PERCEPTION

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Keywords: brightness, perception, cone, ipRGC, melanopsin

ABSTRACT

It is well known that there is an individual difference in brightness perception. This is mainly due to individual variation in the spectral luminous efficiency, and its mechanism is explained by the range of the pathway of the signal received at cones and that projected to the visual cortex. Recently, a new photoreceptor, the intrinsically photosensitive retinal ganglion cell (ipRGC), was discovered and it was revealed that the signal received at ipRGCs is projected to the suprachiasmatic nucleus which is related to the circadian rhythm photo-entrainment. Furthermore, the projection to the lateral geniculate nucleus from the ipRGCs was shown in physiology and it was suggested the ipRGCs are involved in brightness perception in psychophysics. However, individual differences including ipRGCs in brightness perception have not been clarified. The purpose of this study is to investigate individual differences involving ipRGCs in brightness perception. We previously formulated the perceived brightness as a function of both stimulus intensity of ipRGCs and cones as explanatory variables. In this study, we analyzed individual differences using a contribution ratio of ipRGCs and cones in brightness perception using our previous results. As a result, it was found that the contribution ratio is almost bipolar in individual difference. Since it could be considered that this factor is in the pathway from ipRGCs to the lateral geniculate nucleus, it suggests that it is necessary to consider ipRGCs in the individual differences in brightness perception and color perception.

INTRODUCTION

Intrinsically photosensitive retinal ganglion cells (or melanopsin cells) are photoreceptors different from cones and rods. The signal transmission after the photoreception by melanopsin is related to non-image forming pathway such as the circadian rhythm photo-entrainment in suprachiasmatic nucleus and the pupillary light reflex in the olivary pretectal nucleus [1,2]. Moreover, physiological studies have revealed projections from ipRGCs to the lateral geniculate nucleus [3]. It is suggested that they participate in image forming pathway such as in the chromatic and brightness channels [4-8]. However, the mechanism of the projection pathway has not been fully clarified.

It is known that there is an individual variation in the V(λ) involved in cones. It means that there is an individual difference in brightness perception. On the other hand, it is suggested that ipRGCs are involved in brightness perception, so it is necessary to clarify the individual difference including contribution of ipRGCs.

The purpose of this study is to investigate individual differences involving ipRGCs in brightness perception quantitatively. We previously showed the formulation of the perceived brightness as a function of for both stimulus intensity of ipRGCs and cones at the retina as explanatory variables. We used the brightness perception measurement and the pupil diameter evaluation under visual stimuli that were designed with spectral power distribution control and luminance modulation [8]. As a result, it was found that brightness perception could be represented by the sum of power functions of an ipRGCs term and a cones term respectively. In this study, we analyzed the contribution ratio of ipRGCs and cones in brightness perception for each experiment participant using those results. Our data showed that the contribution ratio of ipRGCs in brightness perception became higher with increasing visual stimulus intensity. In addition, we found that there are cases where the contribution of cones is dominant and the contribution of ipRGCs is dominant in the contribution ratios among individuals. The characteristics are almost bipolar, suggesting that individual differences in brightness perception is caused by not only cones but also ipRGCs. The factors of individual differences in brightness perception concerning ipRGCs might be due to the absorption by the macula pigment density [9], the density distribution of ipRGCs [10] or the degrees of responsive neurons in lateral geniculate nucleus [11].

METHODS

Brightness perception for visual stimuli and values of pupil diameter were based on the experimental results previously reported [8]. Seven kinds of visual stimuli with the same luminance and same chromaticity but different spectral power distributions were designed using 6- primary color projectors. The chromaticity coordinate was (x, y) = (0.328, 0.367). Figure 1 shows the spectral power distributions of each visual stimulus. Two kinds of visual stimuli have constant cones and rods response, and all visual stimuli have constant cones response when they have the same luminance. We adopted Melanopic/Photopic ratio (MP ratio) as similarity of the SP ratio to characterize the visual stimulus. MP ratio was calculated following formula:

$$4557\int i(\lambda)P(\lambda)d\lambda / 683\int V(\lambda)P(\lambda)d\lambda \qquad (1),$$

where $i(\lambda)$ is the spectral sensitivity of ipRGCs [12] and $P(\lambda)$ is the spectral power distribution of each visual stimulus. MP ratios of each visual stimulus were 9.3, 8.2, 7.0, 5.7, 5.6, 5.2 and 2.6.

Visual stimuli with luminance modulation from 22 cd/m^2 to 112cd/m^2 were prepared for 7 kinds of spectral power distribution. These visual stimuli were presented at 7 ° nasal peripheral vision of participants with normal color vision (7 participants 25.1years ± 4.5) at a size of 5 °, and perceived brightness was quantified using a magnitude estimation method. Further, pupil diameter was measured under each visual stimulus. We formulated the brightness perception as a function of retinal illuminance and visual stimulus intensity to ipRGCs at retina using the power function for each individual participant according to the method previously reported [8]. Contribution ratio of ipRGCs and cones in brightness perception was calculated using the formula.

RESULTS

The perceived brightness and the pupil diameter as a function of luminance for each visual stimulus were measured [8]. From these results, we formulated the perceived brightness for each individual and calculated the contribution ratio of ipRGCs and cones to perceived brightness with the same method previously reported. The contribution ratio of ipRGCs increased as the visual stimulus intensity increases in all the participants. Furthermore, as the MP ratio increased, the ipRGCs contribution ratio increased. However, the magnitude and the profile were different among participants.

To investigate the individual differences of ipRGCs contribution, the proportion for contribution ratio of ipRGCs of mean value was calculated. Figure 1 shows a box-and-whisker plot of the calculated value of 7 participants. In P2, P4, P6 and P7, the proportion was 0.6 to 1.0, whereas in P1, P3 and P5, the proportion was 1.3 to 2.7. There were cases where the contribution of cones is dominant and cases where the contribution of ipRGCs is dominant in the contribution ratios among individuals. The characteristics were almost bipolar.

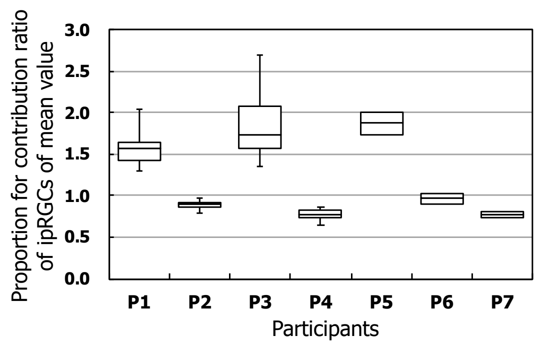

Figure 1. Proportion for contribution ratio of ipRGCs of mean value. 1.0 on the vertical axis indicates the mean value.

DISCUSSION

The purpose of this study is to investigate the individual difference of contribution ratios of ipRGCs and cones in brightness perception considering involvement of ipRGCs. Individual differences in brightness perception in the pathway from cones to visual cortex are explained by the individual variation in the spectral luminous efficiency. Spectral transmittance of crystalline lens, spectral transmittance of macular pigment and density distribution of L-, M- and S-cone are considered as factors of individual differences in spectral luminous efficiency. These differences occur in the pathway from cornea to cones of retina. Individual differences have been shown to be continuous in their distribution. The relationship between ipRGCs response and individual differences in brightness perception has not yet been investigated.

We have clarified the individual contribution ratio and its difference of perceived brightness from the empirical formula that is a function of visual stimulus intensity of ipRGCs and cones. We found that there are cases where the contribution of cones is dominant and other cases where the contribution of ipRGCs is dominant in the contribution ratios among individuals. The characteristics are almost bipolar. The mechanism of involvement in brightness perception of ipRGCs is considered to be dependent of the signal received at ipRGCs and that is projected to the lateral geniculate nucleus and encoded in the visual cortex. We considered that individual differences occur in the pathway from ipRGCs to the lateral geniculate nucleus. Therefore, the following three points are considered as factors of the results. The first factor is macular pigment concentration. The absorption spectrum of the macular pigment and the spectrum sensitivity of ipRGCs are similar in their maximum wavelengths and shapes. That is, it is expected that the influence of the individual difference of the macular density strongly reflects the absorption of light by ipRGCs. The second factor is the number of ipRGCs. It is said that the number of ipRGCs is about 1-2% of the retinal ganglion cells [13]. Furthermore, it is reported that the density of ipRGCs is the highest around 2 mm from fovea in the distribution [10]. Their individual differences of quantity and distribution has not been clarified yet, so it could be considered as a factor of individual differences in brightness perception. The third factor is the number of neurons of the lateral geniculate nucleus that response under visual stimulus to ipRGCs. Davis et al. examined the responses of neurons in the lateral geniculate nucleus using knockout mice by visual stimulus to melanopsin cells under adaptation conditions [11]. As a result, it was shown that 25 to 30% of neurons responded. Even in humans, there might be individual differences in response ratio of lateral geniculate nucleus due to signals from ipRGCs. These possibilities are conceivable, but further examination is necessary for elucidation.

A question is that individual difference of brightness perception involving ipRGCs has not been detected until now. In experiments to determine the spectral luminous efficiency, direct brightness matching method or minimum flicker method were used. ipRGCs have different characteristics from cones in the distribution at retina [10] and time constant for stimulus [14]. It is conceivable that response of ipRGCs cannot be detected due to presentation conditions such as time frequency of visual stimulus, position of field of view and visual field size.

The limitation of this study is that the individual difference of the perceived brightness is the result of presenting the visual stimulus to the peripheral vision and cannot be directly compared with the individual difference involving cones. And the data used in this analysis are results of seven participants' experiment, and an increase in the sample number would be necessary for detailed discussion.

CONCLUSION

We found that there are individual differences in brightness perception involving ipRGCs, using visual stimulus that modulated MP ratio by controlling the spectral power distribution. Individual difference of ipRGCs contribution was almost bipolar, and we speculated that the causes are in the pathway from the photoreception of ipRGCs to the projection to the lateral geniculate nucleus. It is suggested that it becomes a factor of individual differences in brightness perception other than from the spectral luminous efficiency. In recent years, it has been suggested that ipRGCs are also involved in color vision [7]. Considering ipRGCs would be more important in understanding visual perception.

ACKNOWLEDGEMENTS

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Comparison of the simultaneous color contrast stimulated by colored paper and colored illumination

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Keywords: Simultaneous color contrast, colored paper, colored illumination, RVSI, Elementary color naming method.

ABSTRACT

The experiment was done by using two-room technique to create two demonstrations of simultaneous color contrast. In both cases the quanta catch was made equal at the central retina of 13° x 10°. A small gray patch was placed in the center of the colored paper, while the other case, the same area was stimulated by LED illumination to have the same chromaticity as colored paper. A subject judged the gray patch by using elementary color naming. The results showed chromatic adaptation much in illumination condition but not on colored paper.

INTRODUCTION

Simultaneous color contrast is a famous color phenomenon where one color is affected by another color that surrounds itself. The apparent color of the first one at the center normally shifts to the complementary color of the original surrounding color. The effect is not large when the pattern is made by colored papers, which we call here the object mode. Phuangsuwan and Ikeda found that the effect is very large when the surround is made by colored illumination by using two-rooms technique where the experimental booth is composed of two rooms, a subject room and a test room [1)]. There was a small opening window on the wall which separated these rooms. A subject observed a white board placed in the test room through the window. The front wall may be white and the color on the surface can be made by a ceiling light same as for the surrounding field of the object mode. The arrangement is called the illumination mode as the simultaneous color contrast pattern is made by the illumination. Yet, the apparent color of the window in the illumination mode is very vivid unlike the object mode. They interpreted the vividness by the concept of the recognized visual space of illumination RVSI which asserts that the chromatic adaptation is achieved to the illumination and not to the quantal catch at the retina [2)].

The present research was conducted to confirm the assertion by comparing the effect of the simultaneous color contrast between the object mode and illumination mode.

METHODOLOGY

Apparatus

We used a same experimental booth to conduct the two experiments, object mode experiment and the illumination mode experiment. The booth was composed of two rooms, a test room and a subject room.

The subject room was 210 cm long, 110 cm wide, and 200 cm high, and was decorated with various objects to simulate a normal room. The LED light was composed of red, green and blue lights and the lighting color was controlled by a computer. There was a large window between the two rooms of which size was 40 cm wide and 30 cm high giving 13° × 10° of the visual angle. In the illumination mode experiment a white board with a small hole of 3.7 x 3.7 cm^2 (1.3° x 1.3°) at the center to serve a test patch was placed at and to fill the large window to serve the pattern of the simultaneous color contrast when the subject room was illuminated by a colored light. We employed four lighting colors, red, yellow, green, and blue as shown by filled triangles in Figure 1.

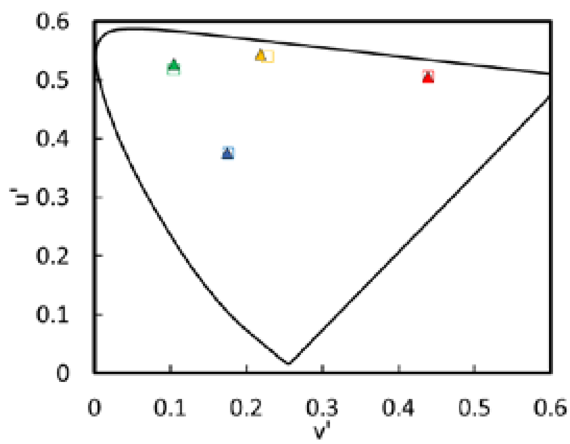

Fig. 1. Chromaticity of illuminations and colored object. ▲; colored illuminations, and □; colored objects.

For the object mode experiment the above-mentioned white board was replaced by colored board of the same specification as above. The four boards were prepared with red, yellow, green, and blue color. When they were illuminated by a white light of LED their colors were same as for the illumination mode as shown by open squares in Fig. 1, which agreed with the colors of the illumination mode.

The test room length was 58 cm. There was a white board placed against the back wall of the test room and the room was illuminated by two fluorescent lamps of the daylight type which connected to a controller to set an intensity of the lights. With our setting, the test patch or white board in the test room appeared to be placed on the wall on the subject room. A subject couldn't notice that the test room existed.

Procedure

In both object and illumination mode experiments a subject judged the color of the small window at the center of a large surrounding field binocularly by the elementary color naming method. Before a judgement, subject was told to look around the room during the 1-minute adaptation without staring at the patch. Subjects wore a cap to prevent to directly look at the LED illumination color. There were 5 repetitions in each condition in both colored papers and illuminations (red, green, yellow, and blue).

To measure the color appearance of the illuminations a subject looked a gray patch of N6 pasted on the side wall of the subject room through a small window on the separating wall of the two rooms from the test room.

Ten subjects, CP, MI, CT, SP, PS, NP, PC, PT, KT, ST, YT, and PW, participated in the experiment. The subjects SP, PS, PT, ST, YT, and PW were naïve subjects to participate to this kind of psychophysical experiment.

RESULTS AND DISCISSION

The amount of elements, chromaticness, whiteness, and blackness, is shown in Fig. 2 by a bar graph for the subject CP. Two bars, the first for the object mode and the next for the illumination mode, are shown for each color of the surrounding, red, yellow, green, and blue from the left to the right. Each bar shows the amount of chromaticness by colored shadow, that of whiteness by white, and blackness by black. Short vertical bars indicate the standard deviation after 5 repetitions.

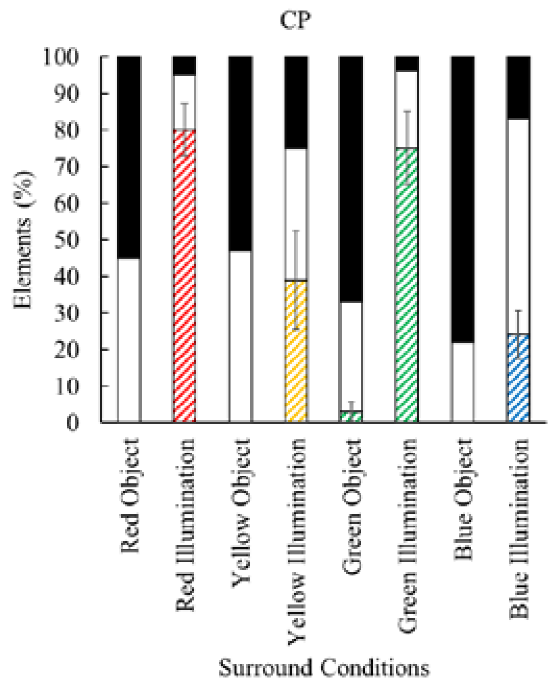

Fig. 2. Amounts of elements, the chromaticness, whiteness, and blackness. Subject CP.

In the object mode, namely the subject looked at the simultaneous color contrast pattern of object, she did not see any color for the test patch. She could see a slight floor for the green background. In the illumination mode on the other hand she saw vivid color at the test patch for all colors of surrounding implying a large effect of the simultaneous color contrast. It is quite clear that the simultaneous contrast effect is large with illumination mode compared to the object mode.

Figure 3 shows the average of ten subjects. Some subjects saw color with the object mode but only small. On the contrary to the object mode, the- amount of chromaticness is very large in the illumination mode.

To see the apparent hue of the test patch data were plotted on a polar diagram used in the opponent colors theory as in Fig. 4. The left figure is from the object mode of red surrounding. Open triangles show the individual data points of the appearance of illumination in the subject room of 10 subjects and the filled triangle their average.

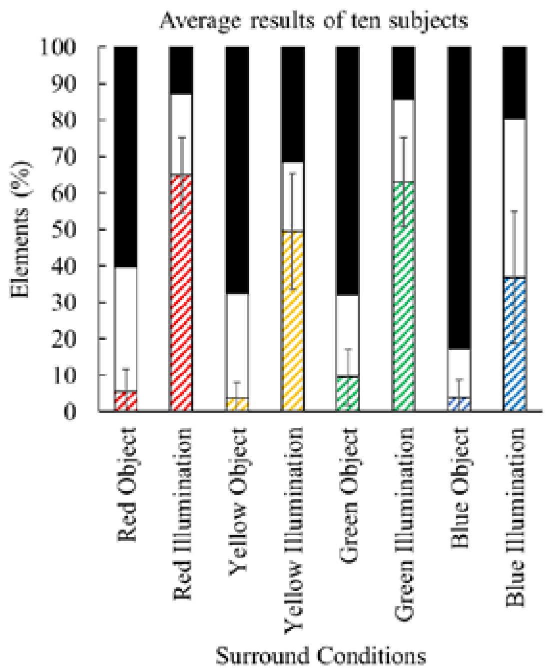

Fig. 3. Average amounts of the elements; chromaticness, whiteness, and blackness of ten subjects.

The color of the test patch is shown by open circles and their average by and filled circle. The apparent hue can be expressed by the angle of the data points measured from the red axis in the-

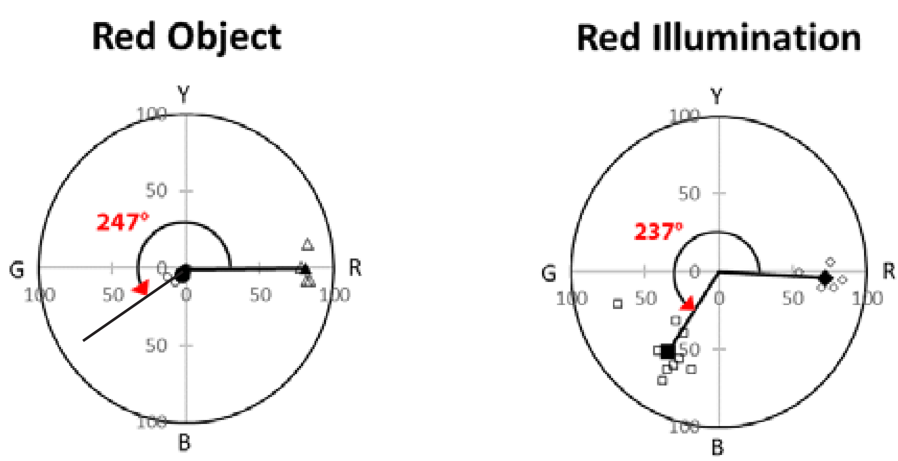

Fig. 4. The hue shift of red object and illumination. Open triangles and diamonds represent the individual color appearance of the colored surround of each subject for object and illumination condition respectively. Open circles and squares represent the individual color appearance of the patch of each subject for object and illumination condition respectively. The solid symbol shows the average value of each condition. The arrows show the hue shift of each condition.

counter clockwise direction as shown by an arrow. The angle difference Δθ between the apparent hue of the subject room and the test patch was measured and shown in Table 1. There is not much difference in Δθ between the object and illumination modes implying same apparent hues of both modes. The different in Δθ can be plotted as a comparison graph between colored surround degree and apparent degree of the test patch as shown in Figure 5. The degree comparison shows that it seems the color simultaneous color constancy in both conditions has the same mechanism as both open and closed symbols in each colored surround came close to each other.

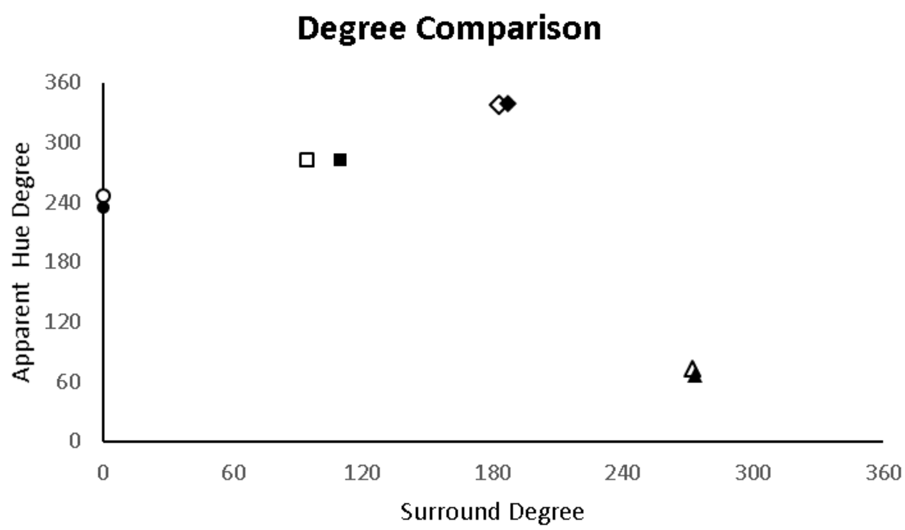

Fig. 5. Degree comparison between colored surround and apparent test patch in term of color degree in polar diagram. The open symbols represent colored paper condition and the close symbols represent colored illumination. The circles, squares, diamonds, and triangles represent red, yellow, green, blue respectively.

Moreover, there was a relationship between blackness and chromaticness as shown in Fig. 6. The more chromaticness, the less blackness of the apparent test patch.

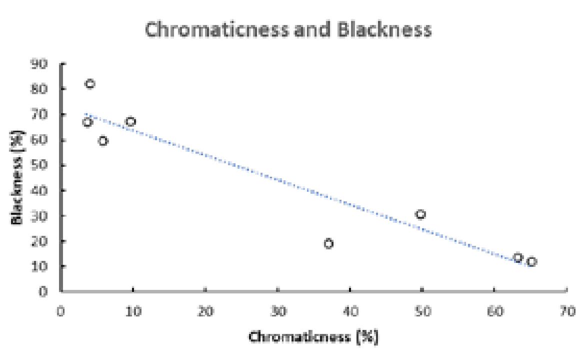

Fig. 6. Relationship between chromaticness and blackness of the test patches of all subjects.

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We found that there was difference in the effect of simultaneous color contrast between the object mode and the illumination mode. It was much larger in the latter mode having large amount of chromaticness in spite of the same retinal situation at least in the area of 13°×10° of the visual angle covering the fovea. The simultaneous color contrast is considered an effect of chromatic adaptation. The brain understands the illumination filling a space and adapts to the illumination to construct the RVSI for the illumination. With the reddish adapted RVSI the achromatic test patch appears cyan. The present result and Prasit's experiments support the notion of the brain chromatic adaptation rather than the retinal chromatic adaptation [3,4]. Although the amount was very small it is true that some subjects perceived the chromaticness with the object mode. This indicates the brain chromatic adaptation takes place for a colored object, though it is weak. Ikeda et al. hypothesized that a RVSI can be constructed on the colored object [5].

Table 1 Apparent hue angle difference

	Object Δθ (deg)	Illumination Δθ (deg)
Red	247	237
Yellow	188	173
Green	155	152
Blue	161	153

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Difference in color area of elderly and young people in the difference of color temperature of lighting

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Keywords: elderly vision, color category, color temperature

ABSTRACT

In this research, we clarify how elderly people differ from young people in tendency of confusing colors by the difference in color temperature of lighting. The experiment was conducted in Thailand and all the participants were Thai, 31 young people aged from 25 to 35, 15 elderlies aged from 60 to 70 years old. Subjects judged the color appearance of 1,046 color patches and sorted out them into one of twelve colors, red, reddish yellow, yellow, greenish yellow, green, greenish blue, blue, bluish purple, purple, reddish purple, pink, and brown, Color patches that were not classified to any of the 12 colors were classified as "Others". The experiment was conducted under two lights by using LED ceiling lighting, the daylight color (about 6,500 K) and incandescent lamp color (about 2,700 K). The Illuminance was set at 700 lx. In this research, focusing on colors classified as "others", we analyze and clarify "the tendency of color in which elderly people become confused". It is noteworthy that there was little difference among young people due to the difference in color temperature of the lighting, but the elderly persons remarkably differed.

INTRODUCTION

Color is comforting our lives in various scenes. However, with age, visual function has declined, inconvenience occurs unconsciously. Since aging is a global problem, many researches on visual impairment of the elderly have been done[1,2)], and the difference between young people and the elderly in the perception range of the main color is also clarified [3, 4)]. In this research, we will grasp the tendency of colors that the elderly people become confused by comparing with young people how color appearance differs depending on the color temperature difference. Based on the results of this research, we aim to present guidelines for the elderly-friendly visual infrastructure and to propose a mechanism for young people to be aware of colors that are likely to be confusing for the elderly in advance.

METHODOLOGY

As shown on the left side of Fig. 1, the laboratory was made with a size of 1.8 m wide × 1.8 m wide and 2.3 m high, with several colorful patterns attached to the white wall I will. Ceiling lighting was installed in the center of the laboratory. The subject sat in front of the table under the light. The lighting equipment is LED lighting (HH-LC714A) made by Panasonic, and the experiment is performed at daylight color of 6000 K at 700 lx and incandescent light color of 2,700 K at 700 lx. The color patches used for the experiment are 1,046 colors provided by Toyo Ink. Each size was 2.4cm × 2.4cm. They were placed on the table randomly. Subjects looked at patches and classified them into 12 colors. 12 colors were "Red", "Reddish Yellow", "Yellow", "Greenish

Yellow", "Green", "Greenish Blue", "Blue", "Bluish Purple", "Purple", "Reddish Purple", "Pink" and "Brown." Regarding the selection of colors in these categories, we referred to several previous studies[5), 6)]. The 12 colors of the experiment were based on the judgment of the subject himself and did not show a specific color. However, we presented a color chart if the subject said that there were no clear criteria. The color chart was based on previous studies [3, 4)]. "Red (5 R 5/12)", " Reddish Yellow (5 YR 5/10)", "Yellow (5 Y 8/12)", " Greenish Yellow (5 GY 5), "Green(5 G 5/8)", "Greenish Blue (5 BG 5/8)", "Blue (5 B 5/8)", " Bluish Purple (5 PB 5/10)", "Purple (5 P 5/10)", " Reddish Purple(5RP5/10) ", "Pink (7.5 RP 5/14) " and " Brown (5 YR 5/6)." As shown on the right side of Fig.1, subjects classified color patches into 12 cases. Color chips that did not belong to any of the 12 categories were placed in the "other" box. Therefore, all color patches were divided into 13 categories.

31young people who aged 25 to 35 and 15 elderlies who aged 60 to 70 joined in this experiment. They all had normal color vision. All subjects carried out experiments once under the light of daylight color and incandescent light color.

Figure 1. Experimental scene

RESULTS

First of all, we entered data for each person, where 1046 color patches each categorized in 13 categories. Next, we assigned four ranks to each color patch selected for each category, depending on the percentage of selected people. If 80% or more select that category, it is rank A. It is rank B if less than 80% and more than 50% of subjects have selected. If it is less than 50% and more than 20% of subjects have selected it is rank C. If it is less than 20% and even one person is selected it is rank D. For each difference in illumination color temperature, we analyzed each of the elderly and young people.

Fig. 2 shows the results. The horizontal axis of the graph is showed the condition of evaluation. From the left, the daylight color of the elderly, the incandescent light color of the elderly, the daylight color of the young person, and the incandescent light color of the young person. The vertical axis is the number of selected color patches, divided into four ranks, and the numbers are shown accumulated. The vertical axis is the number of selected color patches, divided into four ranks and the numbers are shown accumulated. The black fill is rank A, the diagonal lines is B rank, the dot is C rank, and the white fill is D rank. In most of the graphs, no significant difference is seen in young people and old people, but the condition of incandescent light colors of elderly of “Others” has more remarkable features than the others. The number of color patches is very small in compare with daylight of elderlies and also is very small in compare with incandescent light of young. This means that the elderly people are confused under the illumination of incandescent lamps. That is to say, even for a color that can be judged obviously as ambiguous color to young people, the elderly feel some kinds of color. Such tendency is not noticeable in daylight illumination, so we can say that especially on the condition of the lower color temperature of lighting, elderly people is more easer to confuse the ambiguous color.

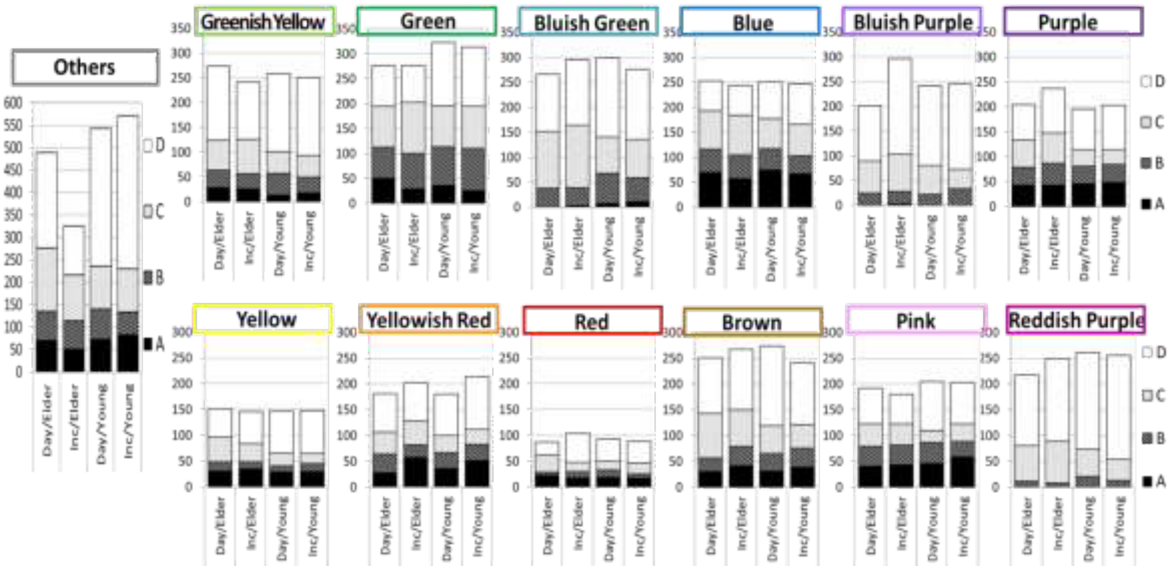

Figure 2. Number of selected color patches in each 13 color category

Furthermore, in order to know the characteristics of the classified color, it was analyzed in the CIE (L *, a *, b *) color space (CIELAB). We analyzed every rank of "other", and find the most notable feature in D rank. FIG. 3 shows the result of analyzing the color patch of rank D of "other". Red ex indicates color patch selected by light of incandescent light and blue filled circle indicates color patch selected by daylight. The upper row shows the elderly people and the lower row shows the young people.

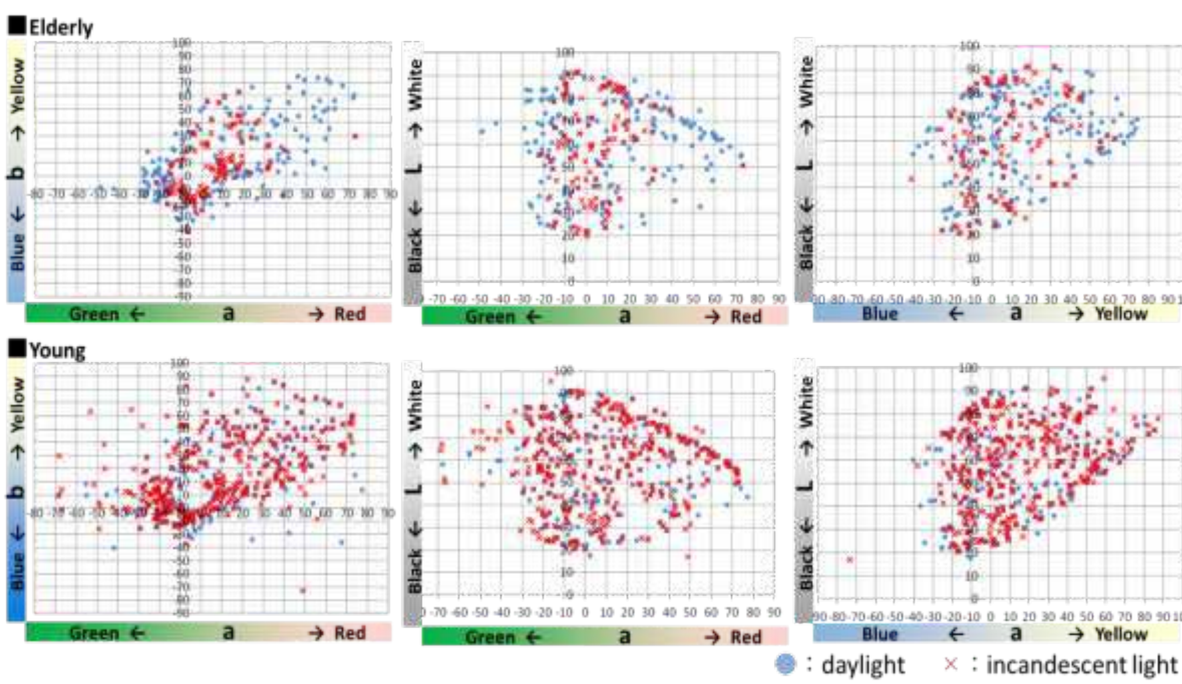

Figure 3. CIE (L *, a *, b *) color space on the rank D of "other"

Looking at Fig. 3, as compared with other conditions, it can be seen that the color tendency of the color patch which the elderly person does not select under the illumination of the incandescent light is many colors by red yellow. Those colors can be judged to be "not belonging to any color category" by young people and elderly people who are under daylight illumination. But only elderly people who are under incandescent light illumination, they feel some different color. Probably, due to their deterioration of visual function, correction cannot be made smoothly when entering a different color space, and they feel confused about the color.

CONCLUSION

It turned out that older people tend to confuse more colors under incandescent light than daylight. However, the most interesting thing in this research is a method that focuses on the color selected by less than 20% of people in the category of "other". By defining "astray color " and analyzing its color, we could clarify the inconvenience trend of elderly people. Many studies so far analyze and compare elderly people and young people based on the colors seen, but from this research, I could grasp the same direction as that from a slightly different point of view, and it is rich in implications.

However, this experimental method needs for improvement. The color patch of 1046 includes quite similar colors, and there is bias also in the color space. It was effective to increase the accuracy on the research by having a large number of colors, but it is counterproductive if the burden on the examinees is significant. After selecting color patches more effective, I would like to deepen their research with this method on how color change occurs due to the difference in color temperature of illumination for the elderly. In the future, I would like to build a database that can be compared internationally.

ACKNOWLEDGEMENT

We appreciate having Toyo Ink for much cooperation such as disclosing information on database of color chip. We also thank the students, staff of STOU University who participated in the experiment.

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INFLUENCE OF DIFFERENCE IN S-CONE STIMULUS VALUE BETWEEN TARGRT AND DISTRACTORS ON VISUAL SEARCH TASK

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Keywords: visual search, color deficiency, S-cone stimulus, multicolored environment

ABSTRACT

Katsura et al. experimented with a visual search performance cued by S-cone stimulus value available for both trichromats and dichromats, and showed an advantage of dichromacy in the conditions that the S-cone stimulus value of a target was between those of two distractors. In the present study, we investigated the visual search performance according to the difference in the S-cone stimulus value between the target and the distractors. The stimuli consisted of thirteen disks. One disk was a target and the others were distractors. Two colors were used for the distractors and each color was assigned to six disks. A target color was between two distractor colors in S-cone stimulus value. There were four conditions of the target-distractors color difference. The observer's task was to respond the position of the target. Three protanopes, three deuteranopes and three trichromats were participated in this experiment. We could basically obtain the same results as Katsura et al., that is, the detection time of dichromats was shorter than trichromats for the reddish or greenish stimuli, even when the color difference was smaller. We found color environment in which dichromats exhibited an advantageous performance.

INTRODUCTION

Human color vision is generally trichromatic and relies on L, M and S cones. Some people are dichromact and lack one type of cone. Such a color vision type is called color deficiency. People with color deficiency might be assumed to be disadvantageous because they confuse some combinations of colors. However, some researches have indicated an advantage of dichromacy. Morgan et al. reported that dichromats performed better than trichromats on a task that required observers to detect different oriented targets in red-green colored objects [1]. In the experiment, the red-green camouflaged pattern affected trichromats as a type of visual noise that impaired searching, but did not affect dichromats because they could not discriminate between the red and green colors. Therefore, the experimental condition was particularly favorable to dichromats. Katsura et al. used a visual search paradigm cued by S-cone stimulus value in which both trichromats and dichromats could sufficiently perceive a target, although dichromats had an advantage [2]. In the present study, we investigated the visual search performance according to the difference in the S-cone stimulus value between the target and the distractors.

METHODS

Observers

Three trichromat, three protanope, and three deuteranope observers were participated in the experiment.

Apparatus

Stimuli were presented on a CRT color display (SONY HMD-H200). The resolution of the display was 1024 × 768 pixels with a refresh rate of 75 Hz. The display was placed at a distance of 53 cm from the observer.

Stimuli

The stimuli consisted of thirteen colored disks presented on a gray background (D65 chromaticity, 15 cd/m^2) as shown as Figure 1 (a). The disks, which were 1 degree in diameter, were arranged at equal intervals on the circumference of a circle with a diameter of 8 degrees. One disk functioned as a target, and the other twelve were distractors. The target color and the distractor colors were only different in terms of S-cone stimulus value. In addition, the S-cone value of the target color was positioned between those of the distractors. The luminance of the disks was 10.2 cd/m^2, and the chromaticity was defined on an equal luminance plane in LMS color space, as proposed by Stockman and Sharp [3]. The luminance (Y) and chromaticity coordinates (l, s) of the disks were described by the following equations:

$$\mathrm{Y = 0.692L + 0.349M} \quad (1)$$

$$l = \frac{0.692L}{Y} \quad (2)$$

$$s = \frac{S}{Y} \quad (3)$$

The D65 chromaticity of the background was equal to (l, s) = (0.69, 0.5). The chromaticity of the target (l_{tar}, s_{tar}) was (0.67, 0.5), (0.69, 0.5), (0.71, 0.5), (0.67, 0.6929), and (0.71, 0.2846). The chromaticities (0.67, 0.6929) and (0.71, 0.2846) were located on loci of dominant wavelengths of 475nm and 575nm, respectively. The s-coordinate differences between the target and the distractors (Δs) were ±0.067, ±0.1, ±0.15, ±0.225, and ±0.3375. However, the condition of Δs = ±0.3375 for the target (0.71, 0.2846) was excluded because it was out of the color gamut of the display.

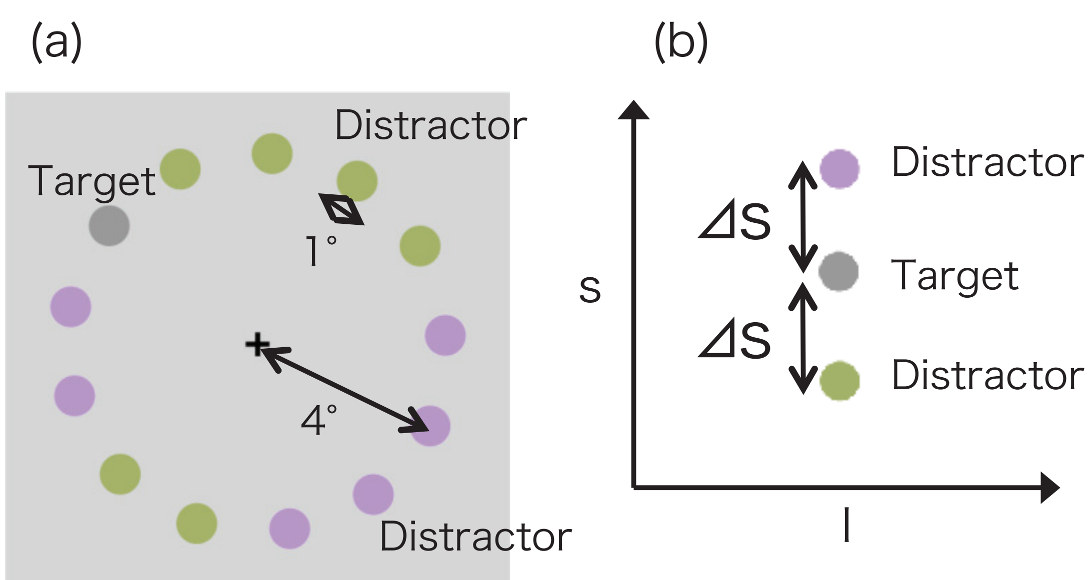

Figure 1: (a) Visual search stimuli used in the study. (b) Relationship between chromaticities of the target and the distractors.

Procedure

Each experimental session commenced after a 2-min dark adaptation period. The stimulus, shown in Figure 1, was presented. A random-dots pattern was displayed for 400 msec following the stimulus to mask color afterimage. The display was occupied by a blank screen (background with a fixation point in the center of the display) after the masking. The observer's task was to indicate the quadrant in which the target disk was located. The response triggered the next stimulus.

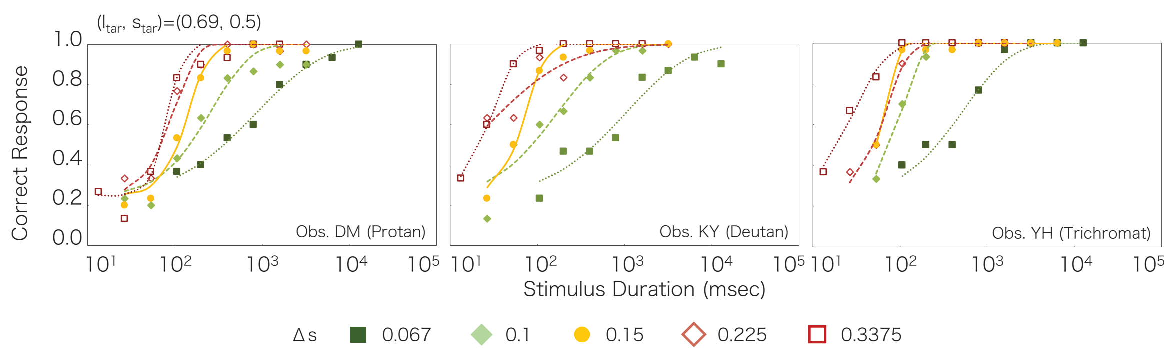

Figure 2: The correct response rate according to the stimulus duration for each color vision type.

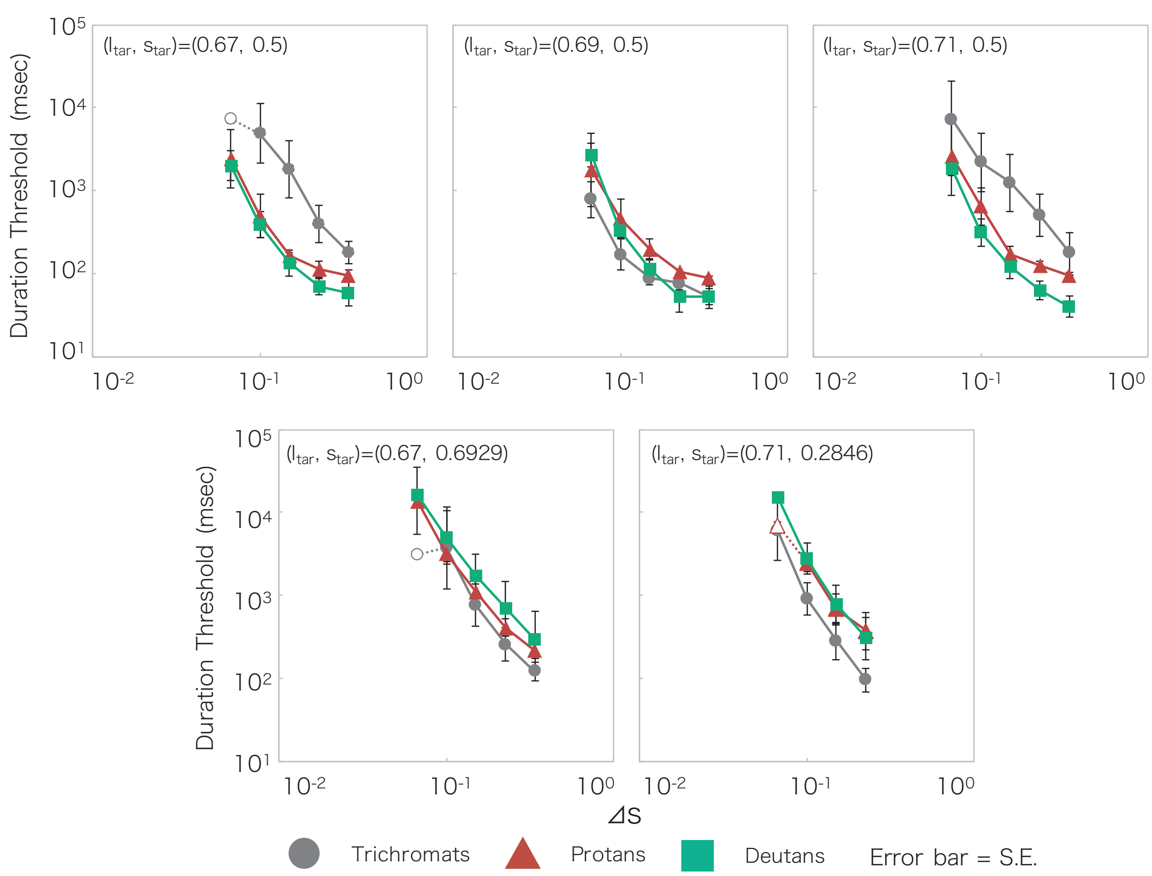

Figure 3: Comparisons of the duration thresholds between color vision type according to Δs

RESULTS AND DISCISSION

Figure 2 shows the relationships between the stimulus duration and correct response rates for each color vision type when (l_{tar}, s_{tar}) was (0.69, 0.5). The different symbols indicate the results of different Δs values. The different lines indicate Weibull Fitted curves for the data points. We found that the correct response rate increased as the stimulus duration increased regardless of Δs for every color vision type. We calculated duration thresholds for cases in which the correct response rate was 72.4% from the results of the fitted Weibull functions.

Figure 3 shows the geometric mean of the duration thresholds for each target chromaticities. The abscissa represents Δs, and the ordinate represents the duration thresholds. The different symbols represent different color vision types. The duration threshold for trichromats was same as that for protanopes and deuteranopes when (l_{tar}, s_{tar}) was (0.69, 0.5), but longer than that for protanopes and deuteranopes when (l_{tar}, s_{tar}) was (0.67, 0.5) and (0.71, 0.5). These tendencies were obtained in all Δs conditions. Therefore, in the conditions of $s_{tar} = 0.5$, the results of Katsura et al., that is, an advantage of dichromat in detecting the target when the stimuli were overall greenish or reddish, were obtained even though the s difference between the target and the distractors was small. When the target chromaticity was (0.67, 0.6929), and (0.71, 0.2846), the duration thresholds for trichromat were slightly shorter than those for protanope and deuteranope.

CONCLUSION

In this study, we investigated the effect of the s value difference between the target color and the distractor colors on the visual search performances reported by katsura et al. When the s_{tar} was 0.5, the advantage of dichromat was obtained regardless of Δs.

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ACKNOWLEDGEMENT

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STRONG EFFECT OF SIMULTANEOUS COLOR CONTRAST PERCEIVED IN THE AFTERIMAGE

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Keywords: Simultaneous color contrast, Afterimage, Elementary color naming, Display

ABSTRACT

In the simultaneous color contrast, the induced color does not appear so vivid in color as. But It appears very vivid when we see the same visual pattern in the afterimage. Similar vivid appearance can be experienced by the two-rooms technique in which the visual pattern is produced by combining a colored illumination in a real space. In this research the color of the test patch was measured in the afterimage by the elementary color naming. The color appearance of the surrounding was also measured in the afterimage. The apparent color was plotted on a polar diagram following the opponent color theory and the apparent hue was expressed by the angle to the color from the red axis. They are denoted by θsurround and θtest for the surrounding and the test patch color, respectively. The angle difference Δθ= θtest - θsurround was plotted against θsurround to see the relationship between the colors of the surrounding and the test patch. The result was compared with that obtained by the two-rooms technique and they were very similar, implying that the color appearance in the afterimage is the result of the illumination adaptation in the brain and not on the retina.

1. INTRODUCTION

We can study the chromatic adaptation by using two rooms technique. It is composed of a subject room and a test room. On the separating wall of the two rooms a small window is opened. If a white board is placed in the test room a subject can see it through the window. If the subject room is illuminated by colored light, for example a red LED lamp, and the test room by a white light, the subject perceives a vivid color in the small window to indicate his/her eyes are adapted to the red illumination.[1)] The retinal situation is similar to the simultaneous color contrast, where a small gray patch is surrounded by color. It is said that if the surrounding color is red, for example, the central gray appears complemental color of the surrounding. If this visual stimulus is produced by papers the color at the center almost remains gray showing weakness of the color induction on the contrast to the result obtained with the two rooms technique. It happened to us that if a subject stared the visual pattern made of papers for about 10 seconds and look at a white board he/she sees the afterimage and to our surprise the central gray patch appears very vivid color. This phenomenon was already noted by Shively in 1973 and he named it a new afterimage. He explained how the effect of the simultaneous color contrast is strong in the afterimage[2)], but the expression of the color appearance was qualitative and quantitative analysis was not given. In the present paper we measure the color appearance by the elementary color naming method and realized the quantitative analysis possible.

2. EXPERIMENT

Simultaneous color contrast patterns were presented on a Samsung model: UA55H6340TK, LED backlight display 55 inches, AC100-240V~50/60Hz 153W, Multi System. The central test patch was of the size 14 x 14 cm2 and luminance 14.6 cd/m2 and white color of x = 0.299 and y = 0.325. The display was placed in a test room and a subject observed it from a subject room through a large window opened at the separating wall between the test and subject rooms, of which size was 24 cm high and 38 cm wide, giving 8° and 13° arc of visual angle, respectively, with the viewing distance 170 cm. The test size became 4°×4°. Thirteen colors were employed as the surrounding field for the central gray patch background by adjusting R, G, B of the monitor. They are shown on the CIEu'v' diagram of Fig. 1 by open circles and tentatively numbered 1 through 13. The white color of the background on which the afterimage is produced was same as the test patch and the luminance was 150 cd/m2 and is shown by an open square in the same figure. Figure 2 shows an example of the patterns.

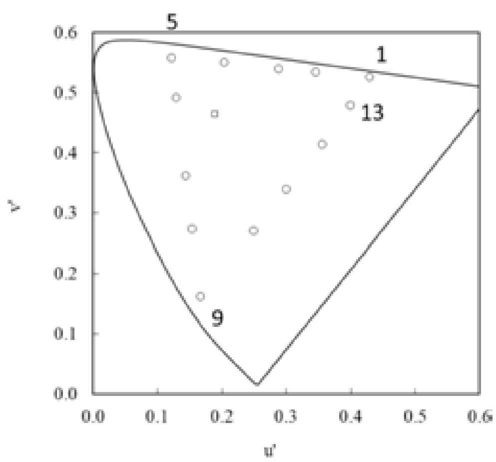

Figure 1. Chromaticities of surroundings (○) and of gray patch and the background on which afterimages are perceived (□).

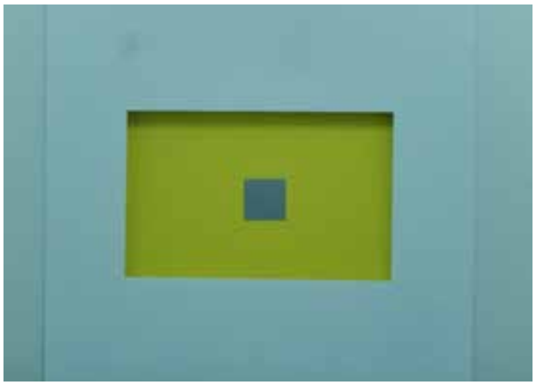

Figure 2. An example of actual patterns.

Three subjects, CP, MI, and YM, who all had normal color vision and were experienced in psychophysical experimentation, participated in the experiment. Both the test and subject rooms are kept dark while the subject was assessing the color of the gray test patch in the afterimage. The subject was asked to fixate his/her eyes to the central test patch for 10 seconds.

3. RESULTS

The results are plotted on polar diagrams used in the opponent colors theory, as shown in Fig. 3. The unique red and green hues are taken along the abscissa and the unique yellow and blue along the ordinate. At the top of the figure a set of raw data is shown as an example. From the values R = 50 % and Y = 50 %, the hue angle θ was calculated to be 45°. The amount of chromaticness is taken along the radius, zero at the origin and 100 % on the circumference. In the present case it was 80 %, which is taken along the 45° line as shown by a small open circle.

Chr	White	Black	R	Y	G	B	θ	R	Y
80	20		50	50			45	56.6	56.6

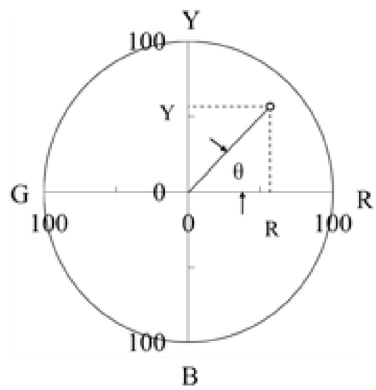

Figure 3. Plot of data point on a polar diagram. θ is the apparent hue angle.

Figure 4 shows results of the color appearance of the surrounding in (a) and its afterimage in (b). They are averages of three subjects. At the surrounding colors 4 and 12 individual data points are shown by small open circles. The hue angle θ of surrounding #1 is 9.9°and that of its surrounding is 252.3°. In other words, the surrounding color was almost unique red, and its afterimage was cyan but almost unique blue (270°) and not opponent colors with each other. The inducing color and the induced color are not opponent colors in the after image. In Fig. 5(a) those two results are plotted on the same polar diagram. If a line connects the data point of #1 of the surrounding and the origin, and another line connects the data point of the corresponding afterimage and the origin, they don't come on one line but make a larger angle (242°) than 180° to show they are not opponent with each other. In (b) The color appearance of the surroundings and that of the afterimage of the central test patch are plotted together. WE calculated the hue angle of each point and plotted the hue angle of the test patch for the hue angle of surrounding in Fig. 6, shown by open circles. A dotted line is their regression line and a solid line is a 45° line. They came very close, implying that the hue of the afterimage of the test patch I almost same as the apparent hue of the surrounding, which was also noted by Shively. He explained the result by the lateral inhibition of the retina. But we don't take that explanation. Figure 5c plots the color appearance of the surrounding afterimage (open triangles) and that of the test patch afterimage (filled triangles). We obtained the hue angle of the former data points and the latter data points, and

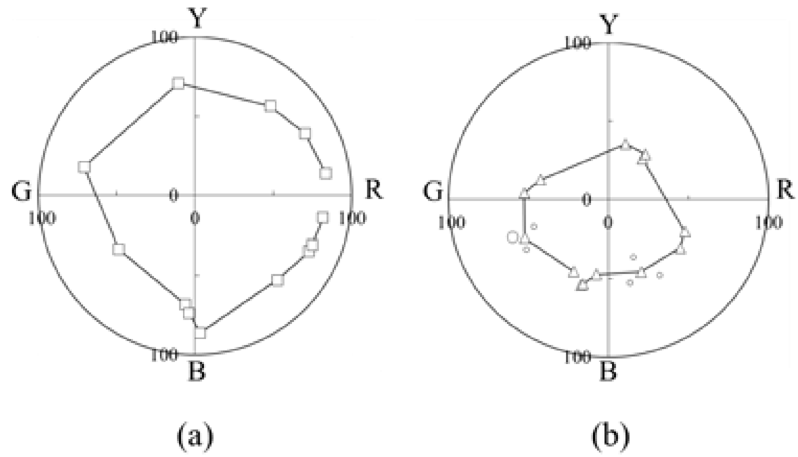

Figure 4. Color appearance of the surroundings (a) and that of their afterimages (b).

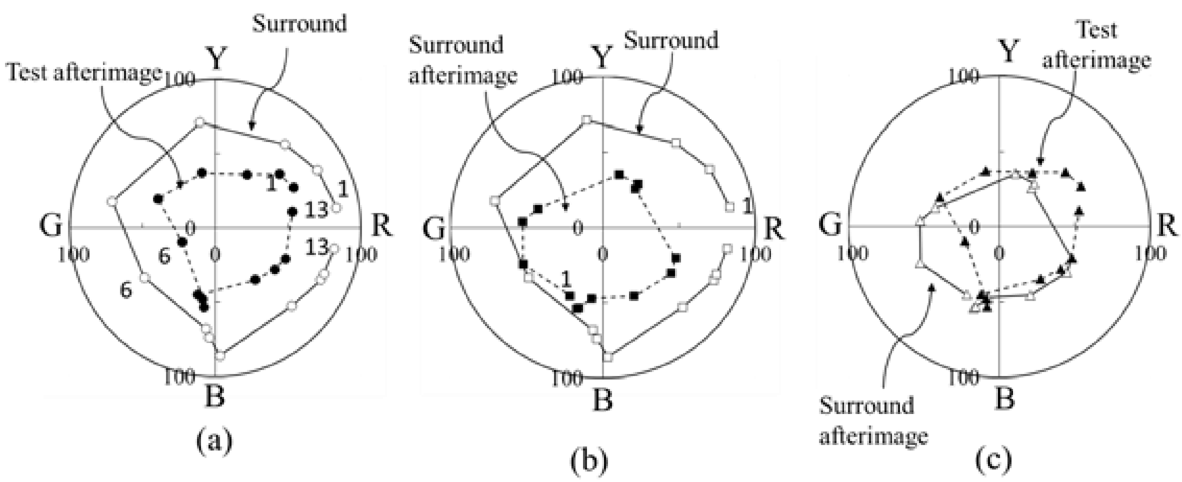

Figure 5. Color appearance of the surroundings and their afterimages (a), Surroundings and test patch afterimages (b), and surrounding afterimages and the test patch afterimages(c).

took the different angle, Δθ= θ(test afterimage) - θ(surrounding afterimage) and plotted for θ(surrounding afterimage). The result is shown in Fig. 6 by filled circles. It goes down in the beginning and sharply goes up after θ(surrounding afterimage) = 240°. The horizontal dotted line is drawn at Δθ=180°which shows the opponent colors relation. The present results indicate far from the property. In the same graph many open symbols are plotted, which were obtained from the two rooms technique. The values along the abscissa are the hue angles of the illuminating light and the values along the ordinate are difference between the hue angle of the central small window and the hue angle of the color of illumination. The filled circles mostly follow the open symbols in the figure to imply that the mechanism of the afterimage in the simultaneous color contrast is similar to that of the two rooms technique.

The afterimage of the surrounding works as the adapting color as the illumination color in the two rooms technique. The color of the test patch in the simultaneous color contrast is induced by the afterimage color of surrounding which works as the adapting color due to the illumination.

Why the afterimage of the surrounding works as the adapting color same as the adapting illumination in the two rooms technique? Any visual pattern including the simultaneous color contrast pattern is composed of borders and colors. In the afterimage the borders are not perceived

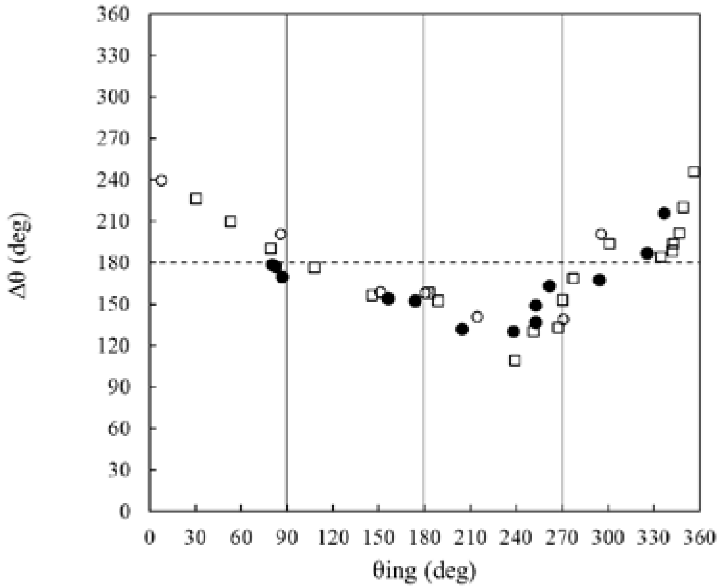

Figure 6. Hue angle difference between the surrounding afterimages and the test patch afterimages plotted for the surrounding afterimages (●). Open symbols were obtained with the two rooms technique[4].

clearly. As the result only, the color remains. Colors without clear borders are perceived as light. And the surrounding afterimage works as light and the visual system recognizes it as the illumination and adapts to it. Then we see a vivid color for the central gray patch.

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ORAL SESSION

OBSERVER METAMERISM IN WIDE COLOR GAMUT DISPLAY FOR ANOMALOUS TRICHROMATS

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Keywords: observer metamerism, anomalous trichromat, color appearance, color matching, wide color gamut

ABSTRACT

We investigated the effect of observer metamerism on colors presented on a wide color gamut display for anomalous trichromats. Because their color matching functions largely deviate from the standard observer's color matching functions and color reproduction of displays is designed based on the standard observer's color matching functions, observer metamerism will be obvious in a wide color gamut display. Therefore, we conducted two experiment to examine observer metamerism of anomalous trichromats observing a reproduced color on a wide color gamut display. Both experiments showed a remarkable observer metamerism was observed in the wide color gamut display for anomalous trichromats.

INTRODUCTION

Observer metamerism refers to the condition which an observer would perceive different spectral stimuli as being the same color whereas other observers would perceive them as being different color. A main cause of observer metamerism is individual difference in the color matching functions. Ramanath reported that observer metamerism is more obvious in a display with three primaries of a narrow spectral band [1]. That is, observer metamerism would become a critical problem in a wide color gamut display with such RGB primaries. Especially, anomalous trichromats would face the problem, because their color matching functions largely deviate from the standard observer's color matching functions and color reproduction of displays is designed based on the standard observer's color matching functions. In this study, we investigated the effect of observer metamerism on presented colors on a wide color gamut display for anomalous trichromats. We conducted two experiment. In Experiment 1, observers compared between color appearances of 27 color chips illuminated with a 5000 K LED lamp and those of 27 color stimuli, which had the same tri-stimulus values as each color chip, presented on the display. In Experiment 2, observers performed a color matching task between the color chips and the color stimuli on the display. We obtained the results that a severe observer metamerism occurred in between the reproduced colors on the display and the color chips for anomalous trichromats.

GENERAL METHODS

Observers

Three color normal trichromats, three protanomalous trichromats, and three deuteranomalous trichromats participated in the experiments of this study. Their color visions were classified by their performances on the Ishihara pseudoisochromatic plates, the Farnsworth-Munsell 100-hue test, the Panel D-15 test, and the Nagel anomaloscope (Anomaloscope OT-II, Neitz).

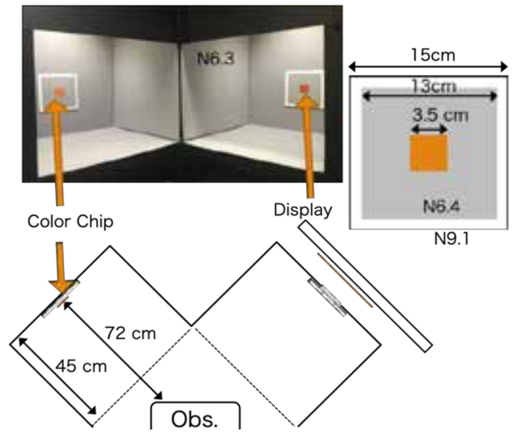

Figure 1. Apparatus

Apparatus

Fig. 1 shows our experimental apparatus consisting of two viewing booths covered by gray papers of N 6.3. A color chip was illuminated with a 5000 K LED lamp (NNN 21607K, National) in one booth. The other booth also was illuminated with another 5000 K LED lamp but have a window of the same size and the same position as the color chip. The observers could view the color presented on the display through the window. The illuminances on the floor surfaces of the booths were 300 lx. We tested three types of displays, which were a laser display (75-LT1, Mitsubishi), an Adobe RGB standard LCD display (ColorEdge CS2420, Eizo), and an sRGB standard CRT display (CPD-15SF9, Sony) in order to examine effects of the spectral bandwidth of the RGB primaries on observer metamerism. The CIE 2015 (x_F, y_F) chromaticity coordinates of the RGB primaries of these displays are shown in Fig.2.

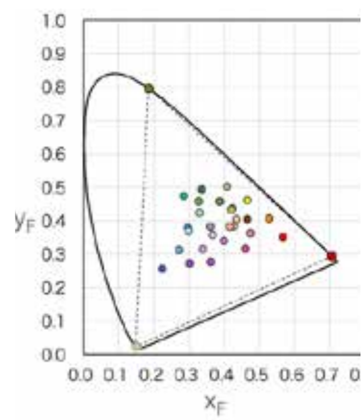

Figure 2. 27 test colors

Test Colors

We used 27 color chips as stimuli. Their CIE (x_F, y_F) chromaticity coordinates were shown in Fig. 3. The size of color chip was 2.7 deg. The background of test color was the medium gray of N 6.4 surrounded by the white of N 9.1 as shown in Fig.1.

EXPERIMENT 1

Stimuli

The color stimuli, which had the same tristimulus values (X_F, Y_F, and Z_F) as the color chips, were presented on each display. The color differences between them were set to be less than 1.0 ($\Delta E_{ab^*} < 1.0$).

Procedure

The observer's task was to respond the color difference in color appearances between the displayed color and the color chip according to the following four criteria.

Criterion #1. They are perceived as almost same colors.

Criterion #2. They are perceived as somewhat different colors.

Criterion #3. An obvious color difference is perceived between them, but they belong to a same color category.

Criterion #4. An obvious color difference is perceived between them, and they belong to different color categories.

In addition, the observers responded color names of the displayed color and the color chip with monolexemic common color names. Each observer performed five trials for each test color.

Results and Discussion

Fig. 4 shows the results of the laser display for each type of color vision. Although trichromat observer AT responded that the color appearances of color chips and those of displayed color on the laser display were almost same, anomalous trichromat observers (MA and TS) responded that there were obvious color differences between them. In addition, obs. MA answered that 12 test colors belonged to different color categories and obs. TS answered that 15 test colors did. Therefore, a remarkable observer metamerism was observed in the wide color gamut display for anomalous trichromats.

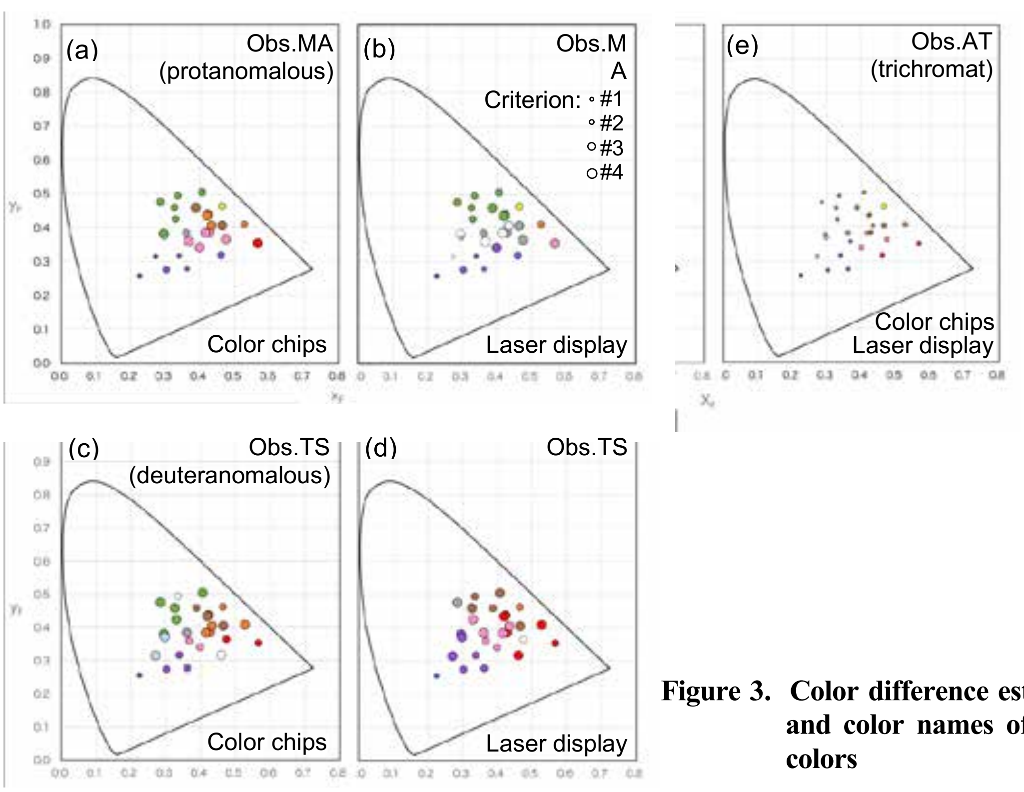

Figure 3. Color difference estimations and color names of the test colors

EXPERIMENT 2

Procedure

The observer's task was to adjust the luminance and the chromaticity of the color stimulus on the display to match the color chips. Each observer performed five matchings for each test color.

Results and Discussion

Fig. 4 shows the results of the laser display for each type of color vision. The chromaticities of all the matched colors shifted toward greens along deuteranopic confusion lines in obs. TS who is

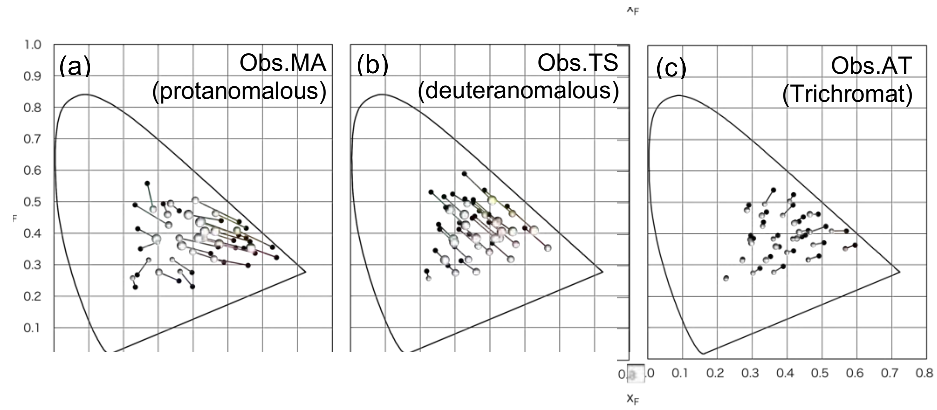

Figure 4. Results of color matching experiments

deuteranomalous. This means that the colors on the laser display become reddish for deuteranomalous trichromats. On the other hand, in obs.MA who is protanomalous, the reddish colors shifted to converge to the center of protanopic confusion lines, but the greenish colors shifted to diverge from it. These results indicate that the reddish colors become greenish and that the greenish colors become reddish. Namely, the red-green saturation of the color on the laser display was decreased. This tendency is consistent with the results of Experiment 1 in which the responses of gray or white were more frequent in achromatic area in the chromaticity diagram. The reason of the difference in the results between protanomalous trichromats and deuteranomalous trichromats is unknown at the present.

We tried to explain these color shifts by a color appearance model of anomalous trichromats proposed by Yaguchi et al [2]. As shown in Fig. 5, the model can account for the color shift of deuteranomalous observer TS. However, it cannot account for all color shifts of protanomalous observers. This suggest that there may be an unknown factor in color appearance for anomalous trichromats.

We calculated the color differences between the matched colors and the color chips in order to examine an effect of the color gamut of display on the magnitude of observer metamerism. The results are shown in Fig. 6. The color differences for the anomalous trichromats were larger than those for the trichromat. Moreover, the color differences in the laser display for the anomalous trichromats were larger than those in other displays. We observed a severe observer metamerism

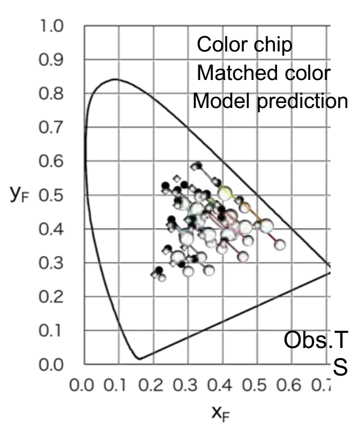

Figure 5. Prediction by Yaguchi et al.'s color appearance model for anomalous trichromats.

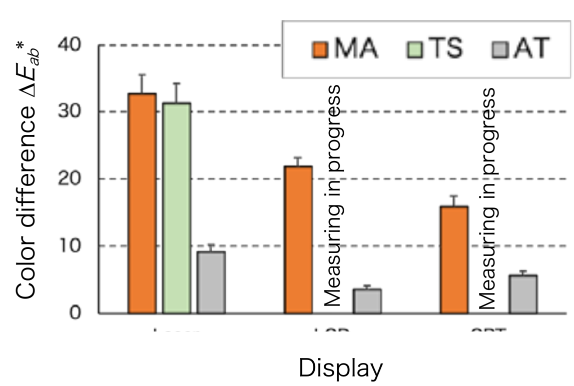

Figure 6. Color differences between the color chips and the matched colors on each display. We eliminated relatively high-saturated test colors in the calculation.

occurred in the wide color gamut display for anomalous trichromats.

CONCLUSIONS

We investigated observer metamerism in a wide color gamut display for anomalous trichromats. We conclude that a severe observer metamerism is confirmed in a wide color gamut display for anomalous trichromats. The observer metamerism for deuteranomalous trichromats can be predicted by a color appearance model proposed by Yaguchi et al. However, there are unknown factors of protanomalous trichromats' observer metamerism in a wide color gamut display, yet.

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EFFECTS OF MACULAR PIGMENT DENSITY ON BRIGHTNESS PERCEPTION OF COLORED LIGHT

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Keywords: Brightness perception, Brightness matching, B/L ratio, Macular pigment.

ORAL SESSION

ABSTRACT

Luminance is calculated with a luminous efficiency function, which indicates the spectral sensitivity of human visual perception of brightness. However, it is a well-known that luminance does not represent the perceived brightness of individual. The degree of mismatch between luminance and perceptive brightness is often evaluated by the brightness-to-luminance ratio (B/L ratio). B/L ratio correctly evaluates the perceptual brightness, but the factors that mediate the individual differences are not clear. This study investigated the quantitative relationship between individual differences in B/L ratio and those in MPOD. The results showed that there are negative slops on liner approximation for all color stimuli, and many of them have high coefficient of determination. This means that the B/L decreases as an individual MPOD increases. Moreover, the same effects were also observed for colored light with little effect of MP. This suggests that there may be the visual mechanisms due to MPOD that may affect brightness perception.

INTRODUCTION

Luminance is normally used as an index of brightness evaluation for colored light. In 1924, the Commission Internationale de l'Éclairage (CIE) defined Luminance, which is based on a luminous efficiency function V(λ). V(λ) indicate the spectral sensitivity of human visual perception of brightness. Although, this is an average value obtained from the results of many observers with normal vision, and does not consider individual differences. Thus, it is a well-known that luminance does not represent the perceived brightness of individual. The degree of mismatch between luminance and perceptive brightness is often evaluated by the brightness-to-luminance ratio (B/L ratio). B/L ratio correctly evaluates the perceptual brightness, but the factors that mediate the individual differences are not clear.

Many factors which mediate the individual differences in brightness have been reported[1-3], such as the lens density, the macular pigment optical density (MPOD), the cone sensitivity, and L/M cone ratio. In particular, the lens density is considered to be a major factor of individual difference in brightness perception depending on age, because the absorption of the lens in the short wavelength region increases with age. MPOD may also be a factor of individual differences in brightness perception as the macular pigment has an absorption region in short wavelength similar to that of the lens, and a large individual difference has been confirmed. In order to clarify factors of individual differences in brightness perception, this study investigated the quantitative relationship between individual differences in B/L ratio and that in MPOD.

MEASUREMENT OF MACULAR PIGMENT OPTICAL DENSITY

Macular pigment[4)]

Macular pigment (MP) is a yellow pigment which exists in the range of 3 to 5 degrees in diameter including the fovea. MP absorbs the short wavelength light of the visible region, which works as a kind of yellow filter. The absorption peak of MP is about 460 nm.

Methods and conditions

MPOD of each subject was measured with the heterochromatic flicker photometry method (HFP). HFP is a psychophysical method which conducts the brightness matching between reference and test light alternatively presented at a constant frequency. In this study, individual MPOD was calculated from the results obtained in central vision and peripheral vision (eccentricity of 6 deg.). The reference and test lights used monochromatic LEDs and presented to the subject through the aperture of 1.6 deg. The peak wavelength of the reference light was 570 nm, whose luminance was kept constant at 4.8 cd/m^2. The peak wavelength of the test light was 470 nm, and the intensity level of the light was changed by varying the duty ratio. The flicker frequency was 20 Hz.

Results of macular pigment optical density

Ten subjects in their twenties including 5 males and 5 females participated in this experiment. The measurement was performed three times with the right eye, and the average value was used as individual MPOD. The results are shown in Figure 1. The minimum, maximum and average MPOD values in this study were 0.163, 0.546, and 0.364, respectively. These values in our past study[5)] which measured 114 Japanese subjects, were 0.07, 0.67, and 0.36, respectively. This means that the subjects of this study cover a wide range of individual differences in MPOD.

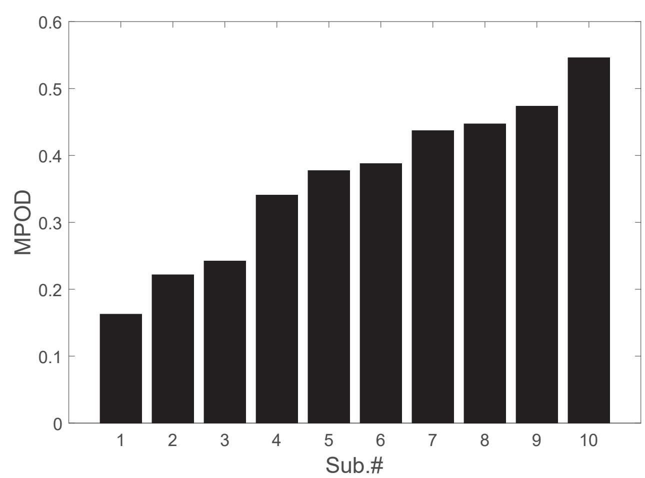

Figure 1. Results of individual MPOD

BRIGHTNESS MATCHING EXPERIMENT

Methods and conditions

The purpose of this experiment is to measure the B/L ratio distribution in the color gamut of display. The B/L ratio is the ratio of the luminance B of the monochromatic light to the luminance L of the colored light, which have been adjusted to the same brightness. Two experiments were carried out; the flicker photometry to obtain the luminance B and the direct comparison method to obtain the luminance L. In both experiments, the subjects adjusted the brightness of the test stimuli so that it would have the same brightness as the achromatic reference stimulus set to any luminance.

The chromaticities of the reference and the test stimuli are shown in Figure 2. For the reference stimulus, the chromaticity [x, y] was [0.313, 0.329], and the luminance was 45.5 cd/m^2. For the test stimuli, 22 colors were selected in consideration of the color gamut of a display. Stimuli were presented on a liquid crystal display, that have the gray background whose luminance was 3.36 cd/m^2. For the flicker photometry, a circular stimulus with a viewing angle of 2 degrees was presented at the center of the display. The flicker frequency was 20 Hz. For the direct comparison method, two square stimuli with a viewing angle of 2 degrees were presented at the display. The reference stimulus was always presented on the left side, and test stimuli were presented on the right side. The gap between reference and test stimuli was 2 degrees. Both experiments performed four times for each color, and average value was used as the matching value. Color of the test stimuli were presented in a random order.

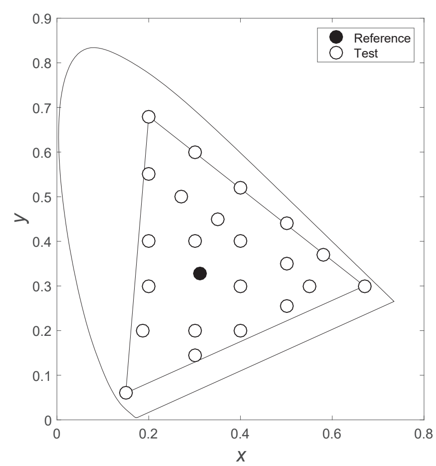

Figure 2. The chromaticities of the reference and the test stimuli

Results of B/L ratio

B/L ratio for each test stimulus was calculated from the ratio with the result obtained by flicker photometry and that obtained by the direct comparison method. Figure 3 shows the logarithmic B/L contour line on the CIE *xy* chromaticity diagram. In this paper, the results of 3 subjects, Sub.1, 4, and 8 were shown. The results were divided into 3 types. Type 1 shows the almost flat B/L value in the whole gamut as seen in the results of Sub.1. Type 2 increases the B/L value toward red and blue primary colors as seen in the results of Sub.4. Type 3 increases the B/L value toward all primary colors; red, green and blue as seen in the results of Sub.8. Individual differences were large, the highest differences were 8.35 times.

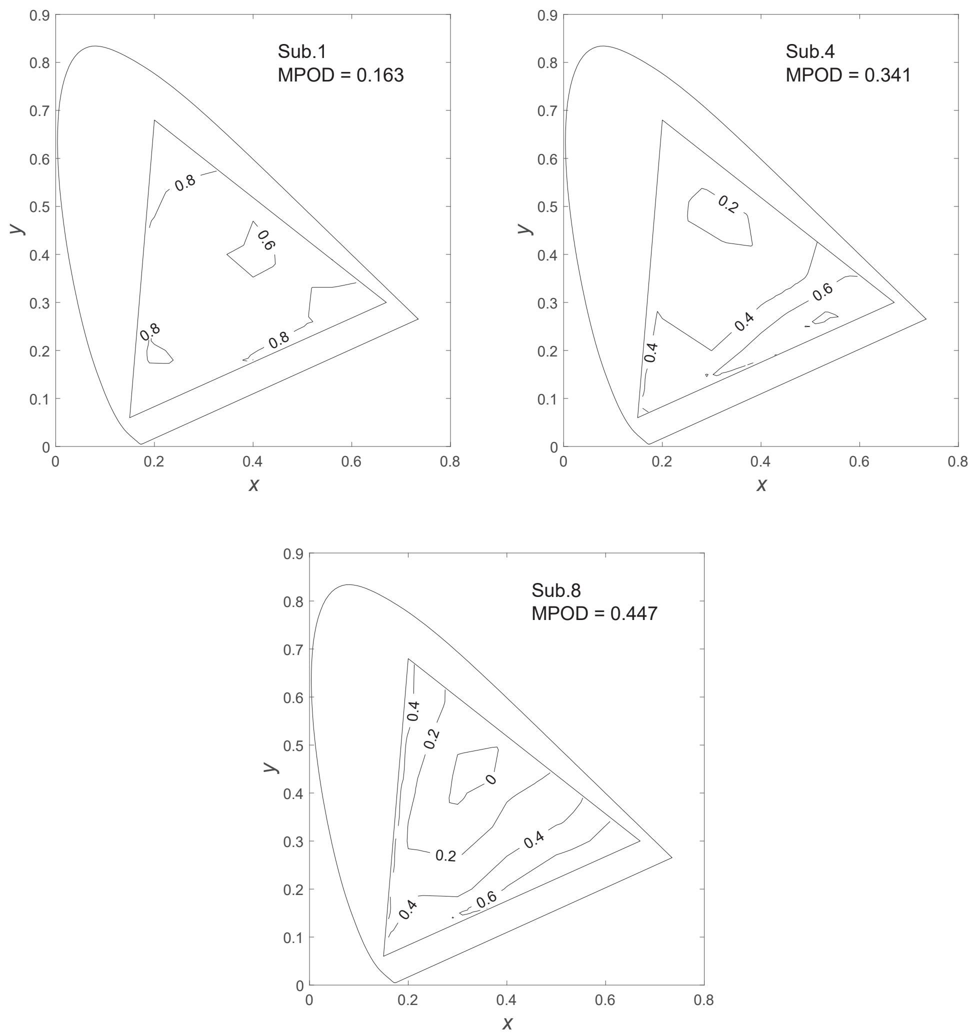

Figure 3. Results of B/L measurement

DISCUSSION

We investigated the quantitative relationship between the individual differences in MPOD and that in B/L ratio. First, the spectral distribution of each stimulus was measured, in order to clarify how much the absorption of MP would be affected. The result is shown in Figure 4. The influence rate indicates the proportion of the amount which is absorbed by the MP for each stimulus. The larger these values, the more influence of MP. Next, the relationship between B/L and MPOD for each stimulus was confirmed. B/L and MPOD were plotted on the vertical and horizontal axis, respectively, and the slope of liner approximation was calculated. The results are shown in Table 1. We found that there is a negative slope for all color stimuli, many of which have high coefficient of determination. This means that the B/L decreases as an individual MPOD increases.

Table 1. The results of liner approximation

Chromaticity coordinate		Liner approximation		Chromaticity coordinate		Liner approximation	
x	*y*	Slope	R^2	*x*	*y*	Slope	R^2
0.670	0.300	-0.815	**0.622**	0.200	0.400	-1.778	**0.681**
0.200	0.680	-1.713	0.489	0.200	0.300	-1.393	**0.809**
0.150	0.060	-0.734	0.191	0.188	0.200	-1.766	**0.813**
0.300	0.145	-0.417	0.214	0.300	0.200	-1.279	**0.631**
0.400	0.200	-0.402	0.315	0.200	0.550	-1.709	0.533
0.500	0.254	-0.241	0.166	0.400	0.300	-1.620	**0.740**
0.300	0.600	-2.659	**0.874**	0.550	0.300	-1.138	**0.882**
0.580	0.370	-0.690	0.592	0.300	0.400	-2.568	**0.970**
0.500	0.440	-2.061	**0.891**	0.400	0.400	-1.350	**0.778**
0.400	0.520	-2.292	**0.919**	0.500	0.350	-1.641	**0.728**
0.270	0.500	-2.286	**0.838**	0.350	0.450	-3.106	**0.909**

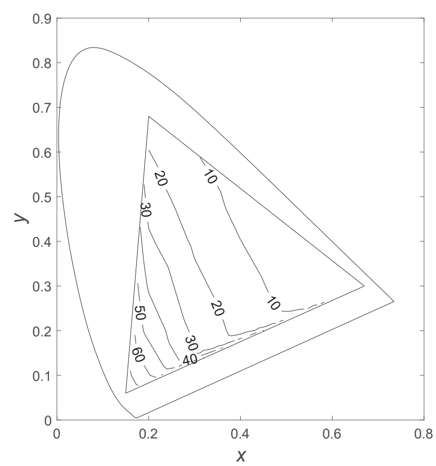

Figure 4. The influence rate of MP for each stimulus

Finally, we investigated the relationship between the slope of linear interpolation of B/L and MPOD and the influence rate of MP for each stimulus. MP has the characteristic of absorbing short wavelength light. Therefore, we can expect that there is a strong effect on the stimulus that contains large amount of short wavelength light such as blue and cyan. The results are shown in Figure 5. Contrary to our expectation, there was no correlation between influence rate of MP and slope of liner approximation. This suggests that there may be the higher mechanism that the compensation for the short wavelength region extends to other wavelength regions.

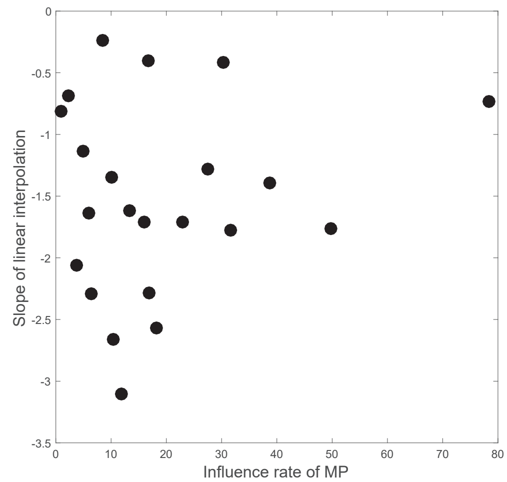

Figure 5. The relationships between slop and influence rate

Summary

In this study, the quantitative relationship between MPOD and B/L was investigated. The results showed that there are negative slopes, and high coefficient of determination. The same effects were also observed for color lights which are less affected by MP. This suggests that there may be the visual mechanisms due to MPOD that affect brightness perception.

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CREATIVE CONTEMPORARY MURAL PAINTING OF NORTHEAST THAILAND TO PARTICIPATE IN THE LOCAL PROVINCE

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Keywords: Mural painting, Loei province, Participation, The story of Lord Buddha, Acrylic on cement wall

ABSTRACT

This research found that at the Phon Kai temple, Na-Or district, Loei Province is still deficient of mural painting. For that reason, this project **"**Creative contemporary mural painting of Northeast Thailand to participate in the local province**"** brought about the purpose to be depicted the mural painting on the four walls to illustrate and educate about religious to the local people. The researcher have been survey the area and inquired the local leader and people opinion for their satisfaction before being paint onto the wall and request for collaboration both side of activity and painting participate on the walls with the researcher team. The survey found that the community considered the painting history of Lord Buddha. The researcher inquired about the satisfaction and the voices to express their opinion by sketches on paper, made a decision selected by the theme. The community are willing to help in the coloring process. Conclusion that, this project has caused actual social participation in the community. The people were satisfied with the beauty of the painting. The mural painting successfully completed by using the Acrylic on the wall technique.

INTRODUCTION : BACKGROUND AND RATIONALE

The research has been conducted in order to analyze archaeological evidence and create knowledge on local history and folk culture which can be used as follows: 1) as the source of learning for people both inside and outside the community, 2) as evidence for developing local culture and 3) develop the local creative learning center at schools adjacent to the temples to encourage Thai teenagers and community to learn art painting in the creative ways and understand values and appreciate the aesthetics of art.

1. OBJECTIVES

1.1. To paint the mural paintings on all four walls with the acrylic painting title "Wat Phon Khai's mural paintings, Maung district, Loei province".

1.2. To offer community service and develop the solutions to problems related to these mural paintings.

1.3. To develop and connect the study networks in order to analyze the problems and causes of aesthetic use.

2. SCOPE OF STUDY

2.1. This research is a qualitative research in which survey on the opinions of community leaders and local people and paints the mural paintings to convey the attitudes.

2.2. Study the relationships between the attitudes of the stakeholders such as monks, artists and people and physical appearance, location and arts and culture.

3. RESEARCH METHODOLOGYND STUDY AREA

The study area is Maung district, Loei province. This study is divided into 3 main steps as follows:

3.1. Understand the study area in terms of history and cultural significance.

3.1.1. Group meeting with artists and group management approach.

3.2. Policy implementation, identification of factors and problems, development of method during operation.

a. Study the patterns of I-san style mural paintings and develop the art sketch I-san contemporary paintings.

b. Survey on the opinions of the villagers in "Creation of I-san contemporary paintings into community participation in Loei province". This step takes from 1 November 2016 to 31 November 2016. The staffs in the process include: 1) 1 photographer, 2) 1 evaluator and 3) 2 coordinators with local community these are two representatives from the Office of Provincial Public Prosecution who know this area very well.

4. OUTCOME : CHARACTERISTICS OF THE ART CREATION

The objectives of this study were to create the mural paintings on the bare white walls of the newly built Buddhist chapel (Bot) which are specific to the local area. The contents of these mural paintings about the Life of Lord Buddha starting with the marriage of Queen Maha Maya with the aim to encourage the audiences to find happiness and to compare the images with the well-known Life of Buddha as

4.1 The environment around the King, the Queen and Prince Siddhartha

4.2 The endeavor, activeness, grateful to mother, believe in righteousness result in admiration.

4.3 Good interaction and the beauty of women and men in the Life of Buddha

5. REMARK : PAINTING PROCESS

The painting process is based on the proportion, composition, color use, the harmony of textures to suit the size of the building. The mural paintings were painted on all four walls

The stories, painting techniques and the beauty of colors were influenced by the paintings in Buddhaisawan Chapels, Bangkok. There were the painting of flowers falling from heaven which was the symbol of good fortune. The quality of the atmosphere was expressed in bright and sweet colors with light color background without heavy coloring. The paintings of the life of Buddha were arranged in row. There was a glass house (Ruen Kaew) on the throne. Some bright colors such as light blue, pink, red, white, yellow were used with paintbrush and paint spray. Fallen flower shape and bright colors were used since Ayutthaya period.

6. CONCLUSION : BUDDHIST CHAPEL WALLS WITH MURAL PAINTINGS

6.1 Mural paintings above the windows from the right side of the sculpture of seated Buddha image were about the life of Buddha to the end of the wall. The stories of these mural paintings began with the marriage of the father and the mother of the Buddha, the birth of Buddha, the ordination of Buddha. These paintings depicted the surfaces of water, ground and stone which gave the feeling of thick and spacious.

6.2 The paintings of Buddha preaching episode

6.3 The paintings of the big tree behind the main Buddha image with the atmosphere, trees, leaves, animals and the colors of hillside, sea and mountains.

6.4 The paintings of obstructing demon


Figure 1. The stories of these mural paintings began with the marriage


Figure 2. The paintings of Buddha preaching episode


Figure 3. The paintings of the big tree behind the main Buddha image

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Figure 4. The paintings of obstructing demon

ACKNOWLEDGEMENT

I would like to thank you National Research Council of Thailand for the funding.

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IMPROVEMENT OF THE COLOR DISCRIMINATION ABILITY WITH A SPOT LIGHTING.

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Keywords: Cataract, elderly people, color discrimination ability, 100 Hue test, spot lighting

ABSTRACT

When the eyes of elderly people get cataract, the environment light scatters into the eyes. The environment light is normally white and the apparent color of objects desaturates on the retina. This is supposed to cause the color discrimination ability poorer. The deterioration could be improved by reducing the environment light by employing a spot lighting system. In this experiment the color discrimination ability was measured by using 100 hue tests under two different illuminating systems; a normal lighting with fluorescent ceiling lamps and a spot lighting which illuminates only color chips to reduce the environment light. The cataract eyes were simulated with the cataract experiencing goggles produced by Panasonic[1]. The color chips of 100 hue test were randomly put on a table under either the ceiling lamps or the spot light and a subject arranged them in the order of color. The subject used the goggles in observation. The error score was counted according to the 100 hue test method. Four subjects participated in the experiment. Results showed that the color discrimination ability did not improve with the spot lighting system. It was concluded that the 100 hue test is not proper to show the advantage of the spot lighting system.

INTRODUCTION

When people get older their eyes normally become cataract. The crystalline lenses get frosted. One of the color perception properties of the cataract eyes is the desaturation of color of objects. This is caused by scattering of incoming light from environment. The light coming to the eyes from the environment is normally white, and the white light scatters all over the retina to desaturate the color of objects that the person is looking at. This was shown by Ikeda and Obama[2] by using the cataract experiencing goggles that simulate the cataract eyes[1]. We can suppose that the desaturation might cause the color discrimination ability to deteriorate. To avoid the deterioration a use of spot lighting is suggested. The spot lighting reduces the environment light and consequently the desaturation of color becomes smaller and the color discrimination ability should recover again. In this paper we use the 100 hue test to measure the color discrimination ability and the experiment was carried out under a normal fluorescent lighting and under a spot-lighting to see if the spot-lighting is better than the fluorescent lighting in the 100 hue test score by using the cataract experiencing goggles.

ORAL SESSION

ORAL SESSION

EXPERIMENT

We use the cataract experiencing goggles developed by Obama et al[2)]. The goggles are composed of two filters, a color filter to simulate the spectral transmittance of cataract eyes and of a haze filter. The spectral transmittance is shown in Fig. 1. It rapidly decreases from 400 nm down to 350 nm. The luminous transmittance was 62%. The haze value of a filter is defined as the ratio of the transmitted scattered light to the transmitted entire light and it was originally 18% when we borrowed the goggles from Dr. Obama but at the present it went up to 23.8% after using them many times for a long time, while the luminous transmittance has changed little. (From 63% to 62%).

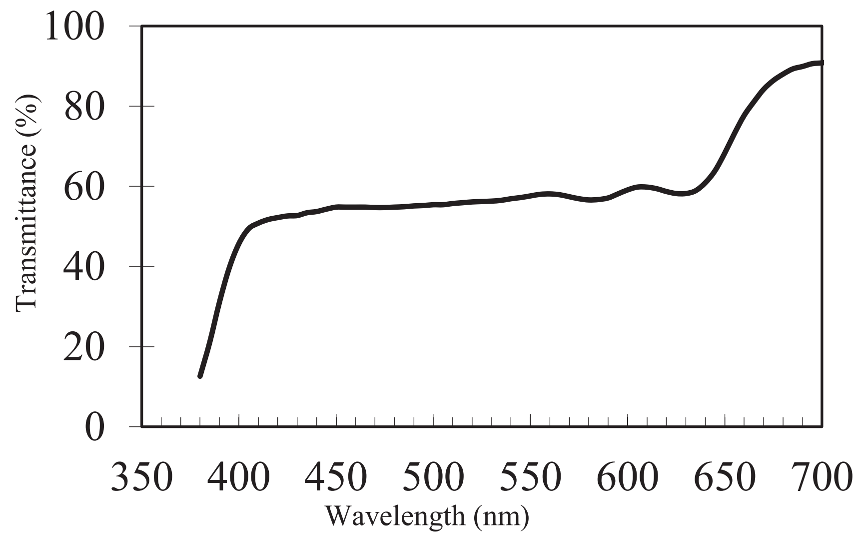

Figure 1. Spectral tramsmittance of the cataract experiencing goggles.

The observing booth was constructed as shown in Fig. 2. It had a space of 200 cm wide and 230 cm deep, in which a large table covered by a black cloth was placed. There were two sets of lighting system prepared, one with the fluorescent lamps and the other the spot light.

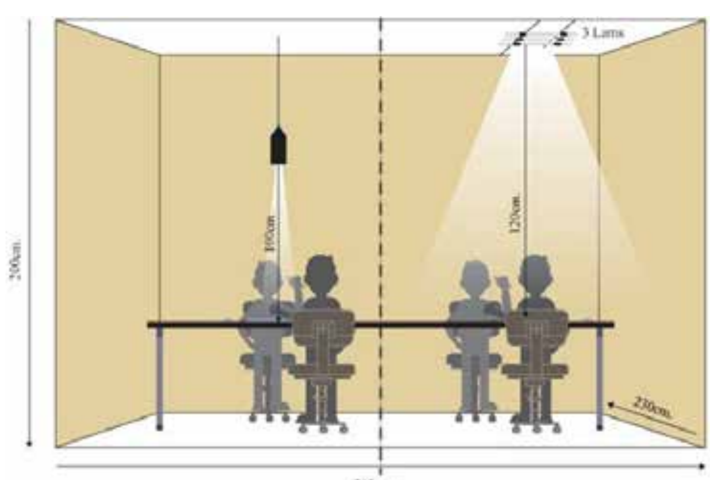

Figure 2. Experimental booth.

The fluorescent lamps were Toshiba Fluorescent Daylight 18W/T8/EX and 3 of them were fixed at the ceiling of the booth. A lamp for the spot lighting was 5W LED lamp of the color temperature 6500K. To decrease the color temperature a yellow filter was coupled with the lamp to adjust its color temperature. The LED lamp was enclosed in a tube-shaped box with one side of 15 x 15 cm^2 and 30 cm long with an opening of 7 x 4 cm^2 ,which illuminated an area of 26 x 17 cm^2 on the table. The illumination conditions of the two lighting systems are summarized in Table 1.

Table 1: Illumination conditions of two lighting systems as measured by Konica Minolta Chroma Meter 200A.

	Spot	Fluorescent
Color temperature	5689K	5529K
Illuminance	539 lx	517 lx

A commercially available 100 hue test set was used which was composed of 85 color chips. The chips were separated to four rod boxes of the length 49 cm, three having 21 chips and another 22. Colors of chips were measured with Konica Minolta CS-2000 Spectroradiometer and the results are shown in Fig. 3 by black dots on u'v' diagram. The CIED65 is shown by an open circle.

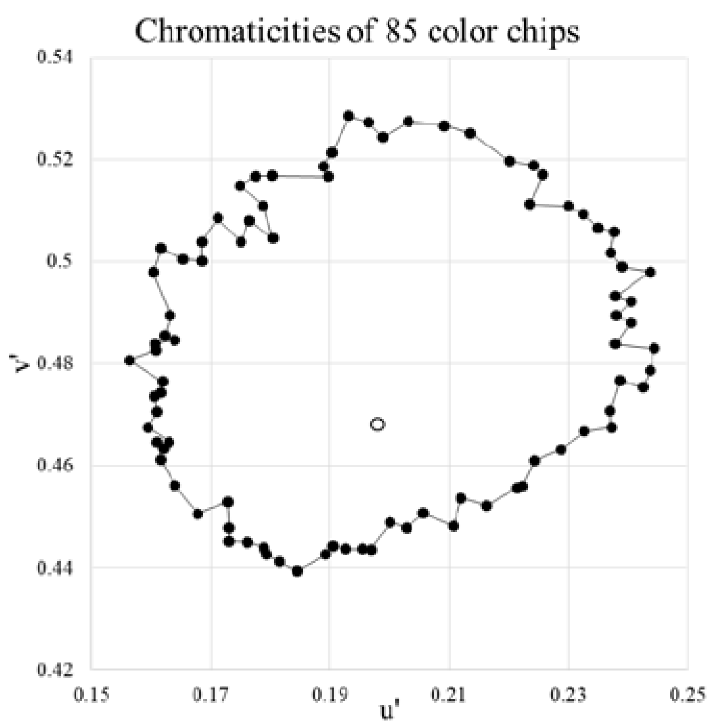

Figure 3. Chromaticities of 85 color chips plotted on the CIE u'v' diagram.

Four subjects with normal color vision participated, MI (85 years old), CP (40), NW (21), and JM (24). The subject NW was a naïve subject participating for the first time for this kind of pshychophysical experiment. The subject MI had IOL in both eyes.

In starting the experiment, all the movable color chips were taken out from the rod box and put in front of the subject. He/she then returned the chips one by one to the box arranging in order of color. He/she should observe chips in the lit area of the spot light when he/she was selecting the next color chip to return to the box. Subjects could rearrange chips after putting all the chips into the box. In the case of the fluorescent lighting all the color chips in the box could be seen at a time, but in the case of the spot lighting the lit area is narrower than the rod length and the subjects moved left and right to see all the color chips under the light. This gave the subjects impression of disadvantage of color order arrangement compared to the fluorescent lighting case. When the subjects thought the arrangement was over, the experimenter took a note of the order on a data sheet shown in Fig. 4 to calculate the error.

		NAME			DATE			#		goggles	YES /	NO												
	RED																							
	84	85	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	GREEN																							
Fluorescent	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	
	BLUE																							
	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	
	PUPLE																							
	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	
		NAME			DATE			#		goggles	YES /	NO												
	RED																							
	84	85	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	GREEN																							
Spot	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	
	BLUE																							
	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	
	PUPLE																							
	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	

Figure 4. Data sheet

The experiment was carried out for once for four combinations of goggles and lightings, fluorescent and without goggles (naked), fluorescent and with goggles, spot and without goggles, and spot and with goggles.

RESULTS

By the order of color chips that subjects determined errors can be calculated according to the 100 hue test manual and can be plotted on a graph as shown in Fig. 5.

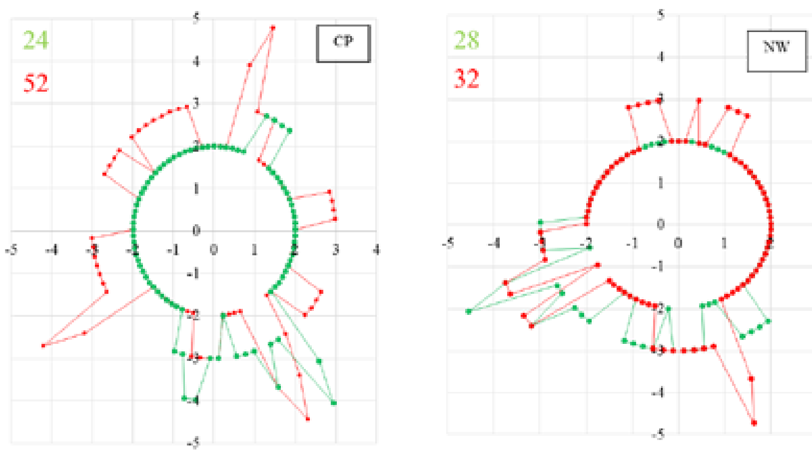

Figure 5. The results from the fluorescent lighting. Green dots connected by green lines are from "no goggles", that is by naked eyes, while red dots connected by red lines are from "with goggles" The left graph is the results of the subject CP and the right the subject NW. The total error can be calculated and they are shown at the upper left corner of respective graph. In calculation the error 2 is counted as 0

The color chip starts from 12 o'clock and increases counter clockwise returning to 12 o'clock position. The distance from the origin gives error, but the calculation method employed gives error 2 for no error, thus the circle of the radius 2 indicates no error in the figure. Figure 5 shows the results from the fluorescent lighting. Green dots connected by green lines are from "no goggles", that is by naked eyes, while red dots connected by red lines are from "with goggles". The left graph is the results of the subject CP and the right the subject NW. The total error can be calculated and they are shown at the upper left corner of respective graph. In calculation the error 2 is counted as 0 as it shows no error. It is quite clear that the error with goggles (red letter) is larger than that with naked eyes (green letter) in both subjects. The total error scores are given in Table 2 for all the four subjects. These results clearly indicate that the cataract eyes have deterioration of the color discrimination ability.

Table 2 Total error for two observing conditions.

Fluorescent	MI	CP	NW	JM
Naked	35	24	28	0
Goggles	64	52	32	4

To reduce the deterioration we proposed to use a spot lighting system by which the environment light could be reduced and consequently to reduce the scattering light in the eye. The results are shown for the subject CP and NW in Fig. 6. Red dots connected by red lines were from the fluorescent lighting system with goggles and green dots with green lines were from the spot lighting system with goggles.

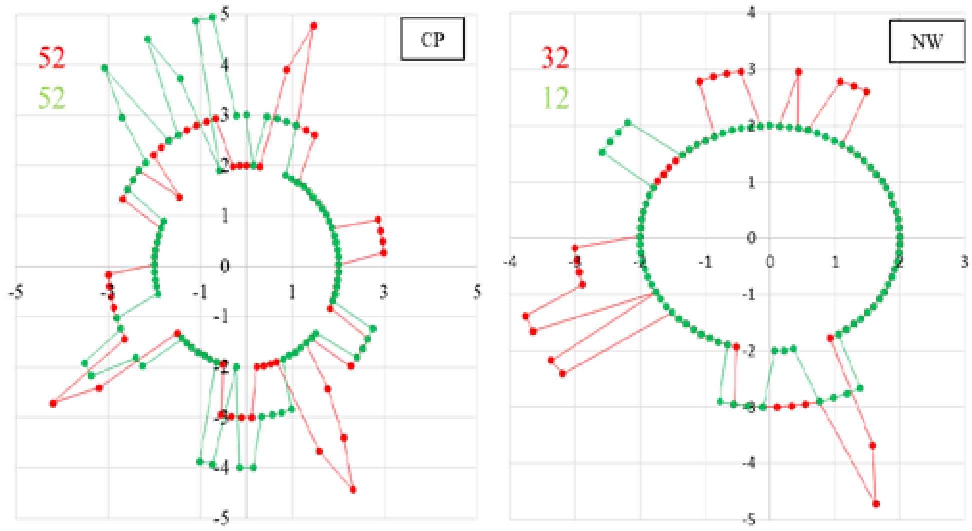

Figure 6. Red dots connected by red lines were from the fluorescent lighting system and green dots with green lines were from the spot lighting system.

The total error scores are shown by letters of the corresponding colors. They are shown for all the four subjects in Table 3. To the contrary to our expectation no improvement of the color discriminability is observed by employing the spot lighting system except the subject NW.

Table 3. Total error for two lighting systems.

	MI	CP	NW	JM
Fluorescents	64	52	32	4
Spot	64	52	12	4

DISCUSSION

On the contrary to our expectation the spot lighting system did not improve the color discrimination ability when it was checked by the 100 hue test. All the subjects felt that it was easier to compare colors under the fluorescent lamps as the entire color chips can be seen at once, while under the spot light the length of the rod box is longer than the lit area and entire color chips could not be observed at once but they had to move left and right to cover the entire color chips. It is true, however, that all the subjects expressed their impression that color chips appear more vivid and clear under the spot light than under the fluorescent light. To make the lit area larger with the spot lighting system by employing more LED lamps than only one should be a future experiment to be done. To try some other task than the 100 hue test would be another future experiment. Color desaturation may not affect the color discrimination ability.

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DEVELOPMENT OF HEATING TEST EQUIPMENT FOR IMPROVED UTILIZATION OF SUPERHEATED STEAM: MONITORING COLOR CHANGE OF FOOD AT HIGH TEMPERATURE

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Keywords: Humidity, Superheated steam, Food processing, Spectrophotometric colorimetry

ABSTRACT

Superheated steam, i.e., high-temperature steam above the boiling point at atmospheric pressure, has been widely used as a heating medium in food baking/drying equipment. The humidity inside the baking/drying equipment have temporal and spatial distribution because there is an inflow of indoor air during food insertion. However, a slight humidity change can influence the heat transfer to the food, which can seriously affect its quality. To solve these problems and improve the utilization of superheated steam, a test apparatus that can set and control the heating conditions was developed in this study. By using this apparatus, we could observe the change in food color under various humidity conditions. To measure the spectral reflection spectrum on the surface of a food sample, spectroscopic measurement devices were installed. A sweet potato slices was inserted at the bottom of the test chamber and heated for 12 minutes with hot air and superheated steam, both at a flow rate of 1 m/s, and a temperature of 200°C. The difference in color change due to the heating media could be observed; the redness of the sample heated with superheated steam was slightly more intense than that of the sample heated with hot air.

INTRODUCTION

Research on the utilization of high temperature steam (superheated steam) [1] has advanced for the purpose of primary heat processing of food aimed at sterilizing agricultural products, deactivating enzymes and improving food quality. Using high-temperature steam, food can be efficiently heated in a short time due to the condensation heat of steam while suppressing oxidation, as compared to heating with high temperature air. However, when food is inserted into ovens currently available in the market, surrounding air flows into the oven together with the food. In the case of a steam oven, the steam is fed into the oven after closing the door, creating a temporal and spatial humidity distribution. Because steam has the ability to add a large quantity of heat to food due to condensation, the heating mechanism is more complicated than heating food in air. A slight change in humidity could significantly affect the heat transfer. Therefore, basic research on food processing requires the use of a test apparatus that can set and control heating conditions.

In this study, a prototype of heating apparatus for advanced use of steam was developed, consisting of an arbitrary humidity generator [2], a heater, and a small chamber. In addition, we tried to measure the spectral reflection spectrum of a food sample during heating using this apparatus.

TEST EQUIPMENT

Figure 1 shows details of the test section made of stainless steel pipe (small chamber, internal diameter 39.4 mm). A superheated steam mixing method [2] that can generate any chosen humidity level by adjusting the flow ratio of air and superheated steam was used to feed hot steam into the test section. To measure the spectral reflection spectrum of the material surface a spectroscopic measuring device (BLACK-comet StellarNet, measurement wavelength range 190 to 1100 nm, resolution 0.5 nm) and a light receiving fiber (QR 400-7-VIS/NIR core manufactured by Ocean Optics Inc. , diameter: 400 µm, length: 2 m) were used [3].

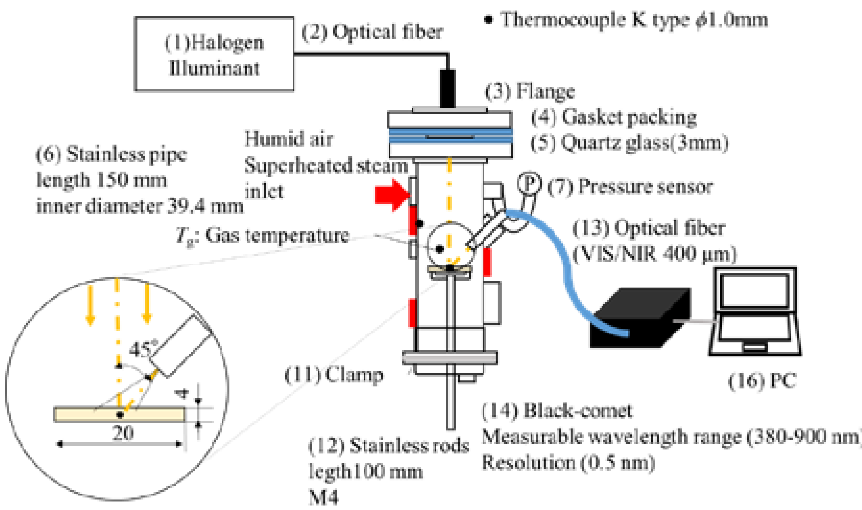

Figure 1. Overall configuration of test section

COLOR MEASUREMENT

A wollastonite porous plate (20 mm × 20 mm × 4 mm $CaSiO_3$, manufactured by Miyagawa Kasei Kogyo Co., Ltd.)) was used, whose spectral reflectance was measured as a white standard. During color measurement spectral reflection spectra of both the white standard and the sample were measured. Spectral reflectance for each wavelength was calculated from obtained data and converted into $L^*a^*b^*$ values in the D65 / 2 degree field of view using the pre-calculated weighting functions determined in JIS Z 8722: 2009 [4].

MEASUREMENT PROCEDURE

First, in order to verify the accuracy of the value of spectral reflectance ColorChecker Classic's 24 colors [5] was measured at room temperature, and pressure and color differences from standard values were obtained. The color difference was calculated according to Eq. (1).

$$\Delta E^*_{ab} = \sqrt{(L^*_{\mathrm{m}} - L^*_{\mathrm{std}})^2 + (a^*_m - a^*_{\mathrm{std}})^2 + (b^*_m - b^*_{\mathrm{std}})^2} \quad (1)$$

where L_{std}^*, a_{std}^*, b_{std}^* are standard values and L_{m}^*, a_{m}^*, b_{m}^* are measured values.

Next, spectral reflectance and color measurement of the food being heated were conducted. Heat was applied for 12 minutes at a steam mole fraction (measure of humidity) of $x = 0.002$ (air) and $x = 1$ (superheated steam), pressure of 1 atm, flow rate of 1 m/s, and temperature of 200°C. As a food sample, Naruto Kintoki sweet potato slices (20 mm × 20 mm × 5 mm, from Tokushima prefecture) were used.

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RESULTS

ColorChecker Classic 24-color test

Table 1 shows the results of color measurements using wollastonite as a white standard.

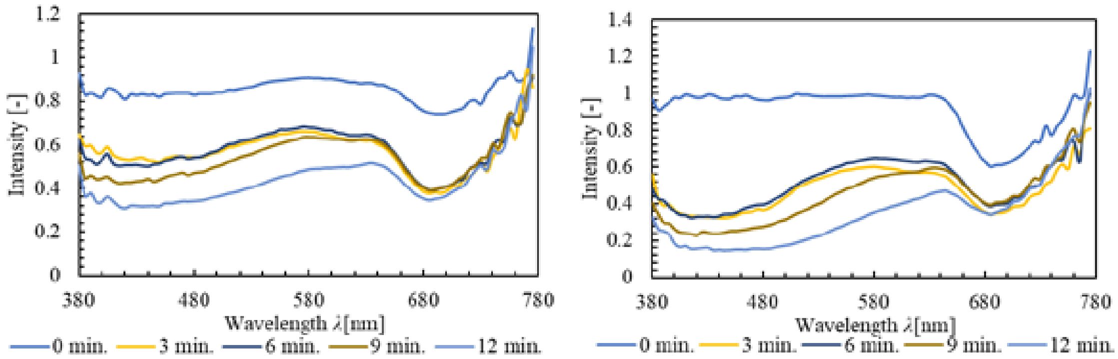
Table 1: Color Difference from Specification Value of ColorChecker Classic

Color name	ΔL^*	Δa^*	Δb^*	ΔE_{ab}^*
dark skin	2.5	1.5	4.2	5.2
light skin	0.7	2.6	0.0	2.7
blue sky	1.1	3.0	1.3	3.5
foliage	0.9	1.3	3.0	3.4
blue flower	2.8	2.0	2.4	4.2
bluish green	0.6	0.8	2.3	2.5
orange	1.9	4.0	4.9	6.6
purplish blue	1.7	6.7	2.3	7.3
moderate red	0.5	1.4	1.4	2.0
purple	2.7	1.0	1.0	3.1
yellow green	1.0	3.8	2.5	4.7
orange yellow	1.5	5.2	3.5	6.5
blue	1.2	5.0	4.7	7.0
green	1.6	1.6	1.5	2.7
red	0.6	4.5	5.0	6.8
yellow	1.5	5.7	3.1	6.7
magenta	0.7	0.1	0.2	0.7
cyan	7.1	9.5	11.0	16.1
white	0.9	0.2	1.1	1.4
n8	2.2	0.8	2.9	3.7
n6.5	1.4	0.7	2.1	2.6
n5	1.3	0.2	1.1	1.7
n3.5	1.6	1.0	1.0	2.1
black	2.5	2.0	2.6	4.1
average	1.7	2.7	2.7	4.5

In general, if the color difference is less than 5, it cannot be distinguished unless it is visually aligned and compared [6]. Color differences exceeding 5 were dark skin, orange, purplish blue, orange yellow, blue, red, yellow, and cyan. The inner wall surface of the stainless steel pipe (Figure 1 (6)) in the test section, which was the measurement environment, was not treated; it was a whitish dull reflective surface, which is the color of stainless steel. For this reason part of the illumination light (Figure 1 (1)(2)) hits and diffuses reflection inside the pipe. The same measurements were repeated after installing black drawing paper on the inside wall of the pipe to block the diffuse reflection. However, the color differences were almost the same as the measured values in Table 1. Therefore it was judged that the reflection on the inner wall of the pipe had no influence on the measurements and subsequent measurements were taken without any particular treatment. From the above results it was possible to confirm the color measurement accuracy of this device.

Food sample test

Changes in the spectral reflection spectrum when the food sample was heated with hot air and superheated steam at 200°C were measured. The measurement results are shown in Figure 2. It was confirmed that the output value for a wavelength of 480-580 nm was influenced by humidity after 9 minutes of heating. Next, the change in $L^*a^*b^*$ values due to humidity was investigated. Changes in the a^* and b^* values are shown in Figure 3 below, and the temporal change in the L^* value is shown in Figure 4. Regarding the chromaticity indicated by a^* and b^* values, redness increased with an increase in humidity [7][8]. As described above, it was possible to experimentally observe the difference in color change due to the heating media (humidity).



(a) $x = 0.002$ [mol/mol] **(b) $x = 1$ [mol/mol]**

Figure 2. Changes in spectral reflection spectrum during heating ($v = 1$ [m/s], $T_g = 200$ [°C])

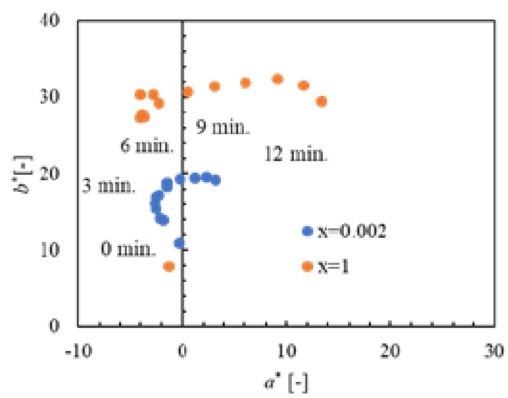


Figure 3. Changes in a^* and b^* values

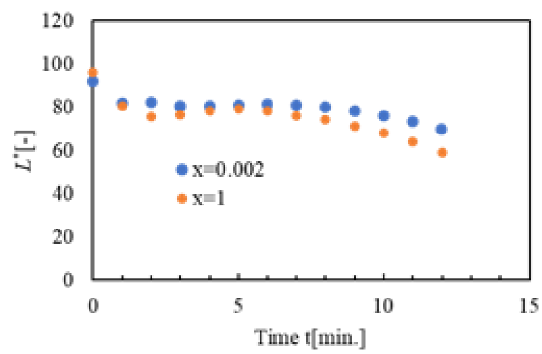


Figure 4. Time change of L^* value

CONCLUSION

We developed a test apparatus that can control temperature and humidity. We validated the spectral reflectance measurement of this apparatus by measurement of ColorChecker Classic's 24 colors. Color measurement during heating of food (sweet potato slices) under various heating conditions was performed and the relationship between the heating conditions and color change of foods could be clarified.

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STUDY OF STUDENT PERCEPTION ON COLORED SOME TRADITIONAL FOODS IN YOGYAKARTA

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Keywords: Color, traditional foods, students, field research

Traditional foods in Yogyakarta belong to culture and daily life activities. Some of them are sold at traditional market and serve as daily consumed food for special occasion. They are still popular for Yogyakarta people, but for young generation and especially for students who come from other regions in Yogyakarta these traditional foods are not familiar. Furthermore these foods are colored with natural dyes for attracting consumers.

This research was field research and conducted in Yogyakarta and used 15-20 university students who come from other cities as respondents. Seven traditional foods such as *cenil, dadar gulung, mata sapi, yangko, mendhut, mutiara* and *geplak* were provided from sellers at traditional market and served as samples for sensory testing by the respondents. They should determine these foods based on shape, color, texture, taste and aroma. They judged comparison on shape and color, taste and color respectively. Scale for determining food aspects was Likert Scale, with scale 1 = do not like very much, scale 9 = like very much.

Most of traditional foods use sticky rice as raw material with different proportion and are added palm sugar and coconut milk for having good taste and aroma. Only *mutiara* use sago for its raw materials and normally coconut milk is used for cooking it. Some of them were wrapped with banana leaves for serving. They belong to wet food and only *yangko* and *geplak* are intermediate foods.

The results showed, overall dadar gulung reached highest response on taste, texture, shape and color. Comparison between color and taste has highest score, it meant that color could represent taste of food although the consumers did not try before. The highest score of combination between color and shape was achieved by *mendhut*. It meant color of foods supported their shape in attracting consumers. Other results depicted that color played important role in traditional foods, although it was not supported by shaped and taste.

PRELIMINARY STUDY ON SPECTRAL CHARACTERISTICS FOR IDENTIFICATION OF ESKD SKIN COLOR UNDER HEMODIALYSIS TREATMENT

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Keywords: Skin Color, Hemodialysis, Spectral Reflectance Factor, CIELAB, NIST CQS

ABSTRACT

End-stage kidney disease (ESKD) patients need to be treated with hemodialysis. The purpose of this research is to find out the skin color change under hemodialysis treatment and the lighting spectral characteristics for identification of it. Thirteen ESKD aged patients' skin color under hemodialysis treatment was measured. The two parts of patients' skin were measured; the back of hand and the inner forearm. There are large differences among individuals of ESKD skin color and measured parts. The results of forearm are whiter than the results of back of hand, so forearm should be better part to judge patients' conditions before and after hemodialysis. Many results show the ESKD skin color became darken and reddish after hemodialysis. It may be caused by the decrease of the amount of water in the blood and cell tissue, and be higher Hemoglobin concentration. However, there were a little color differences of ESKD skin under hemodialysis treatment. By using the simulation program "NIST CQS ver.9.0.1", we compared the color difference of ESKD skin color between before hemodialysis and after, under the reference illuminant and the theoretical SPD which we produced for identification of circulatory disfunction skin color.

INTRODUCTION

Kidney has four important functions to maintenance of homeostasis, Control of water and electrolyte, Control of Acid-base Equilibrium, Discharge of Metabolites and Hormone Production and Control. The first three functions were implemented through formation of urine, and the filtration, reabsorption and secretion of materials are managed in kidney. And then, urine is discharged out of the body. With decreasing these four renal functions, renal failure is developed, and a lot of symptoms appear. If renal failure deteriorates and becomes End-Stage Kidney Disease ESKD, patients need to be treated with blood purification method. ESKD patients being treated with the blood purification method are growing worldwide. Japan has about 320,000 ESKD patients, so the enhancement of ESKD treatment is one of the national medical concerns in Japan.

About 80% of ESKD patients in Japan are treated with hemodialysis. Usually, hemodialysis takes 4 hours at one time to eliminate excessive water and electrolyte out of patients' blood, and to supplement necessary materials to survive. In hemodialysis, it is necessary to remove blood in the amount of about 200 ml/min or more. By tapping from the internal shunt that is anastomosis between artery and vein, the hemodialysis patients can remove blood, get rid of waste materials such as water, sodium and urea by dialyzer, supply needed materials from dialysis fluid, and re-transfuse blood into vein.

Hemodialysis treatment cannot be a perfect substitution for real natural renal functions, so patients are required a long-time dietary treatment, medication and attention to concomitant diseases. Therefore, doctors instruct hemodialysis patients to practice diet regularly and to limit sodium etc. Medical staff especially nurses rely on their intuitive interpretation whether patients become ill based on observation of ESKD patients' skin colour. Some research reported the ESKD skin colour [1], but the skin colour change in worsening health condition is not scientifically quantified.

Taking note of the characteristic that hemodialysis makes accurate assessment of body water amount and moving blood pressure possible, our research finally aims to explore causal relations between ESKD patients' skin colour and blood conditions with their vital data. In this paper, we reported two kinds of approach (1) collecting ESKD skin color data under hemodialysis treatment, and (2) compared the color difference of ESKD skin color between before hemodialysis and after, under the reference illuminant and the theoretical SPD which we produced for identification of circulatory disfunction skin color [2].

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EXPERIMENT

For this experiment, 17 Japanese ESKD patients (7 females and 10 males) were recruited, and the results of 13 patients over 65 years old (6 females and 7 males) were used for this analysis. Table 1 shows the characteristics of these subjects. They were treated with hemodialysis more than 6 month at Tokai University Oiso Hospital, and don't have other serious conditions. Some subjects have diabetic nephropathy. In the hemodialysis cycle which takes three times a week, the longest gap is at the beginning of the week, and then the accumulated water and waste materials reach a maximum. Therefore, subjects were measured at the beginning of the week.

Table 1: Important Dates for ACA2018

ID	Sex	Age (y/o)	Dry Weight (Kg)	Weight befor Dialysis	Weight after Dialysis	Removed Water (liter)	Dialysis Period (year)	Diabetes Mellitus
F	Female	71	45.7	46.9	45.6	1.4	10	–
G	Female	66	44.1	46.9	44.6	2.3	16	Yes
I	Female	68	47.5	48.2	47.5	0.9	10	Yes
K	Female	70	50.2	51.6	50.2	2	20	–
M	Female	68	37.9	40	37.9	2.3	6	–
N	Female	72	48.5	49.7	48.5	1.4	3	–
C	Male	74	59.4	62.4	59.9	2.5	unknown	–
D	Male	77	62	63.7	61.9	1.9	unknown	–
E	Male	68	58.2	60.3	58.3	2.2	13	–
H	Male	75	68.5	70.9	68.3	2.6	4	Yes
J	Male	81	41.5	44.5	42.1	2.5	3	–
O	Male	74	58.4	60.8	58.3	2.6	2	–
Q	Male	68	63.8	64.3	63.7	0.7	5	Yes
Ave.		71.69	52.75	54.63	52.83	1.95	8.4	
SD		4.18	9.14	9.12	9.04	0.62	5.7	
Max		81	68.5	70.9	68.3	2.6	20	
Min		66	37.9	40.0	37.9	0.7	2	

The two parts of patients' skin were measured; (1) back of hand between first metacarpal and second metacarpal with reference to our previous research [2], and (2) middle part of inner forearm. Both parts were of patients' dominant arm which didn't have an internal shunt for hemodialysis. Their skins were measured just before hemodialysis, every hour and the end. The measurement locations of both parts were marked with 3cm square holes to stabilize measurement operation. Although we were fully aware of the importance of patients' face skin colour to judge their health conditions, we did not measure their face skin colour to reduce the burden on patients. The spectrophotometer CM-2600d made by Konica Minolta was used for this experiment. The measurement diameter of CM-2600d was 3mm, light source was D65, mirror reflection was not included (SCE) and viewing field was 10 degrees.

SKIN COLOR UNDER HEMODIALYSIS TREATMENT

According to previous research [2], human skin colour data should be separated by gender because of their significant differences. Figure 1 shows the comparison L*a*b* results between back of hand and inner forearm (the detail results show our previous paper [3]). These figures also showed large differences among individuals. In addition, they showed large differences among measured parts. The results of inner forearm were whiter (higher L* and smaller a*) than the results of back of hand. Inner forearm may be better part to judge patients' conditions than back of hand in hemodialysis.

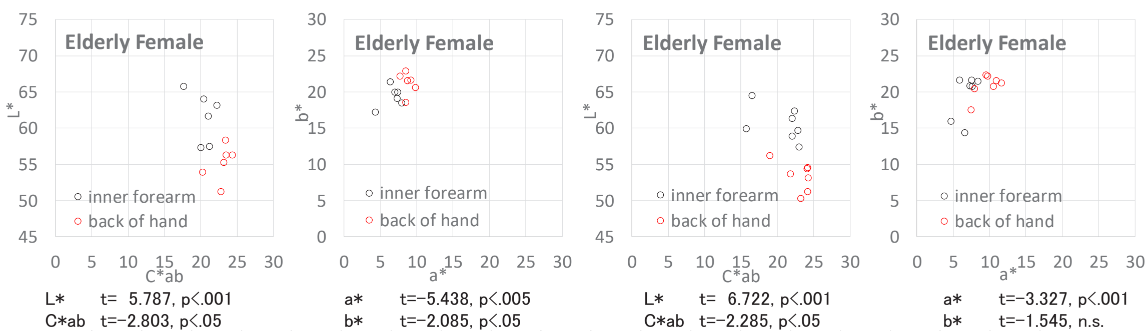


Figure 1: L*a*b* results of ESKD skin colour before hemodialysis [3].

Hourly skin colour under hemodialysis treatment changed very little, especially the results of back of hand (the detail results show our previous paper [3]). These hourly fluctuations varied according to individuals. Therefore, we used only two data before and after hemodialysis.

Figure 2 shows the comparison results of inner forearm's skin colour between before- and after-hemodialysis. Results pointed by red arrows with subject's name show ESKD skin colour change after hemodialysis was darker and reddish. It is considered this phenomenon was caused by the decrease of the amount of water in the blood and cell tissue, higher Hemoglobin concentration. Some results pointed by blue arrows indicated the opposite phenomenon. There were differences according to each individual subject, so we should collect more date in further study.

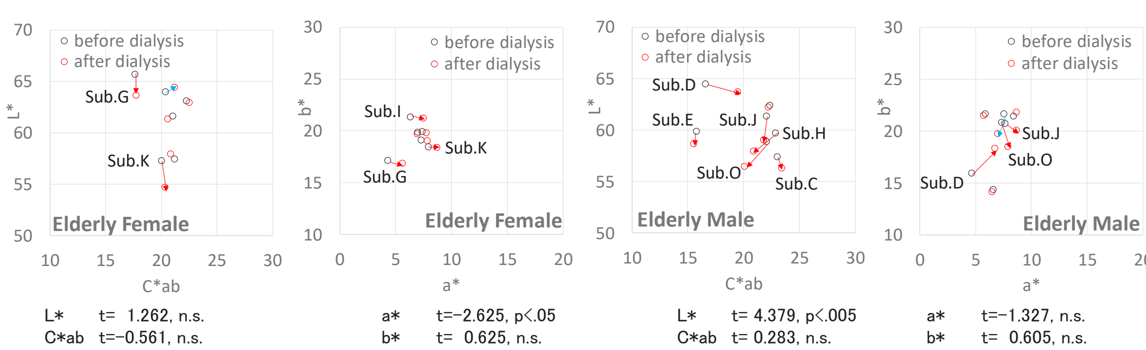


Figure 2: Skin Color Comparison between before- and after- hemodialysis (inner forearm).

The results of spectral reflectance factor between before- and after- hemodialysis at inner forearm skin color are shown in Figure 3. These figures also showed large differences among individuals. The results of Subject G, K, D, J and O had the differences between before- and after- hemodialysis. Moreover, these five subjects' skin color showed the typical tendency in Figure 2. Therefore, we use only these five subjects' data for after analysis.

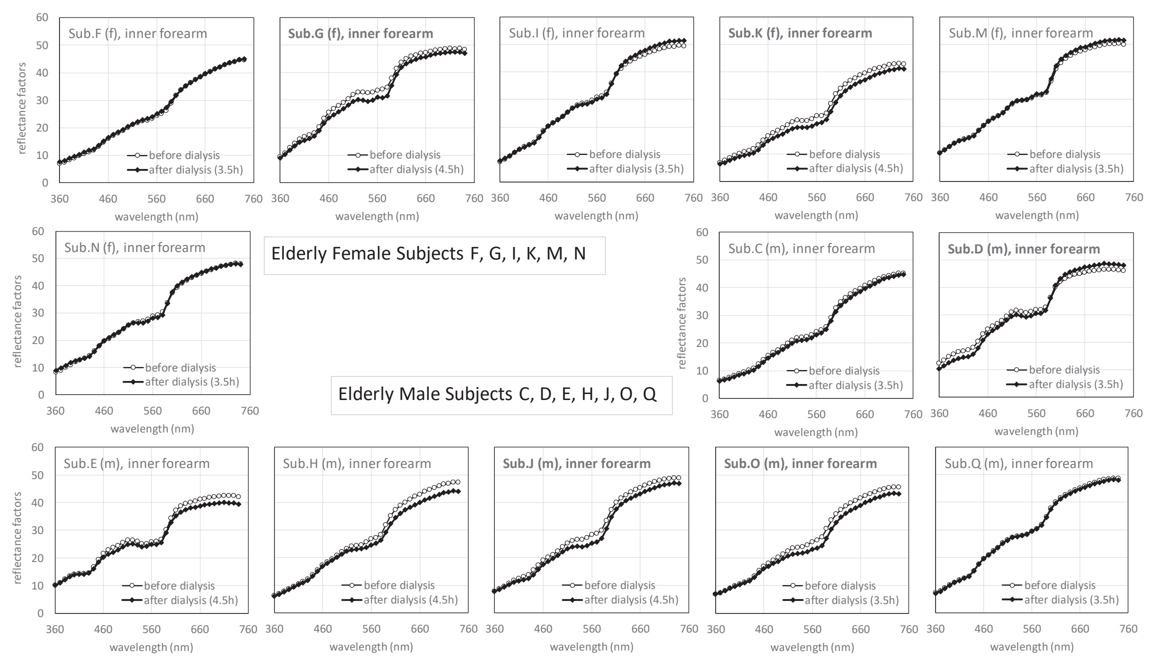


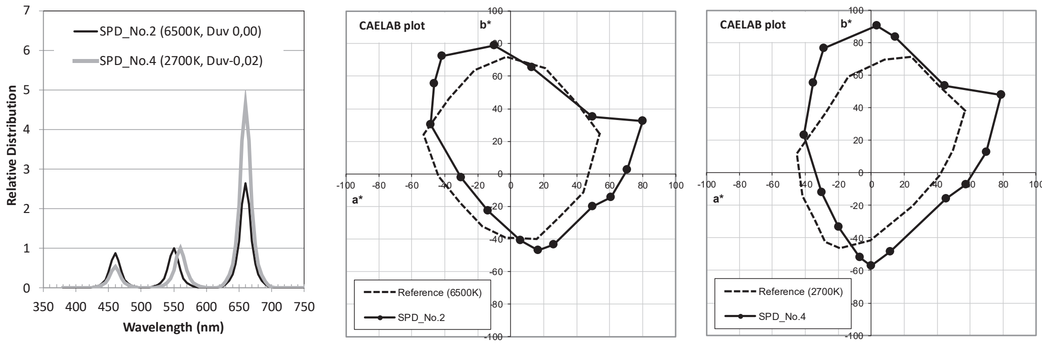
Figure 3: Skin Color Comparison between before- and after- hemodialysis (inner forearm).

COLOR DIFFERENCES OF ESKD SKIN UNDER HEMODIALYSIS TREATMENT AT THEORETICAL LED AND REFERENCE ILLUMINANTS

We used a spreadsheet program "NIST Color Quality Scale (CQS) ver.9.0.1", available from NIST [4] in this paper. This program provides calculation results of colour quantities such as CIE Colour Rendering Index (CRI) and CQS for given light source spectral power distributions (SPDs). Moreover, this program can simulate a white LED SPDs made of 3-LED or 4-LED chips. On both simulation models with the minimization tool in the spreadsheet, we can determine various optimized LED SPDs just by entering the values of target correlated colour temperature (CCT), target Duv, LED's peak wavelengths and spectral width, and so on.

In our previous research [2], using the NIST CQS simulation model, we determined the theoretical spectral distributions of LED light source for identification of skin color under circulatory disfunction conditions. The characteristics of the theoretical SPDs are shown in Figure 4. Both SPDs at CCT of 6500K and 2700K produced the maximum color differences among normal, shocked and congested conditions. Right figure in Figure 4 showed CIELAB plot of color rendering performance with 15 saturated reflective samples in CQS [4]. As compared with the reference illuminants, the theoretical SPDs' gamut was larger than the reference illuminants, and the values of CRI Ra were not high. But these theoretical SPDs produced much larger color differences than the reference illuminants.

We use these theoretical SPDs in this analysis.



	peak wavelength (width)	CCT	Duv	CRI_Ra	CRI_R9	CQS_Qa	CQS_Qf	CQS_Qg
SPD_No.2	460(20) 550(20) 660(20)	6500	0	53	-201	73	71	120
SPD_No.4	460(20) 560(20) 660(20)	2700	-0.02	54	-180	73	70	137

Figure 4: Theoretical SPDs for identification of skin color under circulatory disfunction [2].

The comparison results of color differences of inner forearm's skin colour between before- and after- hemodialysis treatment under the theoretical SPDs and the reference illuminants at CCT of 6700K and 2700K are shown in Table 1. Almost all results of the theoretical SPDs were slightly larger than the ones of the reference illuminants. These theoretical SPDs are determined for identification of skin color under circulatory disfunction conditions, but they may be useful for identification of ESKD skin color under hemodialysis treatment.

Table 1: Color differences between before- and after- hemodialysis treatment at inner forearm skin color under theoretical SPDs and reference illuminants.

	Elderly Female		Elderly Male		
	Sub.G	Sub.K	Sub.D	Sub.J	Sub.O
Reference 6700K	2.37	2.60	3.82	2.58	3.30
SPD_No.2	2.74	2.92	4.39	3.30	3.43
Reference 2700K	2.45	2.66	3.22	2.60	3.39
SPD_No.4	2.87	2.96	3.72	3.42	3.37

CONCLUSIONS

We measured the ESKD patients' skin color under hemodialysis treatment. These are conclusions of this experiment.

(1) There are large differences of ESKD patients skin color among individuals and measured parts.

(2) ESKD skin colour after hemodialysis had a tendency toward darker and reddish change.

(3) The theoretical SPDs which determined for identification of skin color under circulatory disfunction conditions in our previous research may be useful for identification of ESKD skin color under hemodialysis treatment.

Near the future, we will collect more ESKD skin data and analyze the relationship between dialyzed skin colour and blood test results such as hemoglobin and hematocrit, i.e. concentration of red blood cells.

ACKNOWLEDGEMENT

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THE EFFECT OF PROCESSING CONDITIONS ON COLOR, TOTAL PHENOLIC CONTENT AND ANTIOXIDATIVE ACTIVITIES OF CASSAVA LEAF EXTRACTS

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Keywords: Cassava leaf extract, Antioxidant activities, Thermal processing, Acidification

ABSTRACT

Cassava leaves (*Manihot esculenta Crantz*) contain nutrients and bioactive compounds that have antioxidative activities and anti-inflammatory effect. This study aimed to determine the effects of thermal processing and acidification on color (CIE L*a*b*), total phenolic contents (TPCs) and antioxidant activities (Oxygen Radical Absorbance Capacity, ORAC; Ferric Reducing Antioxidant Power, FRAP; and 2,2-diphenyl-1-picrylhydrazyl free radical, DPPH assay) of ethanolic and aqueous cassava leaf extract (CLE). Solutions of ethanolic and aqueous CLE in DI water (0.1% w/v) were prepared without or with acidification to pH 4.0, following by heat treatment at 75°C for 1 min, 95°C for 5 min or 121°C for 5 min. Considering ethanolic CLE, after the heat treatment was applied, lightness (L*) and redness (a*) tended to change with the severity of heat treatment, while yellowness (b*) was unaffected. The TPCs were slightly increased after the thermal processing. The antioxidant activities determined by DPPH radical scavenging and FRAP assays were slightly decreased, while those by ORAC assay were significantly decreased with elevated temperature. On the other hand, the color of the aqueous CLE remained unchanged after being heat-treated at any condition milder than commercial sterilization. The increase in temperature positively affected TPCs. Acidification helped maintaining the color of aqueous CLE as well as the antioxidant properties and TPCs against the thermal processing. In conclusion, according to antioxidant activities, the ethanolic CLE illustrated better health benefits. However, the bioactive compounds in ethanolic CLE were more heat-sensible comparing to aqueous CLE.

INTRODUCTION

Cassava (*Manihot esculenta Crantz)* is one of Thailand's major agricultural plant. In 2016, Thailand, one of the world's largest cassava products, exported over 33 million tons supplying two-third of the world market share (Thailand board of investment, 2017). Cassava stem and leaf, sometimes, can be used in biofuel or feedstock production (Nuwamanya, 2012). Moreover, cassava leaves are widely consumed as a leafy vegetable in several places such as in the Congo and Tanzania, but not in Thailand (Nweke, 2004). Thus the cassava stem and leaf was considered as being a crop residue with no market value.

The increased number of studies underlined the use of cassava leaf as a new source of natural antioxidants. The cassava leaf was also highlighted the bioactive compounds, i.e. antioxidants, associated to retarding aging as well as reducing risk of many serious diseases, for example, cancers, cardiovascular diseases, chronic diseases, etc. The cassava leaf contained high phenolic compounds, antioxidant substances. These phenols can be structured as many forms i.e. simple phenols, phenolic acids, and flavonoids (Zhao, 2015). These compounds are widely contributing color and flavor to plants. Particularly, in previous study, cassava leaf was found to contain several phenolic compounds, for example, coumarin, scopolin, aglycone scopoletin as well as flavonoids, for example, kaempferol-3-O-rutinoside and rutin (Gómez-Vásquez et al., 2004).

This paper aimed to study the effects of acidification and thermal processing on antioxidative compounds in cassava leaf extract and its color, to apply as functional ingredient for heightening nutrition values in beverage.

MATERIALS AND METHODS

Thermal process and acidification

The CLE solutions (0.1% w/v) were prepared with or without acidification to pH 4.0 using HCl, then subjecting to thermal treatment, i.e., pasteurization at 75 °C for 1 min or 95 °C for 5 min or commercial sterilization at 121 °C for 5 min. Acidified CLE, which is classified as acidified food by the Thai regulation due to its pH of 4.6, were only treated at 75 °C for 1 min and 95 °C for 5 min to achieve the commercial sterility. The reference was used for the comparison either ethanol extracted or aqueous extracted sample which the CLE solution without thermal treatment.

Physiochemical properties

Color

Color value (L*a*b*) was evaluated by spectrometer where lightness (L*) value at 0-100, a* referring red and green colors illustrated, and b* indicating yellowish and bluish of the sample. ΔE provides a value indicating the overall difference of sample from the control.

Determination of total phenolic contents

The total phenolic contents (TPC) of CLE solution after processing was determined by the Folin–Ciocalteu method (Ainsworth et al., 2007) The total phenolic content was calculated from the calibration curve, and the results were expressed as mg of gallic acid equivalent per gram.

Determination of antioxidant activities

The samples were analyzed for antioxidant activities using 1-diphenyl-2-picrylhydrazy (DPPH) radical-scavenging assay, ferric reducing antioxidant power (FRAP) assay and Oxygen radical antioxidant capacity (ORAC) assay

The DPPH radical scavenging assay of CLE was determined according to the method of Fukumoto and Mazza, 2000 (49) with some modifications. The DPPH radical scavenging was calculated as Trolox equivalent per gram dry weight (TE/g DW):

The ferric reducing antioxidant power (FRAP) assay was determined according to the method of Benzie and Strain, 1996 with some modification. The 20 µL of CLE were mixed with FRAP reagent (300 mM of acetate buffer (pH 3.6), 10 mM TPTZ in 40 mM HCl and 20 mM $FeCl_3 \cdot 6H_2O$ in ratio of 10:1) and incubated in the dark for 8 minutes at 25 °C. The absorbance was measured at 595 nm using 96-well microplate reader (Synergy HT, Bio-Tek Instruments, Winooski, Vermont, USA). The FRAP values were calculate and expressed in µmol TE/100 g of dry weight.

The Oxygen radical antioxidant capacity (ORAC) *assay* was determine according to Ou et al., 2001 (4) with some modifications. The intensity of fluorescence was measured at an excitation wavelength at 485 nm and emission at 528 nm for 90 minutes using 96-well microplate reader (Synergy HT, Bio-Tek Instruments, Winooski, Vermont, USA). The ORAC value was calculated and expressed as Trolox equivalent per gram dry weight (TE/g DW).

RESULTS AND DISCUSSION

The solutions (0.1% w/v) of ethanolic and aqueous CLE were prepared using the deionized water and without acidification, the pH of ethanolic and aqueous CLE solution were 4.20 and 6.05, respectively. The aqueous CLE solution (without acidification) were pasteurized at 75 °C for 1 minute or 95 °C for 5 minutes; or sterilized at 121 °C for 5 minutes, while the aqueous CLE solution with acidification and the ethanolic CLE solution, as acidified food, was only treated at 75 °C for 1 minute and 95 °C for 5 minutes which the latter condition is considered as commercial sterilization.

Then, the thermal treated samples were determined the effect of temperature and acidification on color, TPCs, and antioxidant activities were investigated. All parameters were repeatedly examined in duplicates.

Table 1: the change of physical properties and antioxidant activities of the ethanolic cassava leaf extract without acidification after thermal processing

Properties	Heat treatment[1]		
	Control	75°C 1 min	95°C 5 min
pH	4.20±0.01[ac]	4.21±0.00[ab]	4.19±0.01[ad]
Color and color values			
L*	2.50±0.15[b]	1.83±0.09[c]	4.63±0.06[a]
a*	-0.61±0.07[b]	-0.39±0.03[a]	-0.87±0.01[c]
b*	-0.61±0.07[b]	-0.39±0.03[a]	-0.87±0.01[c]
ΔE*	-	0.25±0.08[c]	4.45±0.37[a]
TPC (mg GAE/ g sample)	33.00±0.15[b]	33.06±0.06[b]	35.45±0.18[a]
Antioxidant activities (µmol TE/ g sample)			
DPPH	0.116±0.003[a]	0.114±0.000[a]	0.115±0.003[a]
FRAP	123.84±3.07[c]	126.33±2.32[b]	141.11±1.68[a]
ORAC	740.99±33.36[a]	339.44±30.50[c]	412.83±12.30[b]

[1]Mean ± standard deviation of triplicates
[a,b,c]Means with different superscripts within the same row are significantly different ($p \leq 0.05$)

Physico-chemical parameters of cassava leave extract

The pH of ethanolic CLE solution was unchanged after the thermal process, regardless the thermal conditions. Without acidification, the aqueous CLE solution trended to reduce pH with no significance when processed at the higher temperature, while acidified aqueous CLE solution (pH 4.05) showed no change in pH during any thermal process.

Table 1 shows the results of the effect of acidification and thermal process on color values using L* a* b* system. Statistical analysis showed that L* (lightness), a* (redness) and b* (yellowness) parameter were affected by both acidification and thermal condition as shown in table 1.

For 0.1% ethanolic CLE solution, showed the increase of L* value redness (a*) and yellowness (b*) of the solution. ΔE, a value indicating the overall color difference. The increase of color parameters might be caused by the increased of solubility of the ethanol extract during the thermal process, which can be detected by visual observation.

Regarding table 2 and 3, the 0.1% aqueous CLE solutions, both with and without acidification, showed no significantly change of L* value when treated at 75 °C and 90 °C, however, the darkness was increased when aqueous CLE solution without acidification was treated at 121 °C, resulting in lower L* and a* value. The decrease in these color values (“L*” and “a*”) might be associated with degradation of phenol and phenolic compounds and losing anthocyanin pigments. (Avila & Silva, 1999; Ahmed et al., 2004; Nisha et al., 2009; Arribasplata & Elena, 2010). Due to the severe heating of sterilization at 121ºC, oxidation of phenolic compounds in the aqueous CLE solution occurred. This might result in the polymerization of quinone and hence the color of the solution was darkened. It should be noted that acidification to pH 4.0 led to the lighter color of aqueous CLE solution, suggesting the formation of brown pigment was retarded under acidic condition.

Table 2 the change of physical properties and antioxidant activities of the aqueous cassava leaf extract without acidification after thermal processing

Properties	Heat treatment[1]			
	Control	75°C 1 min	95°C 5 min	121°C 5 min
pH	6.05±0.07[a]	5.96±0.03[a]	5.94±0.02[a]	5.89±0.08[a]
Color and color values				
L*	5.05±0.59[a]	5.86±0.13[a]	5.92±0.40[a]	2.58±0.20[b]
a*	-0.89±0.12[ab]	-0.91±0.05[b]	-0.72±0.10[a]	-0.52±0.18[a]
b*	2.37±0.23[a]	2.06±0.10[a]	2.18±0.08[a]	1.49±0.11[b]
ΔE*	-	0.37±0.02[b]	0.41±0.02[b]	3.51±0.23[a]
TPC (mg GAE/ g sample)	10.62±1.28[b]	10.16±1.31[b]	14.89±0.76[a]	13.59±0.83[a]
Antioxidant activities (µmol TE/ g sample)				
DPPH	0.019±0.001[b]	0.017±0.002[b]	0.017±0.002[b]	0.026±0.003[a]
FRAP	80.35±7.10[a]	82.66±6.16[a]	80.88±7.53[a]	55.40±3.19[b]
ORAC	322.50±52.23[b]	322.71±71.28[b]	418.34±4.19[a]	295.63±118.19[ab]

[1]Mean ± standard deviation of triplicates

[a,b,c]Means with different superscripts within the same row are significantly different ($p \leq 0.05$)

Table 3 the change of physical properties and antioxidant activities of the aqueous cassava leaf extract with acidification after thermal processing

	Heat treatment[1]		
	Control	75°C 1 min	95°C 5 min
pH	4.05±0.00[b]	4.08±0.01[a]	4.07±0.00[a]
Color and color values			
L*	5.84±0.24[a]	5.58±0.30[a]	5.36±0.38[a]
a*	-1.08±0.03[b]	-0.96±0.06[ab]	-0.85±0.05[a]
b*	1.78±0.11[a]	1.71±0.18[a]	1.59±0.25[a]
ΔE*	-	0.04±0.02[b]	0.16±0.03[a]
TPC (mg GAE/ g sample)	11.71±0.61[b]	16.43±0.47[a]	16.97±0.37[a]
Antioxidant activities (µmol TE/ g sample)			
DPPH	0.019±0.003[a]	0.014±0.001[b]	0.019±0.002[a]
FRAP	85.49±7.58[a]	89.80±4.83[a]	89.31±3.78[a]
ORAC	365.30±36.70[a]	289.61±57.58[a]	391.09±28.54[a]

[1]Mean ± standard deviation of triplicates

[a,b]Means with different superscripts within the same row are significantly different ($p \leq 0.05$)

Bioactivities of cassava leave extract

According to the bioactivities of CLE, many previous studies had reported that cassava leaf was highlighted regarding functional health benefits based on the presence of various bioactive compounds. These compounds were identified as phenolics (coumarin, scopolin, aglycone scopoletin), flavonoids (kaempferol-3-O-rutinoside and rutin), tannin, vitamin C, saponins, steroids, and glycosides (Gómez-Vásquez, 2004; Bahekar & Kale, 2016). In our study, the stabilities of phenolics and antioxidants of CLE were investigated, regarding the effect of thermal processing and acidification.

Our results had showed that the TPCs of the aqueous ethanolic CLE without acidification were unchanged when pasteurizing at 75 °C, while the TPCs were slightly increased when treating with the higher thermal conditions of 95 °C (Table 1). The antioxidant activities as being measured by DPPH radical scavenging assay were found to be unchanged when treating aqueous ethanolic CLE with high temperature; however, the antioxidant activities by FRAP assay were significantly increased with elevated temperature. The antioxidant activities determined by ORAC assay were found to be decreased with increased temperature. Interestingly, aqueous ethanolic CLE underwent treatment with high temperature at 95 °C for 5 min exhibited higher antioxidant activity that the one treating with high temperature at 75 °C for 1 min. These results suggested that thermal treatment might be able to release more phenolics from phenolics complex. It was also possible that thermal treatment could form phenolics from non-phenolic compounds. These new-formed phenolics might act as antioxidants as being detected by FRAP assays, in which the antioxidant activities were increased with elevated temperature. However, ORAC assay suggested opposite results, which might be due to the difference in types of antioxidants. FRAP assay was performed based on single electron transfer (SET) mechanism, while ORAC assay was determined based on hydrogen atom transfer (HAT) mechanism. Thus, it is possible that the new-formed phenolics might be able to act as antioxidant by transferring single electron to any potential acceptors rather than hydrogen atom. Thermal treatment might also be able to degrade antioxidants under HAT mechanism. No change in antioxidant activities as being determined by DPPH radical scavenging assay suggested that this method might not be sensitive enough to detect any change in the antioxidant activity.

For aqueous CLE without acidification (Table 2), the increase in TPCs was observed after thermal treatment. The greater TPCs were detected when higher processing temperature was applied. Similar trend in antioxidant activities of aqueous ethanolic CLE was observed with aqueous CLE. Antioxidant activities were unchanged as being determined by DPPH radical scavenging assay. However, when applying commercial sterilization condition (121 °C for 5 min), the antioxidant activity was slightly increased, indicating the new-formed antioxidants as a result as thermal treatment. Likewise, antioxidant activities determined by FRAP assay were remained unchanged when applying high temperature at 75 °C for 1 min and 95 °C for 5 min. However, the decrease in antioxidant activity was observed under commercial sterilization condition, suggesting that high temperature of commercial sterilization might be able to degrade some antioxidants. As for ORAC assay, the antioxidant activity was remained unchanged at 75 °C for 1 min, increased at 95 °C for 5 min and decreased at 121 °C for 5 min. These results suggested that only appropriate temperature could promote antioxidants with HAT activity. Too high temperature could degrade antioxidants, while applying lower temperature was ineffective for CLE.

Acidification of aqueous CLE could improve TPCs during thermal process (Table 3). The increased TPCs were observed with elevated temperature. However, the antioxidant activity determined FRAP assay remained unchanged, suggesting that acidification and thermal treatment could not improve SET antioxidants and the new-formed phenolics as being detected by TPCs could not act as SET antioxidants. Interestingly, antioxidant activity detected by DPPH radical scavenging assay was slightly decreased when applying temperature of 75 °C for 1 min, but remained unchanged when applying temperature of 95 °C for 5 min. This could be a result of artifact from the DPPH radical scavenging experiments, since the detected antioxidant activities were very low. Besides, even though statistically insignificant antioxidant activities were observed in ORAC assay, high temperature at 95 °C for 5 min seemed to be able to slightly improve antioxidant activity. Nevertheless, all experiments suggested that acidification could not improve antioxidant activity of aqueous CLE; however, heat treatment could promote TPCs.

CONCLUSION

Effects of processing condition, i.e., thermal processing and acidification, on the physical properties and biological activities of both ethanolic and aqueous extracts of cassava leaves were investigated. Thermal processing resulted in changes in color values (L*, a*, b*) of 0.1% (w/v) of CLE solution both ethanolic and aqueous, among which the solutions pasteurized at 75°C for 1 minute was more similar to the unheated solution than the solution heated at 95°C for 5 minutes. Thermal processing slightly affected total phenolic content and antioxidant activities (DPPH and FRAP assay) while antioxidant activity determined by ORAC assay significantly decreased with the severity of thermal treatment ($p<0.05$). In conclusion, according to antioxidative activities, the ethanolic CLE using illustrated better health benefits. However, the bioactive compounds in ethanolic CLE were more heat-sensible as compare to aqueous CLE. Cassava leaf-extract potentially possess a good tendency for further investigation on antioxidant properties in human. Therefore, this information can be useful for the rational design of functional foods and beverages for nutrition purposes.

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POSTER SESSION

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EFFECT OF NATURAL COMBINATION OF SATURATION AND LIGHTNESS CONTRAST ON COLORFULNESS ADAPTATION

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Keywords: colorfulness adaptation, saturation, lightness contrast, naturalness

ABSTRACT

Our visual system can adapt to change in color environment. It has been shown that we can adapt to the colorfulness of images and the adaptation is stronger for natural images than for unnatural stimuli. When the luminance contrast of the image was increased (decreased) according to the increase (decrease) of saturation of the image, the image appeared more natural than when only saturation was changed. This perceived difference in naturalness may also affect colorfulness adaptation. In this research, we investigated whether the combination of saturation and lightness contrast in adaptation images influenced the colorfulness perception. In the experiment, three types of modulated images were used as adaptation stimuli: images which only their saturation changed, images which their saturation and lightness contrast changed naturally and unnaturally. Test stimulus for colorfulness judgment was an image which only its saturation was changed. Observers judged whether the test image appeared "natural" or "too colorful" after adapted to images with certain saturation level chosen from one of the adaptation stimuli groups. Our results showed that the border of "natural" and "too colorful" appearance became higher when observers adapted to higher saturation, and vice versa. This colorfulness adaptation was stronger when adapting to saturation-modulated stimuli and naturally modulated stimuli, and weaker when adapting to unnaturally modulated stimuli. We further made a direct evaluation of the naturalness of images to measure the subjective naturalness of adaptation images for each observer. The result showed that the evaluation of the naturalness was high for adaptation images which caused high adaptation effect. These results suggest that the effect of colorfulness adaptation to the images is affected by the naturalness of the images due to saturation and lightness contrast modulation.

INTRODUCTION

It has been shown that our visual system can adapt to various change in color environment. Studies on colorfulness adaptation are fewer than those related to hue and lightness, but they are important to understand the characteristics of human appearance. Mizokami et al. showed the effect of colorfulness adaptation by using natural and shuffled images consisting of a shuffled collage of randomized color blocks and revealed the effect was stronger for the natural images than for the shuffled images. It suggests that the naturalness of the spatial image structure affects the strength of the colorfulness adaptation effect [1]. However, they examined the condition that only the saturation of the images was modified. On the other hand, Nakano et al. showed that the image appeared more natural when the luminance contrast of the image was increased (decreased) according to the increase (decrease) of the saturation of the image than when only saturation was changed [2]. This perceived difference in naturalness due to the combination of saturation and luminance contrast may also affect colorfulness adaptation. In this research, we investigated whether the combination of saturation and lightness contrast in adaptation images influenced the colorfulness adaptation.

EXPERIMENT

1. Experimental environment

The experiment was conducted in a dark booth. In the booth, an LCD monitor and a chin rest were installed. An observer fixed the head with the chin rest and kept the viewing distance at 80 cm.

2. Stimuli

Three types of modulated images were used as adaptation stimuli: images which only their saturation changed ("Saturation-modulated stimuli"), images which their lightness contrast changed in proportion to the saturation ("Naturally modulated stimuli") and images which their lightness contrast changed in inverse proportion to the saturation ("Unnaturally modulated stimuli"). Each stimuli group included six images. Their lightness contrast was modulated by multiplying the modulation coefficient j to the contrast of L^*, and their saturation was modulated by multiplying the modulation coefficient k to the metric chroma $C^*{}_{ab}$ in the CIE1976$L^*a^*b^*$ color space. Figure 1 shows the example of adaptation stimuli based on the combination of modulation coefficients (j_a, k_a). Test stimulus for colorfulness judgment was an image which only its saturation was changed, and it was not included in adaptation stimuli. Figure 2 shows the example of test stimuli and their saturation modulation coefficients k_b and the average metric chroma $C^*{}_{ab}$ of each image.

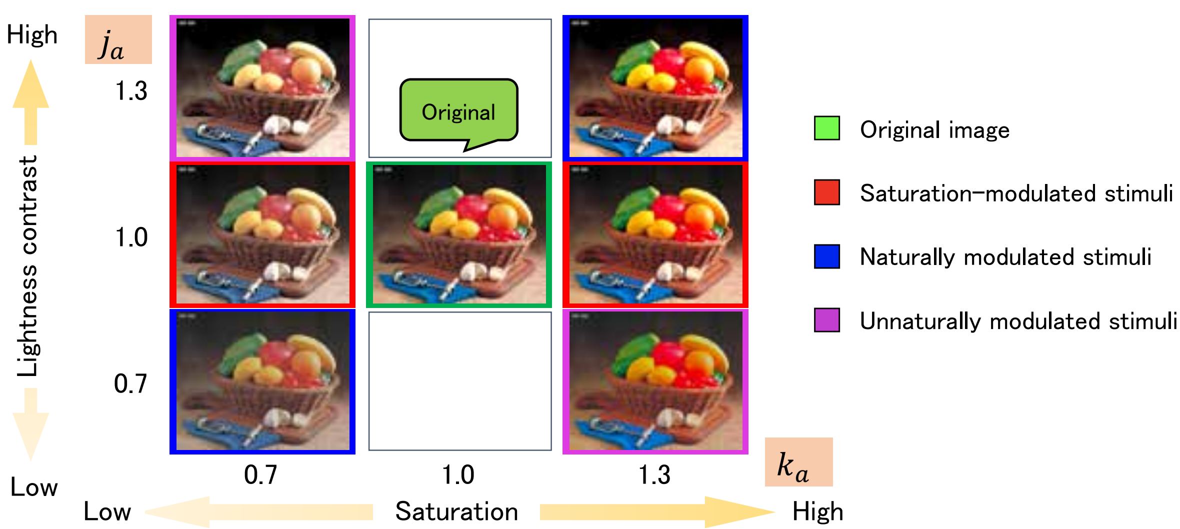

Figure 1. Example of adaptation stimuli

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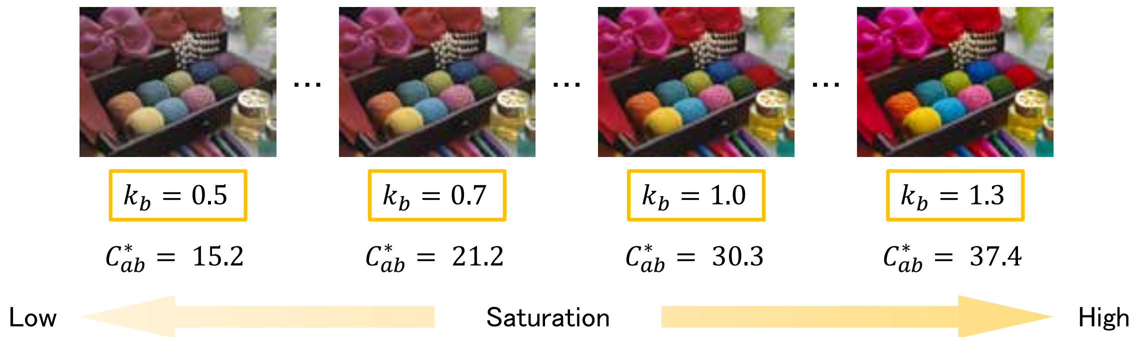

Figure 2. Example of test stimuli

3. Procedure

The experiment was conducted by the method of constant stimuli. After dark adaptation for 3 minutes, six images with certain saturation level chosen from one of the adaptation stimuli groups were randomly presented at different positions on the monitor every 2 seconds and observers adapted to them for 2 minutes. After that, a test image was presented for 3 seconds and observers judged whether the test image appeared “natural” or “too colorful”. After the judgment, observers re-adapted to the same adaptation stimuli for 10 seconds. In this way, all the test stimuli were randomly presented five times. We continued this procedure during one session and conducted three sessions at each adaptation stimuli group. Five observers with normal color vision participated.

RESULT

The modulation coefficient k_b when the probability that the observer responded test stimuli "too colorful" was 50% was obtained by the probit analysis and set as the threshold k_t. Figure 3 shows the relationship between the saturation modulation coefficient of adaptation stimuli k_a and the threshold k_t of test stimuli for each observer. Linear fitting lines in Figure 3 show a linear approximation to the result of each modulation condition and that of the original image by the least squares method. It was shown that the perception of colorfulness was influenced by the adapted saturation of images. When observers adapted to higher saturation, the border of “natural” and "too colorful" appearance became higher and vice versa. The effect of colorfulness adaptation was confirmed in all conditions. The effect was stronger when adapting to saturation-modulated stimuli and naturally modulated stimuli, and weaker when adapting unnaturally modulated stimuli.

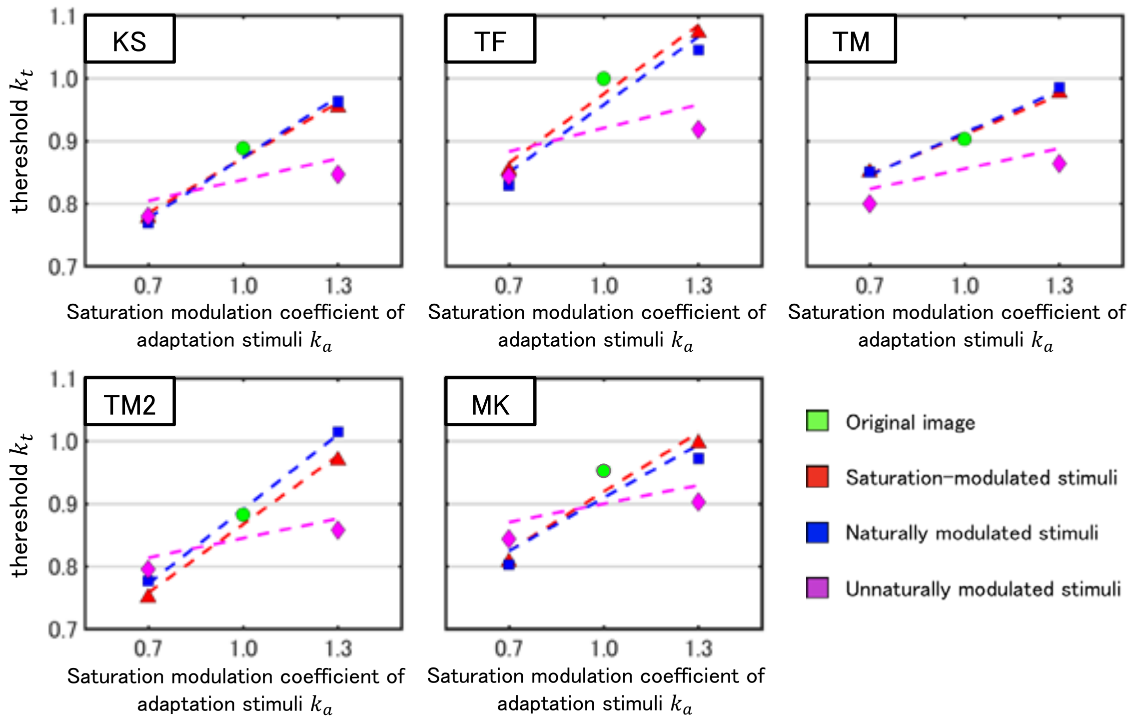

Figure 3. Relationship between the saturation modulation coefficient of adaptation stimuli k_a and the threshold k_t of test stimuli for each observer.

DISCUSSION

Our results suggested the possibility that the naturalness of the adaptation stimuli affected colorfulness adaptation. Therefore, we further made a direct evaluation of the naturalness of images to measure the subjective naturalness of adaptation images for each observer. Observers evaluated the naturalness of all adaptation stimuli by scores, from 1 (most unnatural) to 6 (most natural). Figure 4 shows the relationship between the naturalness of all adaptation stimuli and the threshold k_t of test stimuli in the adaptation experiment for each observer. Each symbol shows each observer and error bar shows the standard deviation. In the low saturation condition ($k_a = 0.7$), the relationship between the threshold k_t and the score of naturalness at any types of adaptation stimuli are not so clear, but it showed moderate negative correlation (the correlation coefficient R = -0.48). In the high saturation condition ($k_a = 1.3$), the threshold k_t in the "Unnaturally modulated stimuli" condition tended to be low, and in this measurement, the score of naturalness was also low. The correlation coefficient between the score of naturalness and the threshold k_t in this condition was relatively high (R = 0.61). These results suggest that the naturalness of subjective evaluation and the effect of saturation adaptation has a relationship. In other words, the result showed that images in saturation-modulated stimuli group and naturally modulated stimuli group obtained high naturalness, but images in unnaturally modulated stimuli group obtained low naturalness in general. Moreover, there is a rough trend that the stimuli were more natural, the adaptation effect was stronger. This trend was consistent with previous research [1].

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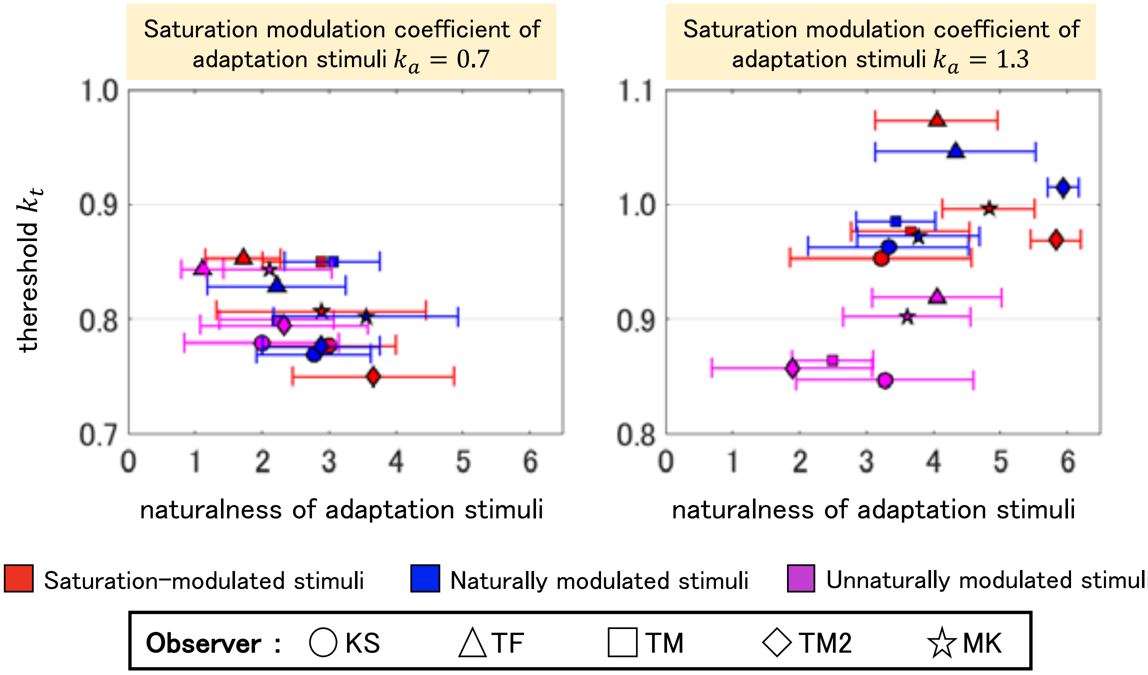

Figure 4. Relationship between the naturalness of all adaptation stimuli and the threshold k_t of test stimuli of each observer.

CONCLUSION

Our results showed that the effect of colorfulness adaptation was influenced by the combination of the saturation and lightness in images. When observers adapted to images with higher saturation, the border of "natural" and "too colorful" appearance became higher and vice versa. This colorfulness adaptation effect was stronger when adapting to stimuli with only saturation modulation and those with both saturation and lightness contrast modulation, and weaker when adapting to stimuli with the unnatural combination of saturation and lightness contrast modulation. The direct evaluation of the naturalness of images showed high naturalness for images in saturation-modulated stimuli group and naturally modulated stimuli, but low naturalness for images in unnaturally modulated stimuli group in general. This trend was consistent with the result of the adaptation experiment. Therefore, it was suggested that the effect of colorfulness adaptation in images is affected by the naturalness of the images due to saturation and lightness contrast modulation.

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EFFECT OF GLOSS ON COLOR CONSTANCY FOR FAMILIAR OBJECTS

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Keywords: Color vision, Color constancy, Psychophysics

ABSTRACT

It has been suggested that the specular reflection occurring on the glossy surface of an object would contribute to color constancy. On the other hand, there are also researches that show no correlation between specular reflection and color constancy, and the influence of specular reflection on color constancy is unclear. This contradiction would be due to a difference in stimuli. For example, uniform stimuli on a conventional black background are difficult to recognize as illuminated objects. In this study, we examine the effect of the surface and specular reflection of objects on color constancy using vegetables as familiar objects in real space. Observers evaluated stimuli with different glossiness under white and reddish color illumination, and we compared those color appearances. As a result, in the real space, the presence or absence of specular reflection did not affect color constancy, but under the limited view condition, color constancy was a little bit better for the glossy surface than the matte surface. These results suggest that the specular reflection slightly contributes to color constancy under limited conditions.

INTRODUCTION

The appearance of the color of an object under chromatic illumination is close to that under white illumination. This phenomenon is called color constancy. It has been suggested that the specular component would contribute to color constancy since it reflects the color of an illuminant. Yang et al. [1] showed that the specular highlight improved color constancy using CG images. However, other researches did not show such an effect, and it is not clear whether the specular highlight contributes to color constancy, yet [1]-[4]. Mizokami et al. [4] investigated the effect of specular reflection on color constancy in real space using wavy-surface samples with different glossiness levels. As a result, there was no correlation between specular reflection and color constancy. However, it has been suggested that the shape of the color sample contributes to color constancy. Uniform stimulus like color charts commonly used in experiments is not often seen in everyday life. Its appearance may be in an aperture color mode under a particular viewing condition, and the effect of gloss on their appearance could be different from that for natural and familiar objects [5]. In this study, we examine whether the surface glossiness of an object influence to color constancy in the case of familiar objects which are often seen in everyday life.

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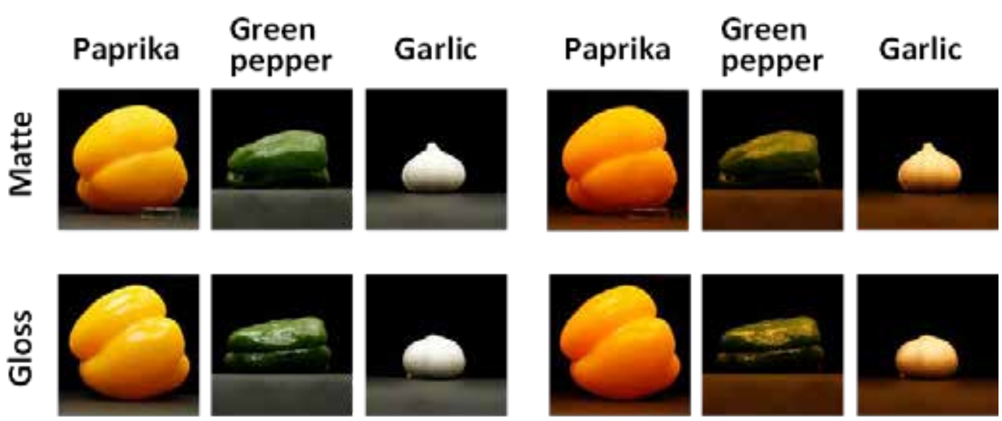
EXPERIMENT

We built a booth arranged like a normal room illuminated either whitish or reddish by lamps with correlated color temperature 5000 K and 2700 K, respectively. We used three types of familiar vegetables as stimuli. They had surface with two gloss types: a gloss and a matte surface. The matte surface was created by coating a matte spray. Figure 1 shows the stimuli used in the experiment. Fig. 1 (a) shows the stimuli placed under the 5000 K lamps and (b) shows the stimuli placed under the 2700 K lamps. An elementary color naming method was used for evaluation. This method is based on the Natural Color System (NCS). Observers responded color with whiteness (W), blackness (S), and chromaticness (C) by adding up to 10. If the C is not 0, they also responded C with the ratio of "red (r) or green (g)" and "yellow (y) or blue (b)" components. Normal view and limited view conditions were tested. In the limited view condition, observers viewed a stimulus only through a tube. They observed with both eyes in both conditions. The procedure was as follows. An observer adapted to the light of the experimental booth for 3 minutes (or dark adapted for 3 minutes in the limited view condition), then he or she responded the color appearance of the stimuli presented in a random order. After that, the light source was changed, and observers repeated the same procedure.



(a) 5000 K **(b) 2700 K**

Figure 1. Stimuli under 5000 K and 2700 K lamps

RESULT

Figure 2 shows a response to a gloss surface in normal view condition under 5000 K which was expected to have the best color constancy performance, and each response under 2700 K averaged among observers. The horizontal axis shows the r-g component and the vertical axis shows the y-b component. Black circle shows a gloss surface in normal view condition under 5000 K. Red stripe, red filled, blue stripe, and blue filled square symbol shows the result for a gloss surface in the normal view condition (Nor_gloss), a matte object in the normal view condition (Nor_matte), a gloss object in the limited view condition (Lim_gloss), and a matte object in the limited view condition (Lim_matte) under 2700 K, respectively. Pictures near each plot in the graph show the stimulus vegetables. Error bars show standard deviation (SD). In all stimuli, Nor_gloss and Nor_matte under 2700 K lamps are close to Nor_gloss under 5000 K lamps. On the other hand, Lim_gloss and Lim_matte under 2700 K lamps are far from Nor_gloss under 5000 K lamps, compared to Nor_gloss and Nor_matte, and the response shifts in the y and r direction. In limited view condition, comparing a gloss and a matte surface, a gloss surface is slightly closer to Lim_gloss under 5000 K. These hue trends were similarly seen in all stimuli. Although the results of other conditions under 5000K were not shown in the graph, there is not much difference from that of Nor_gloss under 5000 K lamps.

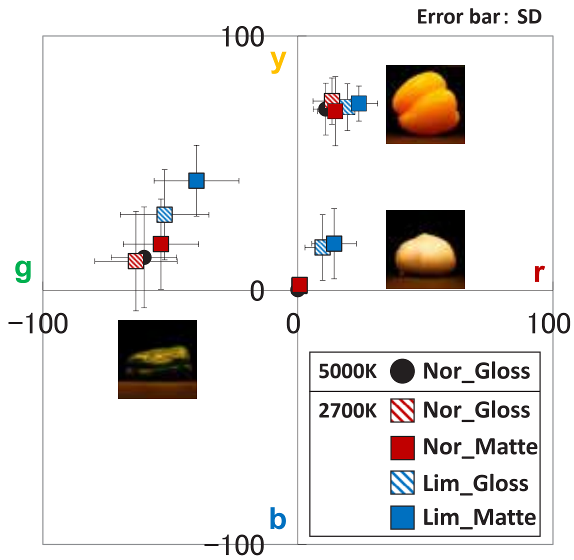


Figure 2. Observer's response of color appearance

A three-dimensional space consists of W – S, r - g, and y - b axes was defined as an elementary color space. This space was obtained by adding the W - S axis to the above hue plane. We calculated the strength of color constancy by taking a shift of color response for each condition (Nor_Gloss, Nor_Matte, Lim_Gloss or Lim_Matte) under 2700 K lamps from that for Nor_Gloss under 5000 K lamps which was expected to have the best color constancy performance. Thus, color constancy is stronger in this color space as the response shifts of each condition from Nor_Gloss under 5000 K lamps are smaller. Figure 3 shows the response shift showing the intensity of color constancy under each condition. The horizontal axis shows the stimulus; the vertical axis shows the intensity of color constancy. The color of bars shows the combination of viewing conditions and gloss conditions, and error bars show SD. Comparing the normal view condition and the limited view condition, we can see that color constancy is higher in normal observation. In the normal view condition, color constancy is stronger for the gloss surface than the matte surface. This trend is clearer in the limited view condition. There was a significant difference between matte and gloss under the limited view condition when the Bonferroni multiple comparison test was carried out.

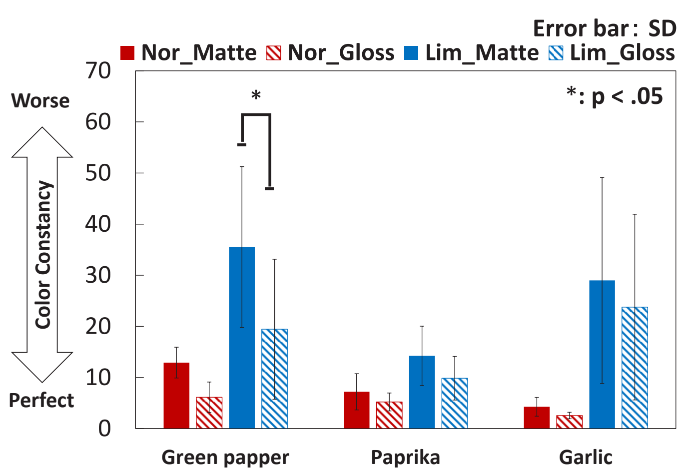
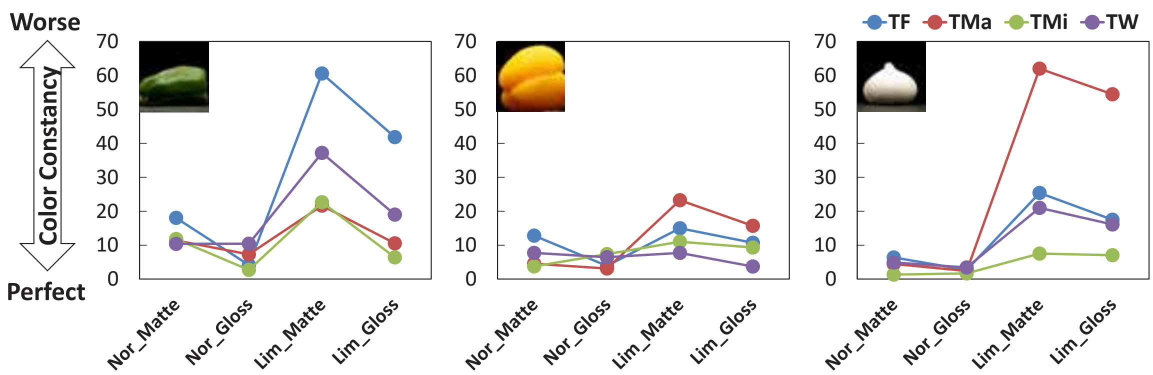


Figure 3. Strength of color constancy (Distance in elementary color space)

Next, the strength of color constancy for each observer is shown in Figure 4. The horizontal axis shows the condition, the vertical axis shows the strength of color constancy, and the color of the plot shows the observers. In the limited view condition, the color constancy for gloss surface is stronger than matte. This trend was similar in all vegetables. In the normal view condition, the color constancy of both the matte and the gloss surface is high, and there was little consistent tendency among observers that color constancy for gloss was higher than for matte.

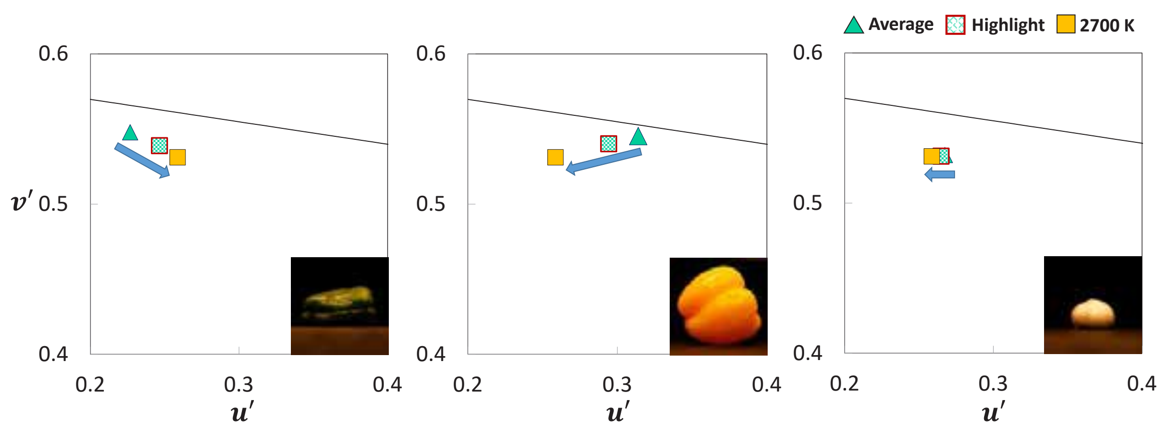


(a). Green paper (b). Paprika (c). Garlic

Figure 4. Strength of color constancy

DISCUSSION

The color constancy for each stimulus worked stronger in the normal view condition than in the limited view condition. This is thought to be due to the strong influence of the information of the surrounding environment. In the limited view condition, the performance of color constancy was higher in the gloss surface than the matte surface. This result would be because the matte stimulus did not exhibit specular highlights, whereas gloss stimulus included specular highlights.



(a). Green paper (b). Paprika (c). Garlic

Figure 5. $u'v'$ chromaticity distribution under 2700 K lamps

Figure.5 shows the $u'v'$ chromaticity distribution of the gloss stimulus under 2700 K lamps. For the measurement, we used a two-dimensional color luminance meter CA-2000 manufactured by KONICA MINOLTA. The blue triangle shows the average chromaticity of the matte stimulus; the blue square shows the chromaticity of the specular highlight portion; the orange square shows the chromaticity of 2700 K lamps. The chromaticity of the specular highlight portion is close to the chromaticity of 2700 K lamps. It is thought that the observer corrected the object color by estimating the illumination color from the chromaticity of this specular highlight. Therefore, the color constancy for gloss is considered to be higher than for matte. If this hypothesis is true, the performance of color constancy must change depending on how much the chromaticity of the specular highlight reflects the chromaticity of the light source. In order to confirm this, we defined *the light source chromaticity reflection rate* (*reflection rate*) that shows how much the specular highlight reflects the chromaticity of the light source and *the color constancy improvement rate* (*improvement rate*) that shows how much the color constancy of gloss has improved compared to matte by the following formula Eq. (1) and Eq. (2), and examined the correlation between the two.

$$Reflection\ rate = \frac{\|Average\ chromaticity - Specular\ reflection\ chromaticity\|}{\|Average\ chromaticity - Light\ source\ chromaticity\|} \quad (1)$$

$$Improvement\ rate = 1 - \frac{Response\ shifts\ of\ gloss}{Response\ shifts\ of\ matte} \quad (2)$$

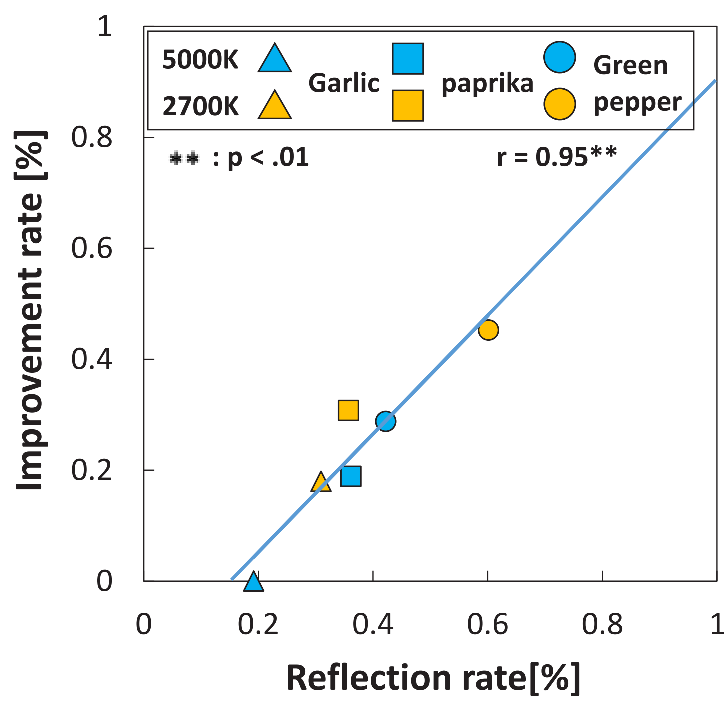


Figure 6. Correlation between *Reflection rate* and *Improvement rate*

Figure 6 shows the correlation between *Reflection rate* and *Improvement rate*. The horizontal axis shows the chromaticity reflection rate, and the vertical axis shows the color constancy improvement rate. Blue and orange symbols show the colors of light sources (5000 K or 2700 K); Triangle, square and circle symbols show garlic, paprika, and green pepper, respectively. As *Reflection rate* increased, *Improvement rate* tends to increase. We calculated Pearson's correlation coefficient was calculated, which was strongly correlated with r = 0.95 and was significant (uncorrelated test of Pearson's correlation coefficient). Therefore, from this result, it is suggested that the color appearance of objects may be corrected by estimating the illumination color using the chromaticity of the specular highlight.

CONCLUSION

The color constancy was stronger in the normal view condition than the limited view condition. In the limited view condition, color constancy was slightly better for surfaces with specular highlights than for objects without specular highlights. These results suggest that surface gloss causing specular reflection could affect color constancy for familiar objects under limited conditions in real space.

ACKNOWLEDGEMENT

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COMPARISON OF TRICHROMATIC AND MULTISPECTRAL SIMULATION MODLS FOR ANOMALOUS TRICHROMATS

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Keywords: Anomalous trichromat, Multispectral image, Simulation of color vision deficiency

ABSTRACT

Conventional color simulations for color deficiency are based on a tristimulus model using chromaticity values in a three-dimensional color space. However, they have limitations on color reproduction since the spectral information of scenes and the spectral sensitivity of people with color deficiency are not taken into consideration. Yaguchi et al. simulated the color appearance of color deficiency using multispectral information and a multispectral model of shifted cone spectral sensitivity, and verified the accuracy of the simulation. However, verification and a comparison with the tristimulus model using the images of daily sceneries have not been performed. In this research, we aim to visualize the simulation of the appearance for the color deficiency by acquiring spectral information of everyday scenes, to further verify the accuracy of simulation and to compare the models. Multispectral information was acquired using a multispectral camera. Subjects were plants, vegetables as natural objects, maps as everyday scenery, and Ishihara test chart as those used for a color vision test. Multispectral information obtained based on the acquired images. We conducted a simulation based on the acquired radiance data. In the multispectral model, the simulation images of color deficiency based on the spectral sensitivity shifts were prepared. In the tristimulus model, a simulation image was created by a modified Brettel's model and changing the proportion of the cone responses of anomalous trichromats in an LMS color space. The chromaticity data of simulation images calculated by each model were plotted and compared on the xy chromaticity diagram. From the results, a small difference was found between the simulations of two models, implying that the accuracy of simulation using both the tristimulus model and the multispectral model are comparable for a certain extent in everyday scenes.

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INTRODUCTION

People can perceive various colors, but their color perception can vary depending on color vision characteristics. Therefore, it is important to clarify the color appearance of color vision deficiency, which seems to be different from normal trichromats. It is known that the degree of color vision deficiency is greatly different among individuals. In particular, it is considered that the difference in the degree of anomalous trichromats is mainly due to the shift width of a cone spectral sensitivity [1].

Conventional color simulations for color deficiency are based on a tristimulus model using chromaticity values in a three-dimensional color space and RGB images [2]. However, they have limitations on color reproduction since the spectral information of scenes and the spectral sensitivity of people with color deficiency are not taken into consideration. In this case, metameric colors with the same tristimulus value but different multispectral information give the same simulation result.

Therefore, a model [3] assuming that the shift of cone spectral sensitivity of L and M cone causes anomalous trichromats was proposed. This model should enable multispectral analysis and allow to analyze of color vision characteristics more accurately. In this model, the shift of L cone sensitivity is classified as protanomalous, the shift of M cone sensitivity as deuteranomalous, and we assumed that difference in the shift width of cone spectral sensitivity causes the difference in the degree of anomalous trichromat. Considering the spectral characteristics, the simulation results may differ for metameric colors. Multispectral information can be acquired using a multispectral camera. Although RGB image represented by three bands, a multispectral camera can acquire the enormous number of spectral data.

Yaguchi et al. [4] simulated the color appearance of color deficiency using multispectral information and the multispectral model of shifted cone spectral sensitivity, and verified the accuracy of the simulation. However, a verification and a comparison with the tristimulus model using the various images of daily sceneries have not been performed. In this research, we aim to visualize the simulation of the appearance for color deficiency by acquiring the spectral information of everyday scenes, to further verify the accuracy of simulation and to compare the models.

METHODS

Simulation model

In this study, we compare the color simulations of color deficiency based on a conventional tristimulus model using a three-dimensional color space and based on the multispectral model using multispectral information, and verified the accuracy of the simulation.

First, we describe a tristimulus model. Brettel's model is known to reproduce the appearance of color deficiency. In Brettel's model, they assumed that dichromats confuse colors on the confusion color locus, and predict the color appearance of dichromats. In the prediction, colors on a confusion color locus are projected on a plane composed of wavelengths which the color appearance of dichromats and normal trichromats were the same. In this research, we used a model with additional processing to Brettel's model [5]. Dichromat means that one types of cones is completely missing, but anomalous trichromat does not. For that reason, they assumed that the color appearance of anomalous trichromats were simulated by reproducing the intermediate color appearance between a color normal trichromat and dichromat and the strength of anomalous trichromat corresponds to their proportion on the LMS color space. The proportion was defined by the modulation coefficient k. The values of the modulation coefficient k were 0.0, 0.2, 0.4, 0.6, 0.8 and 1.0. As the modulation coefficient k is closer to 0.0, color appearance approaches that of dichromats, and as it is closer to 1.0, color appearance approaches that of normal trichromats.

Next, we describe a spectral model. Anomalous trichromats have three kinds of cones, but the spectral sensitivity of one cone deviates. The shift of L cone spectral sensitivity is classified as protanomalous, and the shift of M cone spectral sensitivity is classified as deuteranomalous. Therefore, Yaguchi et al. assumed that the color deficiency is caused because the peak wavelength of the spectral sensitivity of either L cone or M cone approaches the peak wavelength of the other cone. In this model, we consider that the difference in the degree of color deficiency is due to the amount of the L or M cone spectral sensitivity shift [1], and predict the color appearance of anomalous trichromats by shifting the cone spectral sensitivity. First, the LMS cone stimulus value was obtained by taking the spectral transmittance of the macular pigment and the crystalline lens into account with the shifted LMS cone spectral sensitivity [6]. The calculated cone stimulus value was converted to luminance and opponent color stimulus value, and an image with the different degree of color deficiency was prepared by using those sensitivity data and the multispectral information of a scenery. The degree of color deficiency varied with the shift width, and the greater the width, the stronger the color deficiency. The wave number was used as a parameter so that the shift width was equally spaced. The shift width was set to 100 cm^{-1}, 300 cm^{-1}, 500 cm^{-1}, 700 cm^{-1}. The shift width was 1000 cm^{-1} when the peak wavelengths of two cones were perfectly overlapped.

Multispectral information

To perform simulation using a spectral model, multispectral information of scenery is required. Therefore, multispectral images were taken using a hyperspectral camera (Eba Japan NH-7), and multispectral information was acquired from those images. Subjects were plants, vegetables as natural objects, maps as everyday scenery, and Ishihara test chart as those used for a color vision test. A photographing environment was indoor under a D65 simulation light source for the vegetables and the Ishihara chart, and outdoor under sunny blue skies for others. Multispectral information obtained based on the acquired spectral image data and the spectral data of a white calibration plate under each photographing environment. We conducted a simulation based on the acquired radiance data. Images reproduced from the obtained multispectral information are shown in Figure 1.

(a) Flower 1 (b) Flower 2 (c) Map (d) Vegetables (e) Ishihara test chart

Figure 1. Simulation images using multispectral information

RESULTS

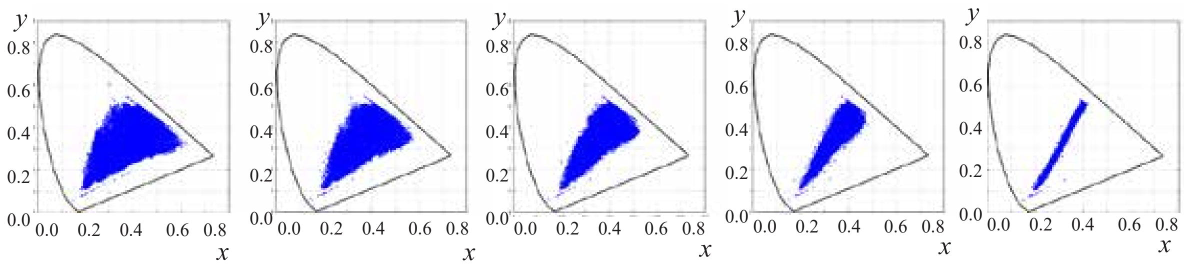
Figure 2 and 3 show the simulation images of deuteranomalous created by each of the models using the image of Flower 2. Figure 4 and 5 show the chromaticity data of each simulation image of Flower 2 plotted on the xy chromaticity diagram. From Figure 4 and 5, whichever model was used, it turned out that the chromaticity distribution similarly converged to a straight line (convergence line) connecting yellow and blue as the degree of color deficiency in simulation image became stronger. This tendency is consistent with the results in the verification experiment of the accuracy of the simulation performed by Yaguchi et al. [4]. This suggests that the simulation can be correctly performed even by using daily landscape images. However, there was a difference in the degree of color modulation between the simulation images of each model. For example, the results of the multispectral model have more greenish components than the those of tristimulus model. This is because the degree of convergence of the chromaticity distribution and the slope of the convergence line are different in each model. The same tendency was shown in the simulation of protanomalous in other images.

(a) 100 cm^{-1} (b) 300 cm^{-1} (c) 500 cm^{-1} (d) 700 cm^{-1} (e) 1000 cm^{-1}

Figure 2. Simulation images of deuteranomalous using spectral model

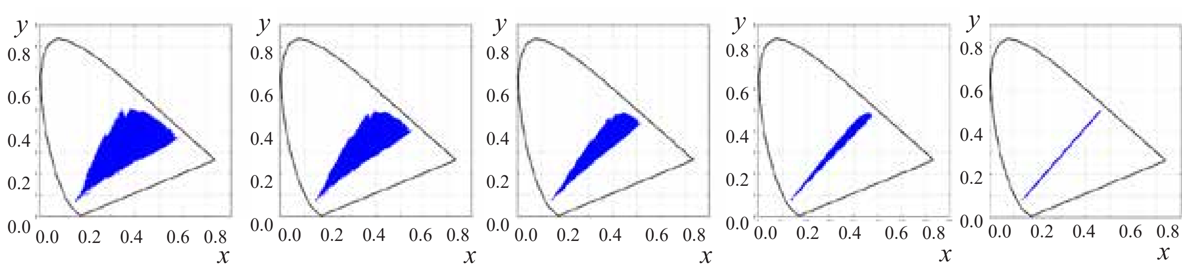
(a) $k = 0.8$ (b) $k = 0.6$ (c) $k = 0.4$ (d) $k = 0.2$ (e) $k = 0.0$

Figure 3. Simulation images deuteranomalous using tristimulus model



(a) 100 cm $^{-1}$ (b) 300 cm $^{-1}$ (c) 500 cm $^{-1}$ (d) 700 cm $^{-1}$ (e) 1000 cm $^{-1}$

Figure 4. Chromaticity diagram of simulation images using spectral model



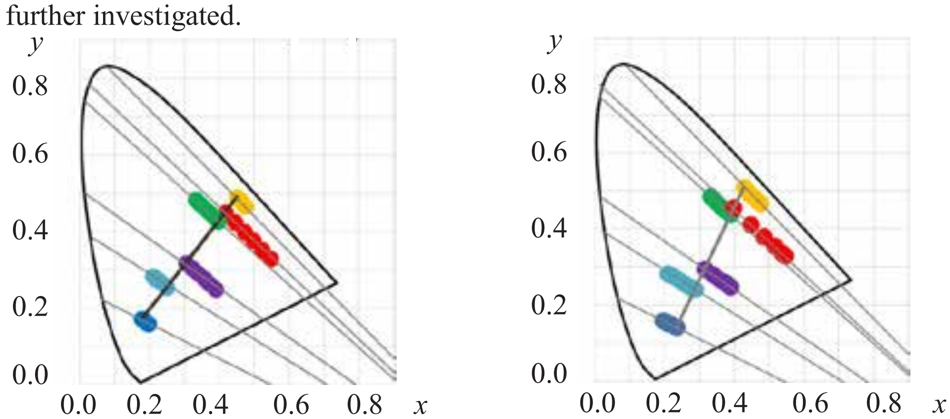
(a) $k = 0.8$ (b) $k = 0.6$ (c) $k = 0.4$ (d) $k = 0.2$ (e) $k = 0.0$

Figure 5. Chromaticity diagram of simulation images using tristimulus model

DISCUSSION

The difference in the color of the simulation result among both models would be caused by the different slope of the convergence line where the chromaticity distribution converges. Therefore, we tested simulation using six colors (blue, green, red, yellow, magenta, and cyan) from Xritecolor checker as monochrome stimuli and compared the difference in convergence lines between models. Figure 6 shows the chromaticity data of the simulation of deutranomalus for each monochrome stimulus plotted on the xy chromaticity diagram. Here, a straight line connecting the simulation of the color appearance of dichromat was considered as a convergence line. As a result, the convergence line of deuteranomalous were $y = 1.1729\,x - 0.036$ in the tristimulus model and $y = 1.9079\,x - 0.3026$ in the spectral model, and the gradient was slightly steeper in the spectral model. The shifts of colors from normal color vision toward stronger color deficiency in both models are approximately along the confusion lines of deuteranope, suggesting the simulation for weaker color deficiency is similar in both models. However, the differences in the simulations of both models become larger as the degree of color deficiency becomes stronger. It should be verified by psychophysical experiments which model's simulation is more accurate.

Furthermore, although the modulation steps were set at equal intervals in each model, the degree of convergence of the chromaticity distribution was different. The simulation results of each model using six monochromatic stimuli show that the tristimulus model converge toward the convergence line with an almost constant color difference. On the other hand, in the spectral model, green, red, and magenta tend to have larger color differences in the xy chromaticity diagram as the degree of color deficiency becomes stronger (or closer to the convergence line), and blue, yellow and cyan do not show the same tendency. This is because the tristimulus model is a linear modulation using modulation coefficients, whereas the spectral model is a nonlinear modulation using wavenumber as the modulation parameter. The relationship of the degree of color deficiency between two models should be further investigated.



(a) tristimulus model **(b) spectral model**

Figure 6. Chromaticity diagram of the simulation of each monochrome stimulus

CONCLUSION

The purpose of this research is to compare the conventional tristimulus model of color deficiency using a three-dimensional color space with a spectral model using multispectral information and to verify the accuracy of the spectral model further. The simulation was carried out using multispectral information acquired by photographing everyday scenes with a hyperspectral camera, and the results between two models were compared. The results show that the chromaticity distribution similarly converged for the simulation images with stronger color deficiency in either model. This suggests that the simulation can be performed correctly by using two models in most of the daily scenes. However, it should be noted that the difference in the slope of the convergence line and spacing of color shift between models may affect simulation results spatially for strong color deficiency. It would be necessary to verify which model's simulation is more accurate by psychophysical experiments.

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VISIBILITY AS A FUNCTION OF SPATIAL FREQUENCY OF A GABOR PATCH AND THE SURROUND LIGHT'S INTENSITY FOR HAZE ESTIMATION OF CATARACT CRYSTALLINE LENS

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Keywords: cataract, haze factor, visibility

ABSTRACT

As a cataract progresses, the crystalline lens becomes hazier, resulting in poor vision. Although cataracts are the most common age-related eye disease, individual variation is too large to estimate the severity from age. To provide a better visual environment, a quantitative evaluation technique for cataracts is necessary. Several methods of cataract assessment have been proposed on the assumption that the haze factor of a crystalline lens increases as the cataract progresses. In the present report, to develop a fast and simplified method of haze estimation, the relationship between the lens haze factor and visibility change caused by a bright surrounding was analyzed. Young participants wearing a filter with known haze factor viewed a Gabor patch surrounded by an annulus with several luminance levels. The participants compared a test stimulus to a reference and reported the visibility for the test relative to the reference. The experimental result showed that the visibility was impaired by the surrounding luminance due to the scattered light by the haze filter. Furthermore, the rate of deterioration was higher with hazier filters. Using the obtained relationship, a novel method for estimating the haze factor of the cataractous crystalline lens is proposed.

INTRODUCTION

Cataracts are one of the most typical age-related eye diseases. Almost every elderly person more than 80 years old suffers from them. As a cataract progresses, the crystalline lens becomes hazier. Such a hazier lens causes light scattering within the eye, resulting in deterioration in spatial resolution and/or color discriminability. As the number of elderly people and cataract patients increases, it is more important to assess cataract progress and provide the appropriate visual environment accordingly. Because the individual variation is too large to estimate the severity from age, quantitative evaluation techniques for cataracts have been needed.

Several simplified methods of cataract assessment have been proposed on the assumption that the haze factor of a crystalline lens increases as the cataract progresses [1]-[6]. For example, Shinoda et al. estimated the haze factor by the deterioration rate in visual acuity caused by the intraocular scattering [2], while Muramoto et al. reported another method based on color appearance changes caused by surrounding color [6].

In this report, to develop a fast and simplified method of haze estimation, the relationship between the lens' haze factor and spatial resolution change caused by bright surroundings was analyzed. In the experiments, young participants wearing a filter with a known haze factor (pseudocataract observers) evaluated the visibility of a Gabor patch with surroundings of various luminance levels.

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Participants compared a reference stimulus and a test successively, and they verbally reported the visibility for the test stimulus relative to the reference (magnitude estimation, ME).

EXPERIMENTAL METHOD

The experiment was conducted in a dark booth. A personal computer (Apple MacBook Pro 13-in) was used to control the experiment and generate stimuli. The experimental program was written using MATLAB R2016a and the Psychophysics Toolbox extensions [7]-[9]. The stimulus, composed of a Gabor patch and surroundings of various luminance levels, was presented on a 17-in CRT monitor (Mitsubishi Diamondtron M2 RDF173H). The Gabor patch was a sinusoidal grating in a Gaussian envelope (SD = 0.66 deg). The size of the surroundings was 13.2 deg × 10.6 deg in width and height.

Figure 1 shows the reference stimulus (a) with its luminance profile (b) and an example of the test stimulus (c) with its luminance profile (d). The vertical axes in Figure 1b and Figure 1d represent relative luminance; the value “1” corresponds to 89.5 cd/m2, the maximum luminance on the CRT monitor. The relative luminance of the reference surroundings was fixed at 0.1, and the spatial frequency of the Gabor patch was fixed at 1.72 c/deg. The relative luminance of the test surround was one of the following: 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, or 0.9. The spatial frequency of the test Gabor was one of the following: 1.72, 2.41, 3.45, 4.83, or 6.90 c/deg. The average luminance of the Gabor patch was 0.25 and the contrast was 0.5 in all the stimuli. These conditions were determined by preliminary experiments where the resolution threshold, i.e., the highest spatial frequency, was measured by the adjustment method for the Gabor patch with various contrasts and various average luminance levels.

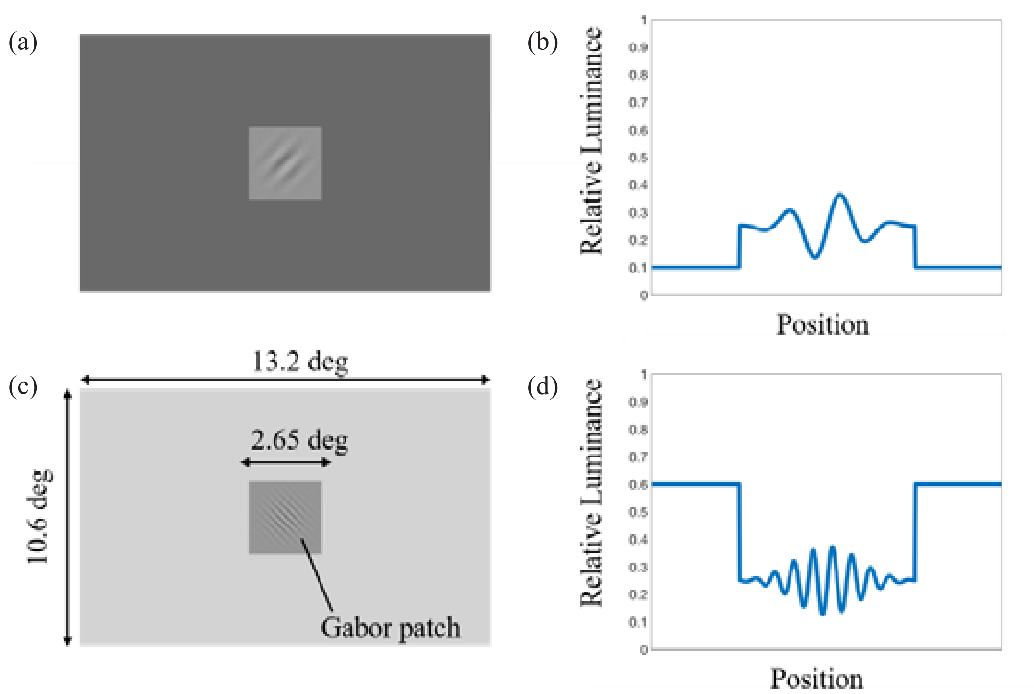

Figure 1. Reference stimulus (a) with its luminance profile (b), and an example of the test stimulus (c) with its luminance profile (d).

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Participants in their early twenties wore glasses consisting of haze filters (pseudocataract observers). Four levels of cataract were simulated by filters with the haze factors of 0, 7.4, 11.6, and 16.8% measured by a haze meter (NIPPON DENSYOKU NDH4000). In the experiment, a participant sat comfortably on a chair at a distance of 130 cm from the CRT monitor and viewed the stimuli monocularly. Each trial began with the presentation of a blank frame. After a key press by the participant, the reference and the test stimuli were presented successively (see Figure 2). The durations of both the reference and the test stimuli were 1 s.

Nine participants took part in the experiment (22-24 years of age, 6 men and 2 women). They had normal or corrected-to-normal vision. The task of the participants was to rate the visibility for the test Gabor patch by the ME method. The participants were instructed to assign a numerical value according to the relative visibility for the test compared with the reference: a value of 100 meant that the test's visibility was equal to that for the reference. An experimental session was composed of trials for a single haze factor. In each trial, the luminance level of the test surroundings and the spatial frequency of the test Gabor patch were randomly selected. There were 180 conditions: four haze factors × nine luminance levels × five spatial frequencies. Each participant conducted 900 trials in total, five trials for each condition. Before the experiment, all participants practiced the task.

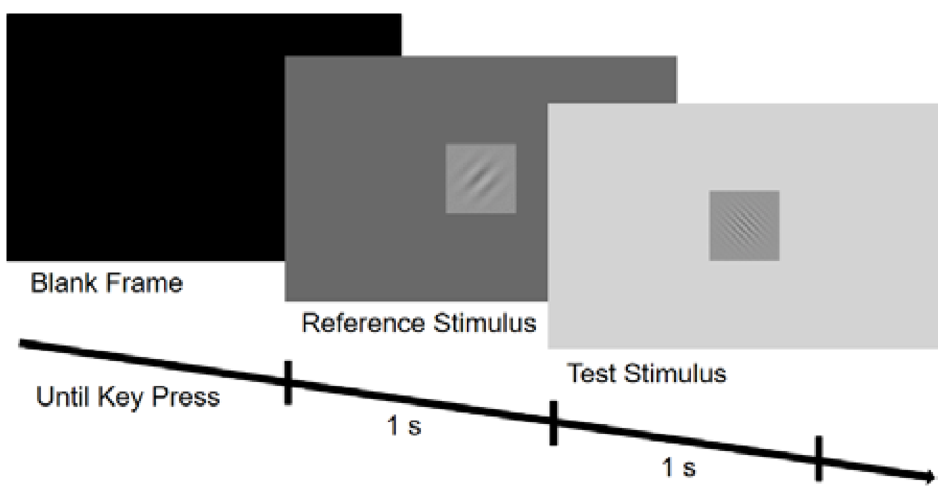

Figure 2. Experimental procedure.

RESULTS AND DISCUSSION

The mean ME values obtained from nine participants are shown in Figure 3. The charts are arranged by the filter's haze factor. The mean ME value is plotted as a function of the luminance of the test surroundings and the spatial frequency of the test Gabor patch. As seen in Figure 3a, when the filter's haze factor was 0, the visibility was not affected by the surround luminance but deteriorated sharply with higher spatial frequencies. For the filter with a nonzero haze factor, the visibility was impaired by the surrounding luminance as well (Figures 3b-3d). Furthermore, the rate of deterioration with the surrounding luminance was higher with hazier filters.

$$ME = 100\left(1 + e^{\frac{x-\mu_F}{\sigma_F}}\right)^{-\frac{1}{2}}\left(1 + e^{\frac{y-\mu_L}{\sigma_L}}\right)^{-\frac{1}{2}} \qquad \begin{aligned} x &= \log(F - F_{ref}) \\ y &= \log(L - L_{ref}) \end{aligned} \qquad (1)$$

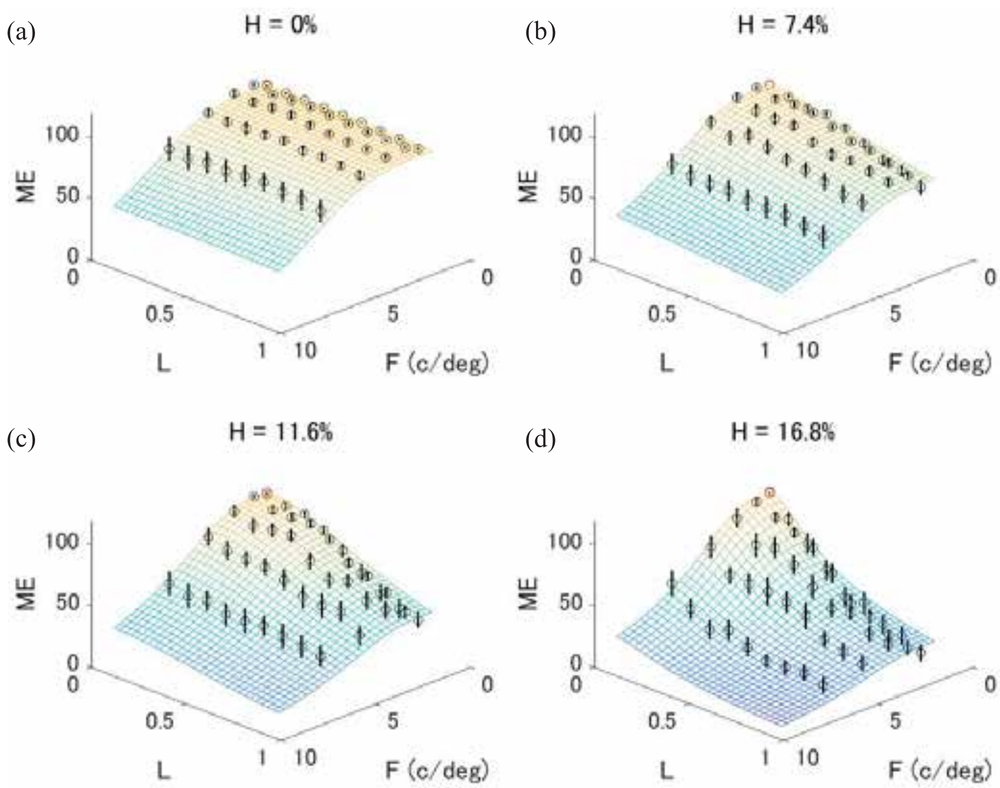

Figure 3. Mean ME values for each condition of haze factor by nine participants.

To express this deterioration rate easily, the plots shown in Figure 3 were approximated with a two-dimensional (2D) sigmoid function of the surround luminance and the spatial frequency of the Gabor patch, as in Eq. (1). This functional result shows that the parameter μ_L had a negative correlation with haze factor. In other words, the curve in Figure 3 fell faster as the haze factor became higher. The parameter μ_L obtained from nine participants is shown in Figure 4.

To estimate the haze factor uniformly in consideration of individual differences among participants, extracting components linked to changes in haze factor without being affected by individual differences is necessary. Therefore, approximate the ME value of all participants using Eq. (1) and approximate (Figure 4, dotted line) the parameter μ_L using Eq. (2). Then, estimate the haze factor from the slope of the tangent of the curve using Eq. (3). Because this method focuses on the degree of change in visibility, it can be applied regardless of individual differences among participants or good/bad vision. Figure 5 shows the haze factor corresponding to the slope of the tangent of the approximate curve.

The haze factor of a cataractous crystalline lens can be estimated using Eq. (1), (2), and (3). The procedure would be as follows. First, perform the visibility evaluation experiment described above on the naked-eye cataract patient, haze = H_C, and obtain μ_C from the result approximated by Eq. (1). Second, a similar experiment is performed in a state where a filter with a known haze factor is attached, haze = H_{CF}, and μ_{CF} is derived from the result. Finally, these values are applied to the function in Figure 4 and $\frac{H_{CF}+H_C}{2}$ is obtained from the inclination of the tangent. Because H_F is known, the haze factor of the original participant can be estimated.

$$H = \alpha\,(-\mu_L + \beta)^{0.5} \quad (2)$$

$$H = -\alpha^2/2a \;\; (\alpha=20.15) \quad (3)$$

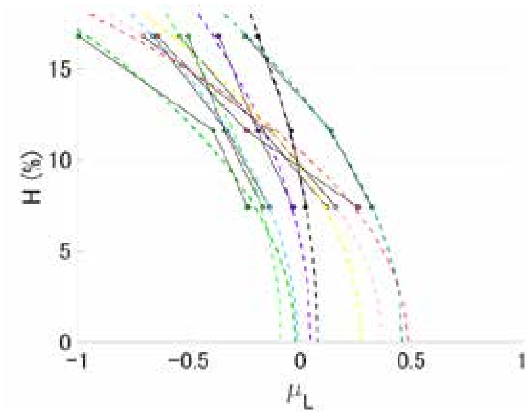

Figure 4. Parameter μ_L obtained from Eq. (1). Dotted lines are approximated by Eq. (2).

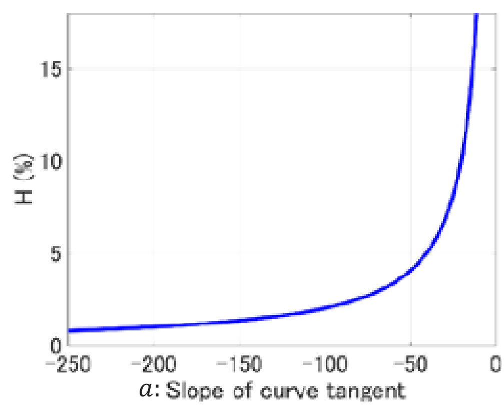

Figure 5. Haze factor corresponding to the slope of the tangent of the approximate curve, Eq. (3). Parameter α indicates mean value.

This procedure should be simplified. With the help of statistical inference, such as Bayesian inference, these parameters could be derived from a small number of data from psychophysical experiments. Such an efficient method for haze estimation would reduce the burden on patients in practical situations.

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The colour blind perception: A Case study on Thai Banknotes Series 16

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Keywords: Colour blind Perception, Thai Banknotes, colour blindness simulation

ABSTRACT

The aim of this research is to simulate the colour perception from different types of colour blind people when they perceive colour from different banknotes. In colour perception of human, the retina of the eye comprise two kinds of light-sensitive cell named rods and cones. Rods operate in low light conditions in order to improve night vision, in the other hand cones function in daylight and are responsible for colour discrimination. The cone cells can be classified into three types which are red cone, green cone and blue cone. These three cone cells have a different sensitivity to light wavelengths. When light reflects from the object into our eyes, it also stimulates the cone cells. Our brain then interprets the signal from the cones cells so that we can see the colour of the object. These three cone cells all perform together allowing we to perceive the whole spectrum of colours. People with normal colour vision have all three types of cone working correctly but colour blindness occurs when one or more of the cone types are faulty. It causes some problems such as traffic lights or banknotes colour detecting since a Banknotes uses colour to identify its value. An experiment was conducted by simulating the visual and colour coordinates of Thai Banknotes series 16 and studying its effects on each colour blindness type: Protanopia, Deuteranopes, and Tritanopes. The colour perception is represented in term of colour coordinates discrepancy under simulation software. The results of simulated Banknotes image are shown for different type of colour blindness.

INTRODUCTION

The perception of colour of the individual observer is a different phenomenon due to their unique in physical make up. The root of the discrepancy between what one individual sees as a particular hue and what which another individual perceives, is centred upon the human visual system. Light enters the eyes through the cornea and passes through the iris, in turn it is focused by the lens on to the retina. The cornea and lens act together as an optical cell, the cornea as a collective objective and the lens as a focusing cell. The ciliary muscles obtain focus point to contract and alter the radius of the front vertex of the lens.

COLOUR BLINDNESS

The nerves that are stimulated via quanta of photons are called the cones along with the rods to produce electrical impulses, these in turn are transferred to the optical lobe of the brain, decoded and formed the perceived image. Both cones and rods contain photosensitive pigments, cones having three different pigments each stimulated by the various visual wavelengths to give us our colour (photopic) vision as shown in Figure 1. The cones become less responsive as light level drops until at around .001 cd/m^2 we no longer see in colour, at this point the rods being much more

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sensitive take over and monochromatic (scotopic) vision takes place. The mesopic vision is the transition from photopic to scotopic vision is seamless and gradual. both the rods and cones in this mesopic range are stimulated and can be observed by the Purkinje phenomenon. This effect takes the form of a change in brightness of the red and blue hues. During the day, hues of red which look lighter than blues and start to look darker during late evening light before nightfall.

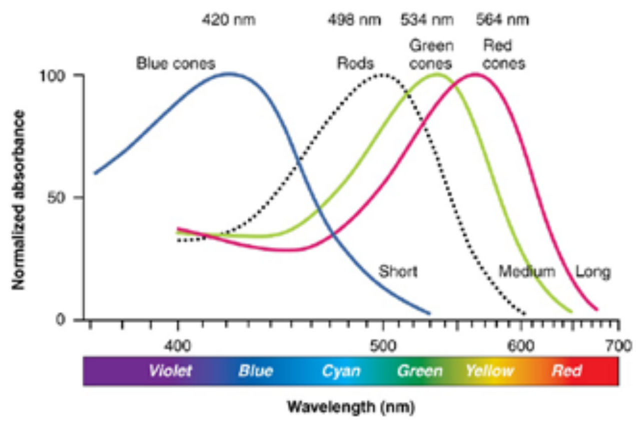


Figure 1 human photoreceptor absorbance for different wavelengths of light [1]

The cone cells can be classified into 3 types which are S type perceives blue light, M type perceives green and L type perceives red. A mild colour vision deficiency occurs when the pigment in one of the three cone types has a defect, and its peak sensitivity is shifted to another wavelength, producing a visual deficiency as shown in Table 1.

Table 1: Human Eye Cones with Wavelength

wavelength	colour	effect
Short	Blue	Tritanopia
Medium	Green	Deuteranopia
Large	Red	protanopia

According to colour blindness research in USA, colour blind people can be found around 8% of the male population and 0.5% of the female population and there are estimated to be over 250 million colour blind people worldwide. In Thailand, there are colour blind people around 10% of all population [2]. Colour blindness can be categorized into two groups; congenital colour vision defects and acquired colour vision defects. Congenital colour vision defects group is a genetic (hereditary) condition and can be found around 8% of the male population and 1% of the female population. For acquired colour vision defects group, this can be a result of long-standing diseases such as diabetes, multiple sclerosis, some liver diseases and almost all eye diseases.

As shown in figure 2, the colour blindness can be characterized into three different types as follow;

1. Protanopia, there are no working red cone cells. Red appears as black. Certain shades of orange, yellow, and green all appear as yellow. People who have this colour blind type will have a difficulty to define the colour in red, black or dark grey including saturation of colour. This type of colour blind is frequently found.

2. Deuteranopia, there are no working green cone cells. They tend to see reds as brownish-yellow and greens as beige. People who have this colour blind type will have a complexity to describe the colour in blue and purple.

3. Tritanopia, People with tritanopia, also known as blue-yellow colour blindness, lack blue cone cells. Blue appears green and yellow appears violet or light grey. Tritanopia is an extremely rare autosomal recessive disorder affecting males and females equally.

Figure 2. The images compare the three most common types of the vision impairment with a regular image

For the colour blind people, it is difficult to define the colour that have slightly different in hue, saturate and brightness. This complicatedness also affects to different circumstances for example; how to choose the colour of fruits or vegetable, how to select the medicine and especially how to define the different types of banknotes which normally the banknotes are specified by their colour. In Thailand, the colour of the banknotes are characterized as shown in Table 2.

Table 2: **The colour of THAI banknote series** 16 (**5**)

Value	**20**	**50**	**100**	**500**	**1000**
color	Green	Blue	Red	Purple	Dark grey
Dimension (mm)	7.20 x 13.80	7.20 x 14.40	7.20 x 15.00	7.20 x 15.60	7.20 x 16.20
Example					

In this paper, we present a simulation of colour perception on different types of Thai banknotes from different types of colour blind people. The results can be used to establish the colour difference between normal people and different types of colour blind people and also can be applied for designing the package for all types of colour blind people.

COLOR BLINDNESS SIMULATION

In order to simulate colour perception of colour blind people, the colour difference in LMS colour space was applied. Three different types of colour blind people (Protanopia, Deuteranopes and Tritanopes) were examined. The colour of different types of Thai banknotes were characterized and displayed in RGB mode. These colour of the banknotes then were converted to LMS and calculated the colour difference from LMS to L'M'S. Afterwards these colour of the banknotes were transformed to RGB. Figure 3 show the method of colour converting for creating colour blindness simulation.

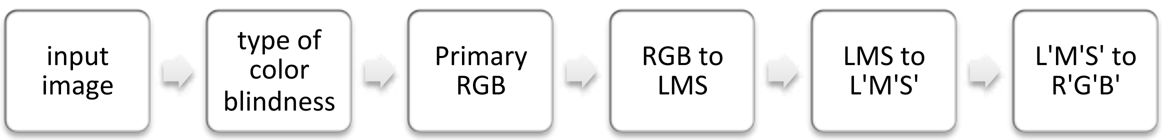


Figure 3. Method of colour converting for creating colour blindness simulation (6)

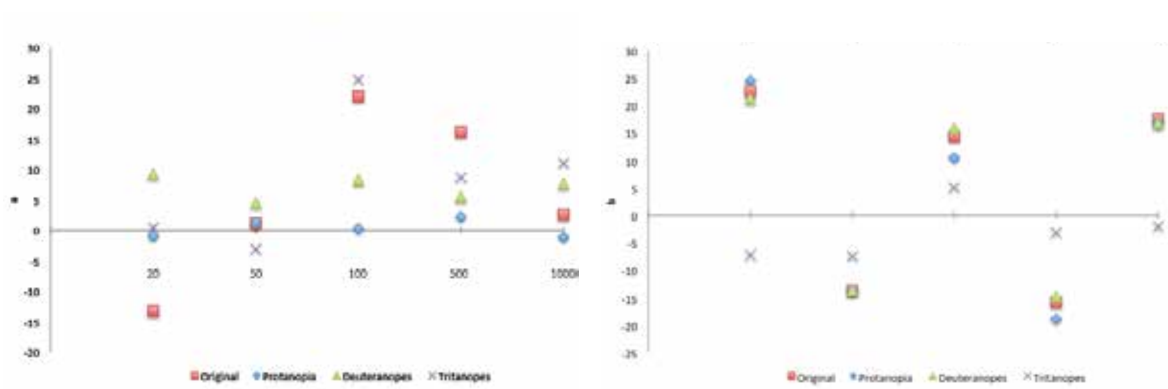
RESULTS AND DISCUSSION

Thai banknotes can be classified into five kinds as showed in Table 2. Each of banknote is presented in different colour. For people who are Protanopia type, three different banknotes (green, red and dark grey) can be perceived in grey mixed with slightly green. However, the blue and purple banknotes can be seen as cyan. For people who are Deuteranopes type, the results showed that three different banknotes (green, red and dark grey) were seen as grey mixed with slightly red and the other two banknotes were perceived as cyan mixed with purple. Both banknotes (green and blue) were seen as green mixed with grey for people who are Tritanopes type. The red banknote was perceived as original colour. The other two banknotes (purple and dark grey) were noticed as light grey.

Table 3 Colour simulation of Thai banknote resulted from different types of colour blind people compared to normal people.

Original	Protanopia	Deuteranopes	Tritanopes
			

As shown in Figure 4, the colour perception of different Thai banknotes from different types of colour blind people can be compared using CIE L*a*b* space. It can be seen that the a* values of blue banknote were slightly different. Nonetheless, the a* values of three banknotes (green, red and purple) were significantly different. These three colours affected the colour perception of colour blind people. In addition, the results in b* values were similar for both type of people; Protanopia type and Deuternopes type except people who are Tritanopes.



(a) (b)

Figure 4 Colour difference of a* and b* obtained from different banknotes and different colour blind people
(a) The a* values obtained from different banknotes and different colour blind people
(b) The b* values obtained from different banknotes and different colour blind people

CONCLUSION

The colour blind perception can be successfully simulated. In order to describe the colour difference of three different types of colour blind people; Protanopia Deuteranopes Tritanopes, LMS colour space was applied. Five different kinds of Thai banknotes were used as colour samples. The CIE l*a*b* colour space was also used to present the colour difference. The results showed that people who are Protanopia and Deuteranopes can perceive similar colour (grey mixed with slightly green and grey mixed with slightly red when green, red and dark grey are displayed. Moreover, the blue and purple banknotes were seen as cyan mixed with purple. However, people who are Tritanopes can see the green and blue banknotes as green, red banknote is quite similar compared to the original. For purple and dark grey banknotes, they can perceive as purple. These results can be implied that different colour blindness were directly affect to colour perception of Thai banknotes. The colour of the banknotes might be similarly perceived and caused difficulty in the usage of the banknotes. On the other hand, these results can be applied for design in print media and package. When the product required different colour in order to isolate price, taste or size, package might apply not only colour but also symbol, font for preventing this problem.

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Effects from Spatial Frequency of Glare Images on Display Visibility

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Keywords: Glare, Visibility, Spatial frequency, Contrast sensitivity, Degradation category rating

ABSTRACT

In the present study, situations where a display image with a glare image of sinusoidal gratings with various spatial frequencies were simulated by digital image processing and the visibility of the display image was subjectively evaluated with a rating scale. Observers' ratings declined as the relative intensity of the glare image increased. The ratings depended on the spatial frequency of sinusoidal gratings (glare images) as well. Such a dependency may reflect the contrast sensitivity function for the glare images.

INTRODUCTION

Various display devices, such as cell phones, mobile gaming platforms, tablets, and laptop PCs, are used in everywhere now. As a result, a glare of ambient light has become one of the most annoying problems, degrading the visibility of a display [1][2][3]. Optical properties such as reflectance and haze factor have been commonly used to describe the quality of any anti-glare or anti-reflection treatments on the display surface. In practical situations, however, these optical properties often disagree with actual appearance or subjective evaluation. They are pointwise properties, in the sense that they are measured and designed to express the optical phenomena at one point on the display surface, while the people view the whole screen from various angles at once. Therefore, a standard index must be developed so that it could correspond well with subjective evaluation of glare.

Previous studies reported the effect of spatial frequency of a glare image on the visibility using a visibility matching method [4][5]. In their experiments, the visibility of a display image degraded by superimposition of the glare image was reproduced by adjusting the luminance and the contrast of the original display image. The results of luminance-contrast adjustment deviated from those physically predicted by minimizing a sum of squared errors of each image pixels. Furthermore, the deviation varied depending of the spatial frequency of the glare image. In the present study, a situation in which a glare image was superimposed on a display image was simulated and the visibility of the display image was evaluated with a rating scale.

EXPERIMENT

When a glare image is superimposed on a display image, the contrast decreases in inverse proportion to the luminance increase. In the present study, such a situation of superimposition of the display image and the glare image was simulated by digital image processing on a display (HP, Pavilion23bw) laminated with a hard film. Twenty-four display images were prepared as follows: images from the Kodak Photo CD PCD0992 [6] were trimmed into 512×512 pixels, monochromatized. The contrast of all the images was reduced to 0.5. As the glare image, a sinusoidal grating of either one of 5 spatial frequencies (9.87, 4.93, 2.46, 1.23, or 0.61 cycles/degree) was superimposed over the display image. These frequencies were selected to cover the range around the

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vertex of the contrast sensitivity function (CSF) by Campbell and Robson [7]. All the sinusoidal gratings had the contrast of 0.8 and the mean luminance of the half of a maximum luminance of the display. The superimposed image was produced simply by adding the luminance of the display image and the glare image. As shown in Figure 1, by multiplying each image by intensity adjustment coefficients d or g on luminance summation, situations of various glare intensity were simulated. Note that the actual physical situations were simulated on the display screen with high fidelity by carrying out all the image calculation in the RGB luminance values instead of the display RGB values.

Figure. 1 Calculation of the superimposed image

Nine conditions of different glare intensities were simulated by assigning either 0.5, 0.25, or 0.125 to the intensity adjustment coefficients d and g, as shown in Figure 2. These images were generated and presented using MATLAB and Psychophysics Toolbox version 3 [8][9][10].

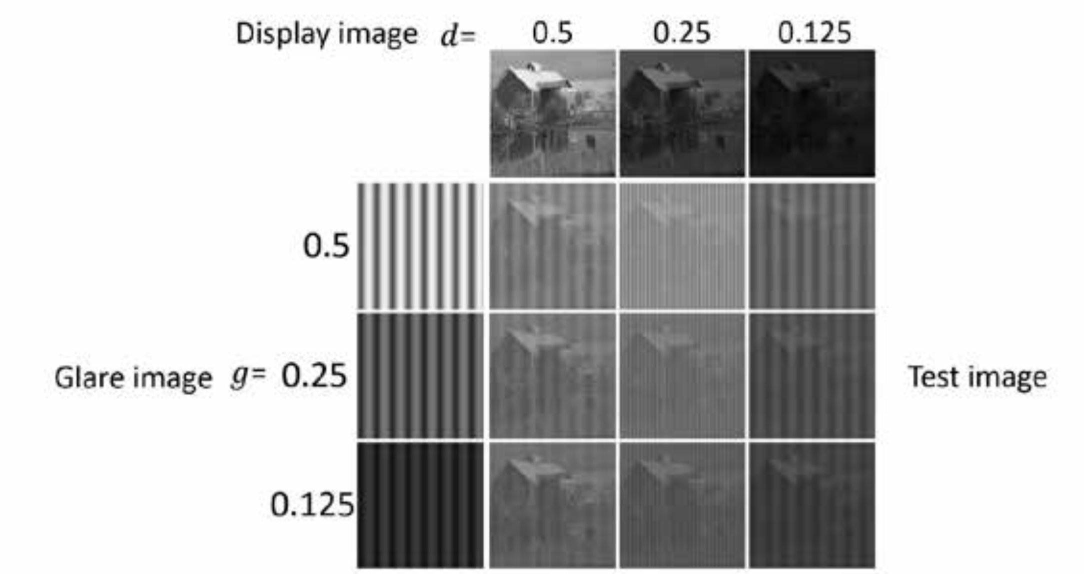

Figure. 2 Conditions of the superimposed image to evaluate

Five observers with normal or corrected-to-normal vision participated in the experiment. The observer sat on a chair at a distance of 60 cm from the display in a dark-room. The visual angle of all the images was 13 degrees. A reference stimulus (a display image) and a test stimulus (a superimposed image) were successively presented on the left and right of the display respectively (see Figure 3). Observers repeatedly evaluated the visibility of the test compared to the reference using an extended degradation category rating (DCR) described in Table 1. DCR is one of the experimental methods prescribed in the International Telecommunication Union Telecommunication Standardization Sector (ITU-T) Recommendation [11][12], where observers evaluate image degradations using a score of 1-5. As conventional DCR does not consider improvements, we extended DCR to evaluate both the degradation and improvement using a scale of 1-9.

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Table. 1 Extended DCR

score	Rating Word
1	Very annoying
2	Annoying
3	Slight annoying
4	Deterioration perceptible, but not so annoying
5	Imperceptible
6	Improvement perceptible, but not so favorable
7	Slightly favorable
8	Favorable
9	Very favorable

RESULT and DISCUSSION

The mean ratings from five participants are shown in Figure 4. Data were plotted with an upside-down Gaussian function of the spatial frequency f (Eq. 1). The standard deviation, not shown in the chart, ranges from 0.19 to 0.39. The types of symbol denote the three different values of d and the types of line denote the three different values of g.

$$F(f) = \alpha - exp\left[-\frac{(\log_{10} f - \mu)^2}{2\sigma^2}\right] \quad (1)$$

The observers' ratings were affected by the spatial frequency of the sinusoidal gratings (glare images), exhibiting a downward-convex function of f. Such a dependency may reflect the contrast sensitivity function for the glare images. The ratings declined as the intensity of glare images increased, as expected. The ratings for the equal relative intensity g/d overlapped with each other, indicating that the relative glare intensity, not absolute intensity, may determine the visibility of the display image

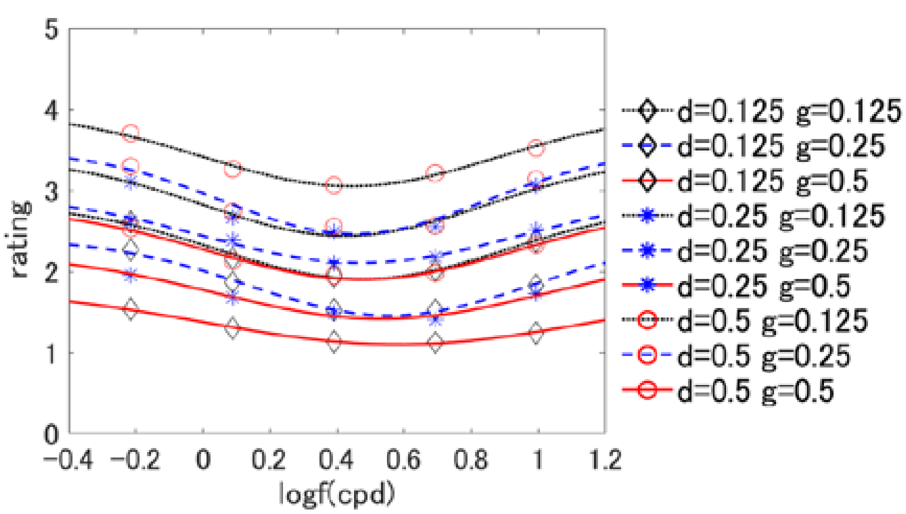

Figure. 4 Observers' ratings and fitting curves of Eq. 1

Figure 5 shows parameters α, μ, and σ plotted against the relative intensity of the glare g/d. The parameter α declined with the increase in the relative intensity g/d, showing the overall deterioration in the display visibility can be expressed by a linear function of the logarithm of the relative intensity. The sharp ascent of σ at $g/d = 4$ may have reflected a floor effect, since the ratings almost reach the lowest rating "1". The parameter μ shifted toward the higher spatial frequency as the relative intensity of the glare image increased. In other words, when an intense glare

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image is superimposed on a display, the components of higher spatial frequency have stronger effect on the deterioration of display visibility. Any factors or mechanisms for such an interaction between the glare intensity and the spatial frequency characteristics cannot be found at this moment. Though the spatial frequency characteristics of the glare image was focused on in the present study, those of the display image or, substantially, interaction between them must be investigated to develop an evaluation index for glare effect on the display visibility.

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The effect of the image sharpness to the color constancy in a photograph

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Keywords: Color constancy, Unclear image, Photograph, 3D image, Achromatic

Color constancy, it's a phenomenon that we can perceive a white object as white under lights of various spectral power distribution. Although there were researches concluding color constancy in 2-D image demonstrated by specific viewing condition which changes the 2D image to a 3D image. It is interesting to investigate if there is there another determinant for this phenomenon? In particular does the resolution perception or sharp or unclear image affect the color constancy perception?

A scene of a room was photographed decorated with Munsell color chips around test patch, blue green object and various color object by a DSLR camera of which color balance was fixed at 5600K under five-illuminations, white, magenta, green, yellow, and blue. Then two photographs of different unclearness were produced by applying the mean filter algorithm and three photographs served as test stimuli, the original image, a little unclear image and an unclear

A 4K LED television monitor of the size 68×37cm^2 giving visual angle 34°×21° was placed in a dark room to display the stimulus. A test patch of the size 1.6°×1.6° was displayed at the center of the photograph and its color was adjusted with a help of a numpad keyboard which was directly connected to a computer. The luminance of the monitor was kept at 150 cd/m^2. A subject set on a chair at the distance 98 cm from the monitor. There was two-minutes adaptation including dark and light adaption before doing the experiment total is four-minutes. A subject adjusted color of the test patch until it appeared achromatic or gray by using the numpad keyboard.

It was found that there was no systematic difference in each photograph among the three resolutions as to the color constancy. We conclude that a low-resolution photographic image seemed to not influence a color constancy perception.

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1. Introduction

Human was achromatic adaptation and can perceive a white object as white under lights of various spectral power distribution or had good color constancy. Although there were researches concluding color constancy in 2-D image demonstrated by specific viewing condition which changes the 2D image to a 3D image [1]. it is interesting when we look at the photograph under various illuminations and under different unclearness or sharpness human will had bad color constancy in a photograph according to unclear image or not?

2.Experimental Apparatus

The apparatus was divided for two parts which are preparing scenes part as shown in Figure 1(a). and experimental apparatus part as shown in Figure 1(b). Each part had different apparatus and different purpose.

(a) (b)

Figure 1. apparatus of preparing before experiment(a) experimental apparatus that front view by the subject and controller computer(b)

In the part one, there were three scenes which the first one was a room decorated with Munsell color chips around a center test patch as shown in Figure 2(a), a second was decorated with blue and green object as shown in Figure 2(b), third was decorated with various color object as shown in Figure 2(c) by a DSLR camera which white balance was fixed at 5600K and each scene has five illuminations which are white, magenta, green, yellow, and blue. And all scene under five-LED light illuminations, white 0.3449, 0.543 yellow 0.4675, 0.4131 magenta 0.3245, 0.2352 green 0.3505, 0.5219 and blue 0.2486, 0.2438.

Photographs of different unclearness were produced by applying the mean filter algorithm and three photographs served as test stimuli that were an original image, a little unclear image and an unclear image as shown in Figure 4. And quantity of image will increase for 15 images per each scene.

In the part two, the experimental apparatus has a 4K LED television monitor of the size 68×37 cm^2 giving visual angle 34°×21° was placed in a dark room to display the stimulus. A test patch of the size 1.6×1.6 was displayed at the center of the photograph in the monitor. The luminance of the monitor was kept at 150 cd/m^2. the monitor and a numpad connected to a computer that placed outside the dark room. And equipment which tack subject's head inside the dark room.

3.Stimuli

The experiment had three scenes that different about decorated with object color which were a scene that decorated with Munsell color chips and objects as shown in Figure 2(a), a scene that decorated with most of green and blue objects as shown in Figure 2(b), and a scene that decorated with various objects color objects which had many color in this scene as shown in Figure 2(b).

(a) (b) (c)

Figure 2. Three images of a scene that different object color. Color chip image(a) blue-green image(b) various object image(c).

In addition to three scenes as above. The experimental has more image that was an image which took under five-illuminations as shown in Figure 3. which were white, yellow, magenta, green and blue. That was mean an image will be increased quantity was 5 images of each scenes, an image will has 15 images.15 images will be increased quantity more, from made each image had 3 unclearness images which were original image as shown in Figure 4(a) a little unclear image as shown in Figure 4(b). and an unclear image as shown in Figure 4(c). So, an image will have all amount was 45 images per 1 scene.

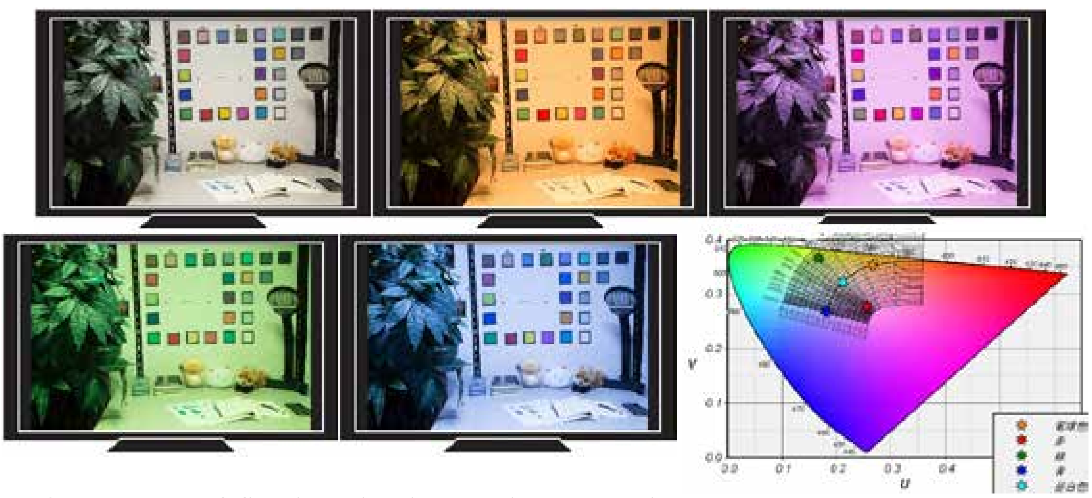

Figure 3. Example of five illuminations which are white, yellow, magenta, green and blue from left to right and 5 illuminations lies on spectral locus.

(a) (b) (c)

Figure 4. Three steps of unclear image which are Original(a). a little unclear(b). an unclear(c).

4.Experiment

4.1 Experiment prepared

Before beginning the experiment necessary procedure to prepare subject and subject's room. Bring all images which passed unclearness processed to a computer that connected to 4k monitor inside the dark room.

4.2 Experimental conditions

When subject doing experiment had to tack a sight do not move by tacking subject' chin equipment as shown in figure 1(b). A subject set on a chair at the distance 98 cm from the monitor. because each subject has difference in biological body. Try to fit the position of the eyes is good for a direction and position.

Three subjects participate in the experiment which were PC, NP and MT and before subject doing experiment had to passed Ishihara test, matching the color test and Munsell hue test. To ensure that subjects' sight had a normal sight.

4.3 Procedure

When subject was inside the dark room let he or she sit on the chair set up subject' chin on head tacking equipment and let subject held on numpad. First, the monitor will appear black screen. The subject adapted to dark for 2 minutes and adapted white for 2 minutes before judging the color appearance of the test patch and during adaptation subjects not necessary to lock a head with equipment. When adaptation has finished and subject arrive at stable judgement for experiment and then an image will appear on the monitor with random test patch as shown in Figure 5. Then the subject uses a numpad for change the test patch to match achromatic or gray or neutral by pressing the numpad keyboard as changing in LAB color space for 5 times per image. Each subject has to do experiment like this task for 45 images according to quantity that took a picture that was every illumination of each scene and every unclearness image. Sorting the experiment scene by scene, in each scene will sorted by sharpness began from original image Followed by a little unclear image and unclear image and each sharpness image will sorted by illumination began from white Followed by yellow magenta green and blue. After finished all experiment, bring the x, y data to averaging.

Figure 5. The picture that subjects will see in the monitor when program was running and a numpad that subject had to press.

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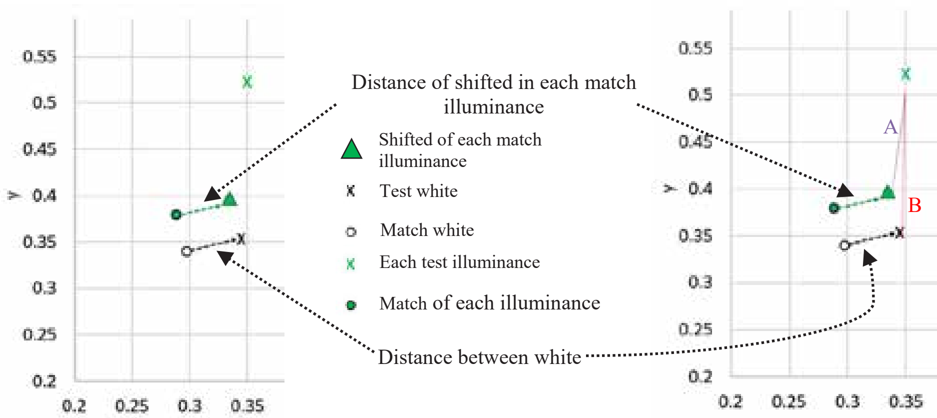
5. Results and Discussion

Averaged x, y value from the experiment image by image that was 45 images per 1 subject, in one image has experimental for 5 times, so each image had to bring data from 5 times of experiment to averaging, used this task for author subject. So, had to averaging for 135 images from three subjects in all scene, last averaging had to average for each scene which were color chips scene, green and blue scene, various object color scene by average from three subject in each illumination as shown in table (1).

Table 1. Averaging each scene, this table was averaging of green and blue scene

Original white	x	y	Original yellow	x	y	Original magenta	x	y	Original green	x	y	Original blue	x	y
Average	0.297	0.339	Average	0.371	0.394	Average	0.318	0.293	Average	0.289	0.379	Average	0.274	0.287
little unclear white			**little unclear yellow**			**little unclear magenta**			**little unclear green**			**little unclear blue**		
Average	0.304	0.342	Average	0.376	0.394	Average	0.317	0.283	Average	0.297	0.401	Average	0.273	0.292
unclear white			**unclear yellow**			**unclear magenta**			**unclear green**			**unclear blue**		
Average	0.307	0.341	Average	0.381	0.401	Average	0.315	0.277	Average	0.298	0.404	Average	0.264	0.284
Test white	**0.345**	**0.353**	**Test yellow**	**0.468**	**0.413**	**Test magenta**	**0.325**	**0.235**	**Test green**	**0.351**	**0.522**	**Test blue**	**0.249**	**0.244**

we had to knew the distance between the test white and match white which was the shift of the real co-ordinates illumination and the white which each subject perceived. Then we can use this distance to knew a shifted of each match illumination according to the white illumination about how shift of the perception of each subject as shown in Figure 6. Then we use this information for calculated the color constancy index



(a) (b)

Figure 6. Distance of a shifted of each match illumination according to the white illumination(a), distance from Shifted of each match illuminance to Each test illuminance (A) and distance from Test white to each test illuminance (B).

Used equation (1, 2) was formula for found distance of shifted in each match illumination x and y value ($x, y_{shifted}$) when a_{match} = match of each illuminance, x, y_{test1} was test white and x, y_{match} was match white. Before calculating color constancy index had to found distance of A line (distance between shifted of each match illuminance and each test illuminance) as shown in figure 6(b). by used formula as shown in equation (3) when $x, y_{shifted}$ was shifted of each match illuminance, x, y_{test2} was each test illuminance. Used formula as shown in equation (4) for found distance of B line as shown in figure 6(b). or distance between test white and each test illuminance when x, y_{test1} was test white and x, y_{test2} was each test illuminance. Last, used A and B value add to formula as shown in equation (5) for found color constancy index, if result of these equation was 1 that was perfect color constancy, so we were to know color constancy index of each unclearness which were original, a little unclear image, an unclear image

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$$x_{shifted} = a_{match} + (x_{test1} - x_{match}) \quad (1)$$

$$y_{shifted} = a_{match} + (y_{test1} - y_{match}) \quad (2)$$

$$A = \sqrt{(x_{shifted} - x_{test2})^2 + (y_{shifted} - y_{test2})^2} \quad (3)$$

$$B = \sqrt{(x_{test1} - x_{test2})^2 + (y_{test1} - y_{test2})^2} \quad (4)$$

$$\text{Color constancy index} = 1 - \left(\frac{A}{B}\right) \quad (5)$$

A = the distance between the Shifted of each illuminance and each test illumination ordinates as shown in figure 6. B = the distance between test white illumination and each test illumination ordinates as shown in figure 6.

From hypothesis, when we look at the photograph under various illuminations and under different unclearness or sharpness human will had bad color constancy in a photograph according to unclear image or not? It was found that there was no systematic difference in each sharpness image among the three resolutions as to the color constancy as shown in Figure 7. Concluding was a low-resolution photographic image seemed to not influence a color constancy perception.

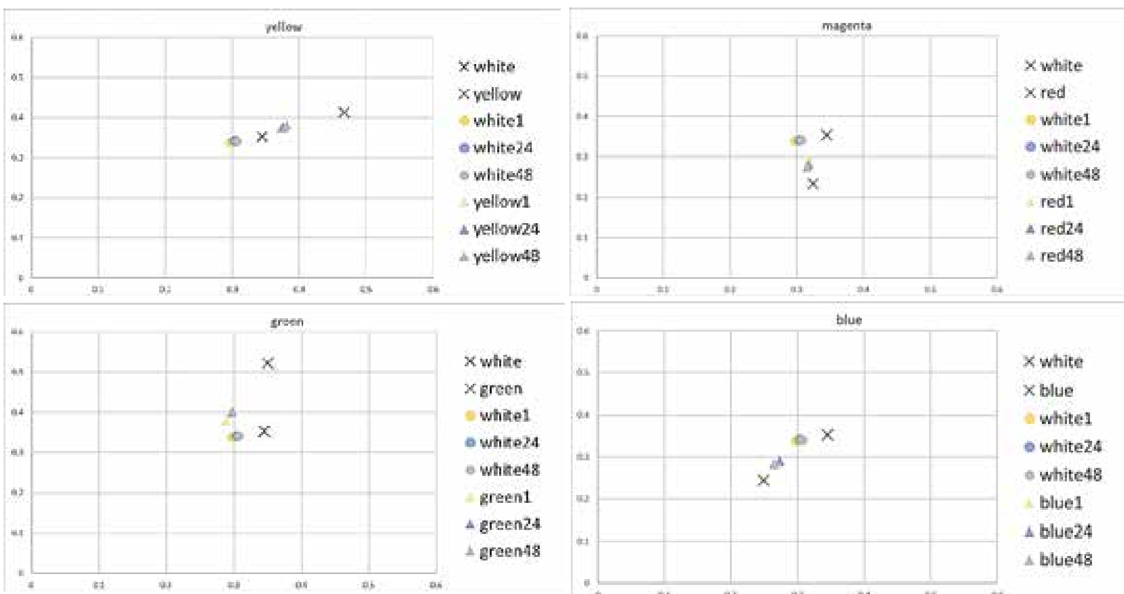

Figure 7. A result of averaging green and blue scene

6. Acknowledgement

This research was supported by Chiba university and thank you for teacher and my colleague for supported me.

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WHITENESS ENHANCEMENT USING THE WATERCOLOR EFFECT

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Keywords: Whiteness, Watercolor effect, Whiteness enhancement

ABSTRACT

A colored line running parallel and contiguous to a darker contour will appear to spread its color onto a white area enclosed by the line. This phenomenon is called the watercolor effect. This effect indicates that our perception for the central part can be altered depending on the surrounding color setting. In our previous preliminary experiment, we confirmed that the perceived whiteness was enhanced in a certain combination of the colors. In this study, we conducted evaluation experiments as to whether whiteness enhancement using the watercolor effect depends on the presentation medium by conducting the same experiment using a display and a paper print.

In the display experiment, the combination of the colors which enhanced the whiteness of the inner area were: blue-yellow, blue-green, blue-pink. The setting which put the blue inside tended to be chosen as whiter. In the paper experiment, the similar trends were obtained: blue-orange, blue-green and blue-pink combinations were chosen. However, the differences were more distinctive in the display experiment. Our results indicate that the watercolor effect can be observed regardless of the medium used, but the effects are greater with the display.

POSTER SESSION

INTRODUCTION

A colored line running parallel and contiguous to a darker contour will appear to spread its color onto a white area enclosed by the line. When drawing an outline figure with a double line consisting of two chromatic colors, the color inside the double outline appears to seep out of the enclosed region. This phenomenon is called the watercolor effect [1]. This effect indicates that our perception for the central part can be altered depending on the surrounding color setting. In our previous preliminary experiment, we confirmed that the perceived whiteness was enhanced in a certain combination of the colors [2]. In this study, we conducted evaluation experiments to see whether or not whiteness enhancement using the watercolor effect depends on the presentation medium by conducting the same experiment using a display and a paper print.

METHOD

(1) Experimental using display stimulus

We used a liquid crystal color display (LG 22MP57VQ-P). The distance between a subject and a display was 70 cm. A 11.5 cm x 11.5 cm square whose contour consisted of dual lines of 9-cycles of sine wave was used as a stimulus (Fig.1). 8 different combinations of the colors were used to draw the inner and outer color of the square: blue(inside)-yellow(outside)(BY), yellow-blue(YB), green-red(GR), red-green(RG), blue-orange(BO), blue-pink(BP), red-blue(RB), and blue-green(BG) (Fig.2). 28 pairs of different color conditions were presented to a subject. Each pair of the stimuli was showed side-by-side with an interval of 2.5 cm. In order to get rid of the location effect, flipped configurations were also used for all the 28 pairs. In total, a subject was asked to evaluate 56 pairs. The stimuli on the display were drawn on a white (D65) background. 15 subjects (3 males and 12 females) were participated in the experiment.

(2) Experimental using paper stimulus

The shapes and sizes of the paper stimulus were the same as in the display stimulus experiments. A daylight fluorescent lamp (NEC FHF32EX-D-HX) was used as the light source inside an experiment booth shielding external light with a blackout curtain. Each pair of the stimuli was showed side-by-side with an interval of 2.5 cm. In order to get rid of the location effect, flipped configurations were also used for all the 28 pairs. In total, a subject was asked to evaluate 56 pairs. In the paper setting, the stimuli were printed out on a white photo paper. 15 subjects (15 females) were participated in the experiment.

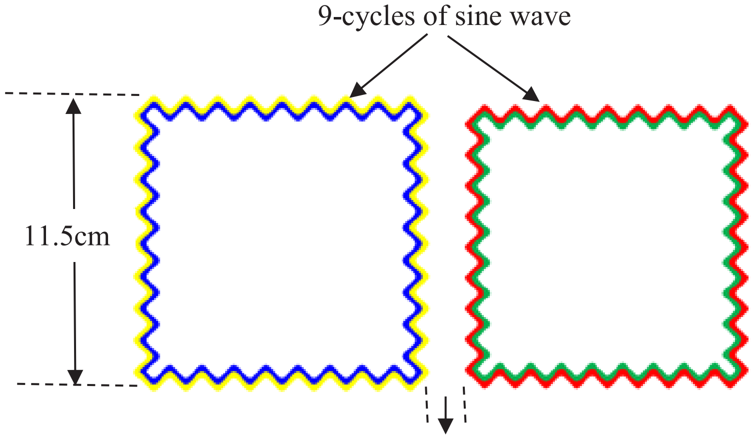

Figure 1. Experiments stimulus (1)

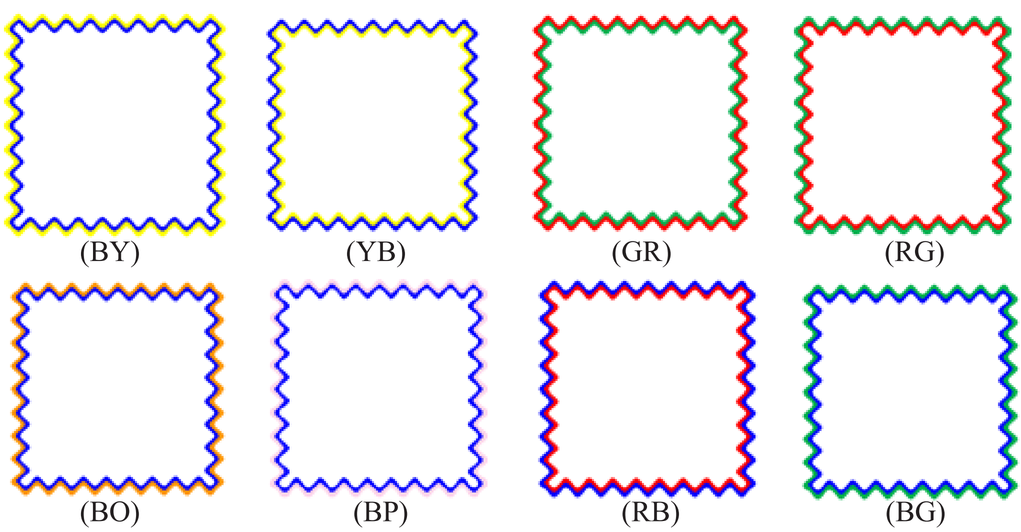

Figure 2. Experiments stimulus (2)

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(3) Experimental procedure

Before starting an experimental session, a subject adapted to the illumination (paper exp.), or a white background (display exp.) for one minute. A subject was asked to choose which of the inner area of the two stimuli appeared more whitish. The observation duration was not limited: the stimuli were presented to the subject until he/she responded. The order of the presentation was randomly chosen in advance. Thus, all the subjects observed the stimuli in the same order. Each subject repeated 5 times.

RESULTS AND DISCUSSION

In display experiments, blue - yellow, blue - green, blue - pink was selected as the combination of colors that enhanced whiteness from the average value of Z scores (Fig.3). Similarly, blue - orange, blue - green and blue - pink were selected in paper experiments (Fig. 4). In both conditions, the configurations which contained blue as inside tended to be chosen as enhanced white. This is consistent with the results of previous studies, showing that the color affecting whiteness was blue [3].

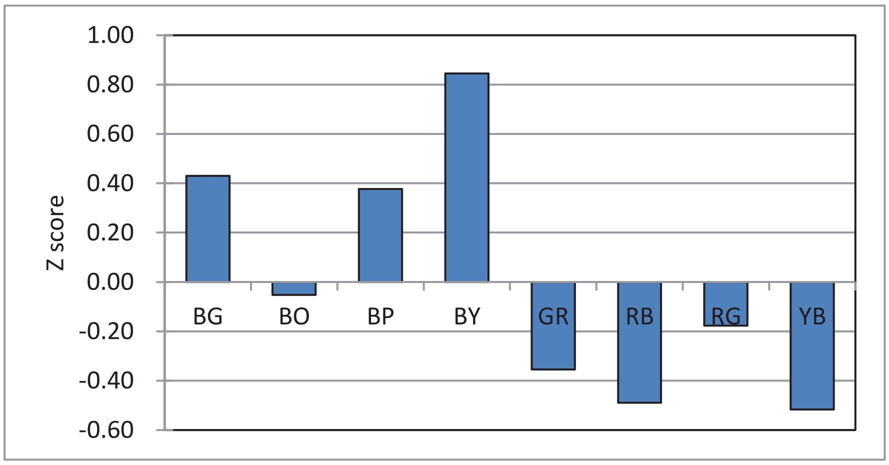

Figure 3. Z score average of display experiment

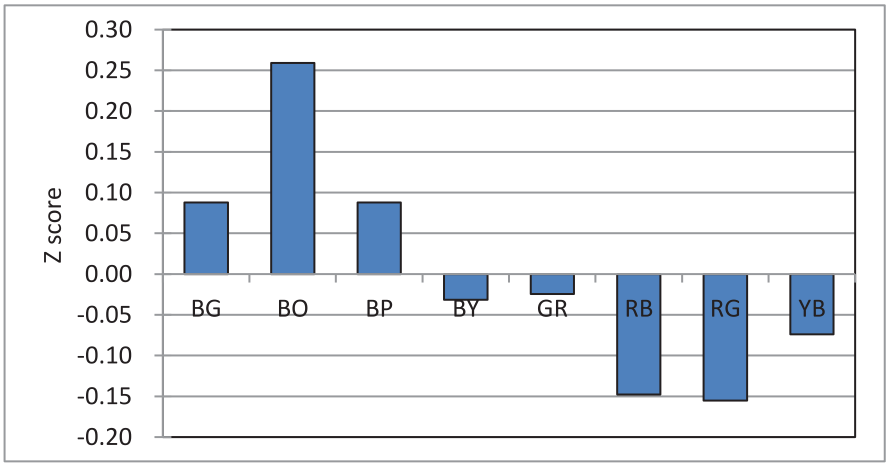

Figure 4. Z score average of paper experiment

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In this experiment, z-scores obtained for red-blue, yellow-blue, green-red were low. Because this combination is complementary to the complementary color relationship, we think that the watercolor effect of the inner color increased and the color blurred. This might be because these combination of colors were those of complementary colors. The watercolor effect was larger, thus, which inner color was spread to the central area.

The Z scores of subjects SI and KM are shown in Fig. 5 (a) and (b) respectively.

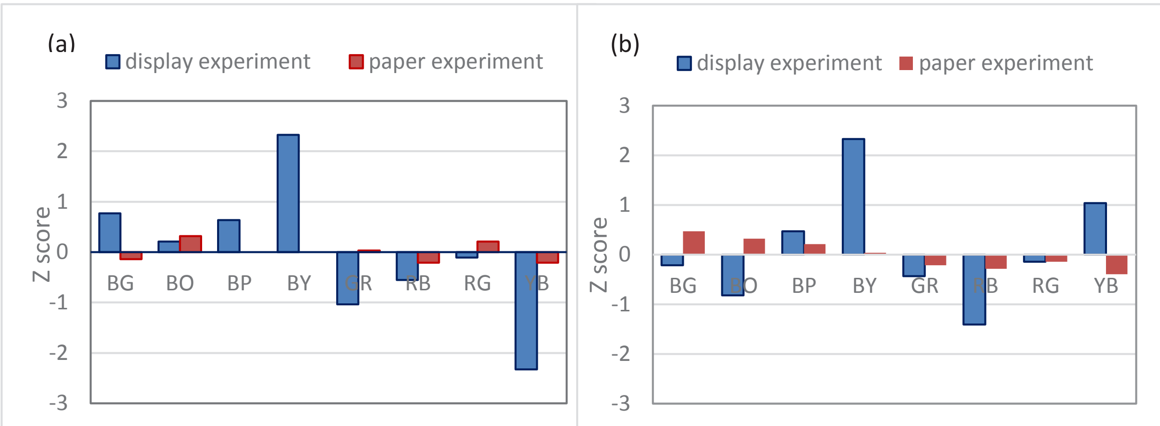

Figure 5. Comparison of Z-scores: (a) subject SI, (b) subject KM

From these two figures, it is obvious that the range of the Z scores are significantly larger in display experiment than that in paper print experiment. A positive value means that the effect of whiteness enhancement was high. On the other hand, the Z scores of the experiment using the paper print had a positive and negative values as those of the display experiment. The difference in the paper print experiment was smaller, which might cause the inconsistency of the trends of the selection.

For display experiments, it is also necessary to examine the contrast of the image.

CONCLUSIONS

As a result of experiments to evaluate whether improvement of whiteness utilizing watercolor effect depends on the presentation medium,

1. In both experiments using display and paper prints, we could confirm that whiteness was enhanced using the watercolor effect.
2. In both experiments using display and paper prints subjects tended to choose that the stimulus which used blue as the inside color as producing more whiteness.
3. The difference in stimulus selection for whiteness enhancement in the presentation medium is more pronounced in the display.
4. Watercolor effect is observed irrespective of the used medium, but its effect is larger in the display.

POSTER SESSION

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EFFECT OF ILLUMINANCE LEVELS, STIMULUS SIZE AND OBSERVATION PERIOD ON COLOR IDENTIFICATION

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Keywords: mesopic illuminance level, stimulus size, observation period, color identification, eyewitness testimony, visual environment

ABSTRACT

Eyewitness testimony has been acknowledged as one of the most powerful forms of testimony in criminal justice. In many cases, there is eyewitness testimony that includes the description of color; therefore, it is necessary for judicial officials to have good knowledge on characteristics of visual perception. Many people, however, unconsciously tend to recognize that the visual perception of others is the same as theirs, so there is less attention paid to visual perception. In the present study, the effects of illuminance levels, stimulus size, and observation period on color identification are examined.

In the experiment, participant viewed a stimulus presented on a display and identified the color stimulus by naming them using one of 19 preselected color terms. An experimental session was conducted under one of four illuminance levels, in which the stimuli of randomly selected size and duration were presented. The experimental result showed the influences of illuminance, stimulus size, and presentation duration on color identification. It was found that color identification became less stable at lower illuminance level, with smaller stimulus size, and with shorter presentation duration.

INTRODUCTION

Eyewitness testimony has been acknowledged to be one of the most powerful forms of testimony in criminal justice and among the most effective and important clues in investigation [1]. Recently, the reliability of eyewitness statements has been questioned and extensively studied in psychology [2][3]. Nevertheless, little attention has been paid to visual perception that is greatly affected by conditions and may affect the accuracy of eyewitness testimony. Many people who are not familiar with such characteristics of visual perception unconsciously tend to assume that the visual perception or ability of an eyewitness is the same as those of their everyday visual experience.

Previous studies [4][5] have reported that the accuracy of eyewitnesses was affected by illuminance and viewing distance. Another study [6] showed that the absence or presence of colors in a suspect's attire affected the accuracy of witness identification. Other studies [7]-[10] have reported that color identification was greatly affected by illuminance and stimulus size. In the present study, effects of the observation period or duration of stimulus presentation on color identification was examined in addition to illuminance levels and stimulus size.

EXPERIMENT

In the experiment, participant viewed a stimulus on a display screen (EIZO, CG2420), and identified the color stimulus by a color-naming method using 19 preselected color terms [11]: white, black, red, green, yellow, blue, brown, purple, pink, orange, gray, water, skin, indigo, green tea, maroon, sand, globeflower, and cream. Not detecting stimulus, the participant selected undetectable. The experimental booth is shown in Figure 1. The participant holding a numeric keypad sat on a chair at a distance of 100 cm from the display. The inside of the experimental booth was illuminated by fluorescent lamps (Panasonic, FLR40S D-SDL/M daylight color).

The horizontal illuminance was set to 200, 20, 1.8, or 0.2 lx at the place on the display screen. Sixty-five colors were selected as stimuli from Munsell colors. Sixty chromatic color samples were selected from 20 hues, with value of 6, chroma of 2, 6, maximum value of 8 or 10. Five achromatic color samples were N1, N4, N6, N8, and N9. These color stimuli were exactly simulated on the display through the calculation of CIEXYZs under each of the illuminance levels. The visual angle of the stimulus circle was 5°, 1°, or 0.5°. The duration of stimulus presentation was 9, 1, or 0.5 s. Stimulus presentation and recording participant responses used MATLAB and the Psychophysics Toolbox Version 3 [12]-[14] on the PC (Apple, MacBook Pro 13 inch).

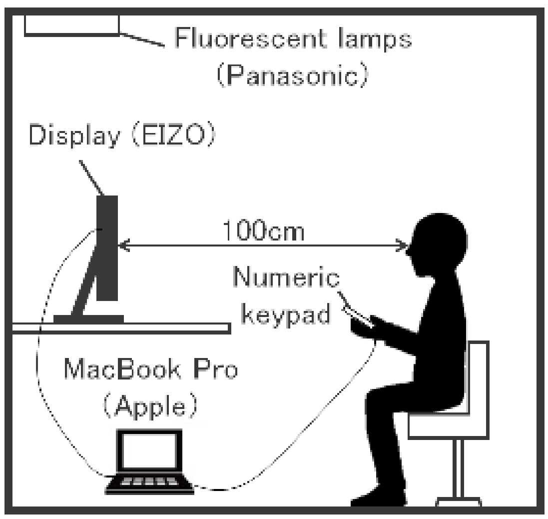

Figure 1. Experimental booth

A single session consisted of the repetition of color-naming tasks for stimuli of randomly selected size and duration under constant illuminance level. The stimulus presentation order in a single trial was as follows: blank frame, stimulus presentation, blank frame (1s) and color term choices (see Figure 2). The circle stimulus was presented on an achromatic background corresponding to N5 in Munsell color. The participant adapted to the illuminance for 10 min before the experimental session started. To examine consistency or stability in color identification, each participant conducted color naming once for each of the color stimuli and conditions in separate sessions. Four people (2 men, 2 women) participated in the experiment.

POSTER SESSION

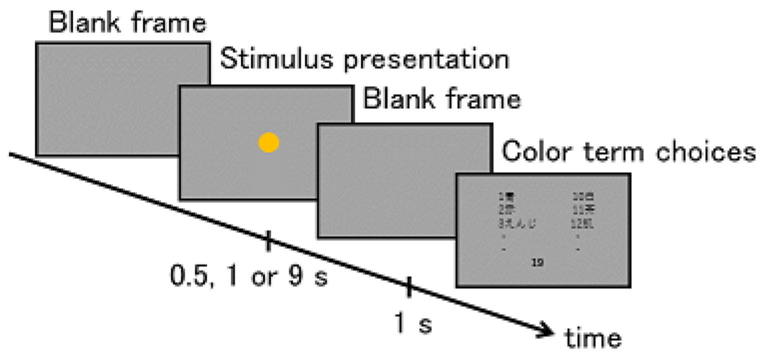

Figure 2. Experimental procedure

RESULT AND DISCUSSION

Figure 3 shows a part of the experimental result of four participants: (A) 200 lx, 0.5°, 0.5 s, (B) 0.2 lx, 5°, 0.5 s, (C) 0.2 lx, 0.5°, 9 s, and (D) 0.2 lx, 0.5°, 0.5 s. Symbols in the charts show responses by four participants to color stimuli of plotted chromaticities. Crosses represent color stimuli which more than 3 participants undetected. Symbols of asterisk, open circle, dot and plus indicate unstable responses in the sense that the color stimulus drew less than two same responses by four participants. Asterisks represent color stimuli which two participants undetected. Dots represent color stimuli to which two same achromatic color terms were assigned. Open circles represent color stimuli to which two same chromatic color terms were assigned. Pluses represent color stimuli to which four different responses were assigned. All other symbols show stable responses in the sense that the color stimulus was given the same color term by more than three participants. A broken line is the color gamut of the display, and a solid line shows spectrum loci. Responses to five achromatic color stimuli are plotted on the right of the figure.

The effects of stimulus size and presentation duration were found at lower illuminance. Especially, the influences of stimulus size and presentation duration on color identification were observed under the illuminance of 0.2 lx. As shown in Figure 3(D) unstable responses considerably increased compared to Figure 3(A), indicating the effect of illuminance levels on color identification.

Comparison between Figures 3(B) and (D) reveals the effect of stimulus size. Unstable responses increased with small stimulus size. Some of the color stimuli identified as “green” with the size of 5° disappeared with the size of 0.5°. The effect of the observation period is revealed by comparing Figures 3(C) to (D). Unstable responses increased, and the number of color stimuli named “blue” decreased with the presentation duration of 0.5 s.

The experimental result clearly showed the influences of illuminance, stimulus size, and presentation duration on color identification. The number of color stimuli stably identified decreased at lower illuminance level, with smaller stimulus size and shorter presentation duration.

Interestingly, the color stimuli identified as achromatic color (gray triangles or dots) were spread over the region from green-yellow to purple-blue. Moreover, the color stimuli (crosses or asterisks) in the same region may have appeared achromatic and been hard to detect from the background of N5. Thus, the color ranging from green-yellow to purple-blue might be neutralized at low illuminance level. Such a phenomenon is similar to that observed in the previous studies [7][8].

All of the results suggest that eyewitness statements including descriptions of color observed under poor conditions should be carefully treated or interpreted. The result of the present study will help judicial officials evaluate correctly eyewitness statements including color information.

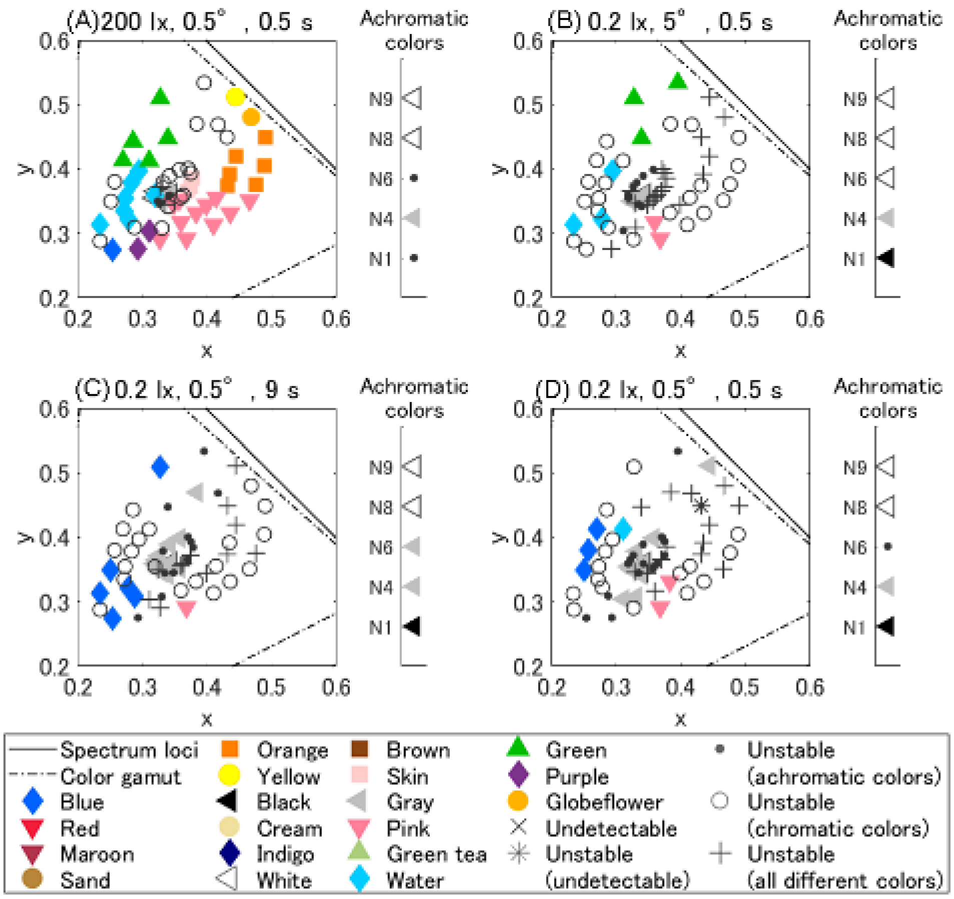

Figure 3. Result of the color identification by four participants

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INVESTIGATING INTERACTION BETWEEN SOUNDS AND GRAPHICS ON PERCEPTUAL TRANSPARENCY

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Keywords: Cross-modal shitsukan perception, audiovisual, computer graphics, transparency, modeling

ABSTRACT

In this paper, we constructed a model for cross-modal perception of transparency by investigating the interaction between sounds and graphics. First, we conducted subjective evaluation experiments using sounds and graphics stimuli for investigating cross-modal transparency perception. There are three types of stimuli in the experiment: visual stimuli (22 CG stimuli), audio stimuli (15 sound stimuli) and audiovisual stimuli (22 × 15 = 330 stimuli). Also, there are three sections in the experiment. The first one is a visual experiment, the second one is an audiovisual experiment, and the third one is an auditory experiment. For the evaluation of transparency perception, we employed the magnitude evaluation method. Next, we analyzed the influence of sounds on transparency perception from the experiment results. The results suggested that cross-model transparency perception could be represented by a combination of visual-only and auditory-only perception. Then, based on the results, we developed a cross-modal transparency perception model by a linear sum of CG and sound parameters. Finally, we confirmed the feasibility of the cross-modal model through a validation experiment.

INTRODUCTION

In recent years, realistic computer graphics (CG) reproduction techniques have been developed in the research field of CG. Previous CG researches have realized realistic reproduction such as color appearance and shading by using physical (optical) laws in the real world. Researches that reproduce not only color but also "shitsukan (i.e. material appearance / material perception)" of objects has been actively investigated [1]-[3].

Humans often recognize the shitsukan perception based on cross-modal sensations of not only visual information but also combinational information such as a surface shape by touching an object (haptic information) and a sound by hitting an object (auditory information). Fujisaki et al. conducted an experiment of shitsukan cognitions by concerning visual and auditory senses [4]. They investigated shitsukan cognitions based on three senses of visual, auditory and haptic senses [5]. Rodrigo et al. [6] suggested that cross-modal shitsukan recognitions provided more rich perception compared with the recognition with one specific sense. Bonneel et al. [7] clarified that the interaction between visual and auditory details in the perception of material similarity. They also applied their findings to CG renderings for reducing rendering costs and improving LOD (level of detail) of sound. However, these studies on cross-modal shitsukan perceptions are mainly focused on the interpretation of the human perceptions and cognitions. For reproducing CG images with rich shitsukan (material appearance / material perception), it is considered that not only visual reproduction but also cross-modal reproduction. Then, image reproduction with considering auditory senses are important. However, researches on cross-modal perception have not focused on and investigated "image reproduction" enough.

POSTER SESSION

In this research, we present a model for representing the interaction between sound effects and CG related to transparency. In the shitsukan perception, transparency is one of the important components in CG rendering. Thus, we decide to focus on transparency in this research. First, we prepare visual, auditory and audiovisual experimental stimuli. Then, we conduct a cross-modal evaluation experiment using the stimuli. Next, we analyze the influence of sound effect on transparency perception. Based on the experimental results, we model cross-modal transparency perception and validate the feasibility of the model.

SUBJECTIVE EVALUATION EXPERIMENT

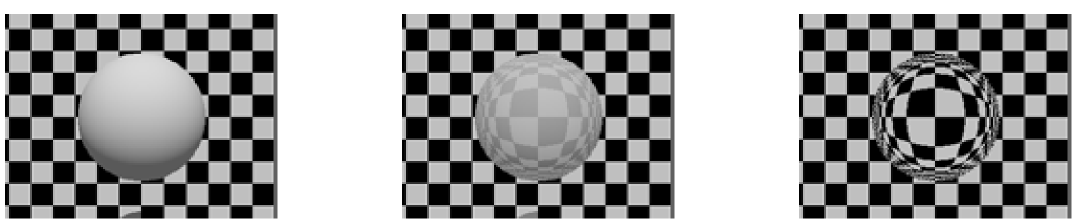
We prepared three types of experimental stimuli: (1) visual stimuli, (2) auditory stimuli, and (3) audiovisual stimuli. Two experiments were carried out using two parameters of visual CG stimuli. One of the parameters is a transmittance, the other is a refractive index. The experiments consisted of three sections: (1) visual experiment (evaluation of 22 visual stimuli), (2) audiovisual experiment (evaluation of 330 visual-auditory combined stimuli), and (3) auditory experiment (evaluation of 15 auditory stimuli).

Stimuli

As visual stimuli, we generated CG images by changing transmittance or refractive indexes of sphere objects. For stimuli with transmittance changes (the refractive index is fixed to 1.5), we prepared 11 types of CG images whose transmittance from 0.0 to 1.0 at the interval of 0.1. Figure 1 shows the examples of visual stimuli with changing transmittance. For those of refractive index changes (the transmittance is fixed to 0.5), we also done 11 types of CG images whose refractive index from 1.0 to 2.0 at the interval of 0.1. Figure 2 shows the examples of visual stimuli with changing refractive indexes.

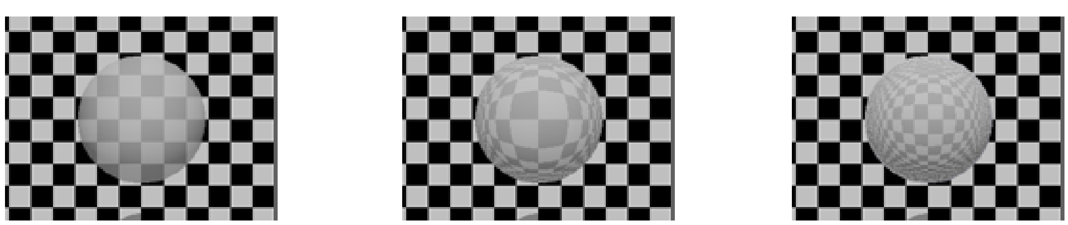
As auditory stimuli, we prepared 15 sound effects on transparency by collecting free audio materials on WEB. These auditory stimuli were mainly generated by hitting a transparent object such as glass and included various kinds (for example, high sound, low sounds, etc.).

We also prepared 330 audiovisual stimuli by combining the 22 visual stimuli and the 15 auditory stimuli described above.



(a) The transmittance = 0.0 (b) The transmittance = 0.5 (c) The transmittance = 1.0

Figure 1. Sample of the transmittance change stimuli (the refractive is fixed to 1.5)



(a) The refractive = 1.0 (b) The refractive = 1.5 (c) The refractive = 2.0

Figure 2. Sample of the refractive change stimuli (the transmittance is fixed to 0.5)

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Procedure and evaluation method

For the subjective evaluation, we conducted two experiments: one is the experiment based on the stimuli with changing the transmittance, and the other is that with changing the refractive index. First, we trained subjects using the dummy evaluation program before the experiment, so that they become accustomed to the evaluation method. Next, three sections of visual experiment (evaluation of 11 visual stimuli with changing the transmittance or the refractive index), audiovisual experiment (evaluation of 165 audiovisual stimuli), auditory experiment (evaluation of 15 auditory stimuli) were executed in order.

The magnitude estimation method was used to evaluate transparency perception. As the reference stimuli, a CG image with the transmittance = 0.5 and the refractive = 1.5 was used (Figures 1(b) and 2(b)). The sphere (state without sound attached) located in this image was taken as the criterion of transparency as 50. The evaluation lower limit (when not feeling transparency at all) is set to 0, and the upper limit is not set.

In the visual experiment, subjects answered transparency scores for 11 visual stimuli. In audiovisual experiment, subjects answered transparency scores by comparing the reference image (visual information only) with the combinational stimuli of CG images and sound effects for the 165 types of audiovisual stimuli. In auditory experiment, subjects compared the transparency that can be recalled from sounds with that of the reference image (visual information only), and answered scores of the 15 auditory stimuli.

Environment

Stimuli was presented with the monitor EIZO ColorEdge CG-221 BK and the headphone Audio-technica ATH-MSR 7. The viewing distance was 50 cm, and the viewing angle of the stimuli was approximately 8 degrees. In all experiments, the number of subjects were twelve (including both male and female with twenties). Figure 3 shows the state of the experiment. In the actual experiments, the experiment was conducted in a dark room.

Figure 3. Experimental situation

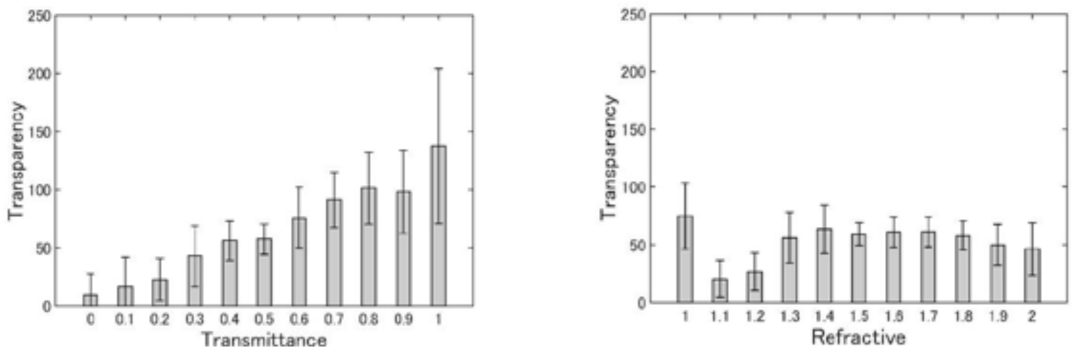
EXPERIMENTAL RESULTS

Figure 4 shows the result of the visual experiment. Figure 4(a) shows that as the transmittance increases, the transparency becomes higher. As shown in Figure 4(b), when the refractive index is 1.0, the transparency becomes high. But the refractive index become 1.1, the transparency sharply decreased. Then the transparency was peaked at the refractive = 1.5 and gently declined over 1.5.

The relationship between sound and transparency is shown in Figure 5. Error bars in these figures are standard deviations between subjects. In addition, the horizontal axis of Figure 5 shows the sound feature (in this study, the frequency at peak power in Fourier domain was used as the sound feature).

Figure 6 shows the result of the audiovisual experiment. As shown in Figure 6, the result of audiovisual experiment has a similar to a combination (or sum) of single-modal results (i.e. visual and auditory experimental results as shown in Figures 4 and 5).

From these results, it was suggested that the transparency perception was changed by combining the image and sound effects. In other words, by changing the combination of the physical parameters of the image or the sound effect (the transmittance, the refractive index or peak frequency of sound), it is possible to manipulate the cross-modal transparency perception.



(a) Stimuli with changing transmittance **(b) Stimuli with changing refractive indexes**

Figure 4. Results of visual experiment

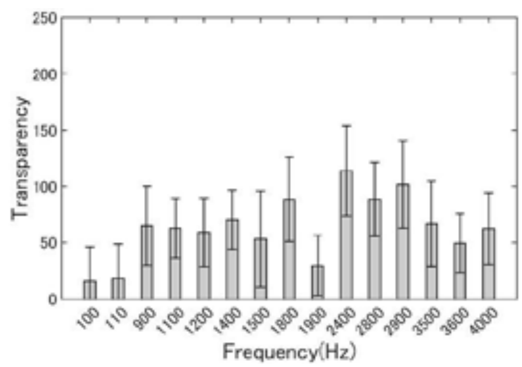
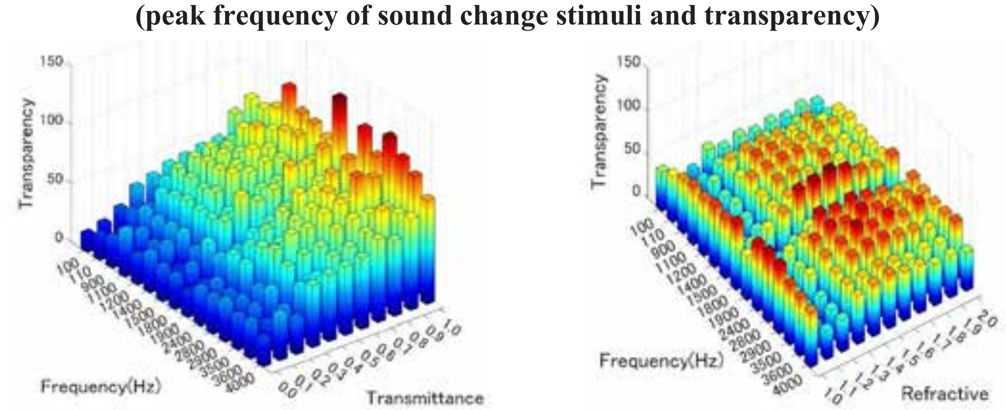


Figure 5. Result of auditory experiment
(peak frequency of sound change stimuli and transparency)



(a) Transmittance and peak frequency **(b) Refractive index and peak frequency**

Figure 6. Results of audiovisual experiment

CONSTRUCTING A MODEL FOR CROSS-MODAL TRANSPARENCY

Experimental results show that transparency can be manipulated by changing the combination of visual parameters and auditory parameters. Based on the findings, by analyzing the experimental results, a model formula for predicting the transparency in cross-modal was developed. Especially, we derived a model formula using the transmittance, the refractive, and the peak frequency (which are physical parameters) as explanatory variables and the transparency in cross-modal as object variables.

$$T_{av} = a_{av}O(t) + b_{av}P(i) + c_{av}Q(f) + d_{av} \quad (1)$$

$$O(t) = a_t logt + b_t \quad (2)$$

$$P(i) = a_i i + b_i \quad (3)$$

$$Q(f) = a_f f^2 + b_f f + c_f \quad (4)$$

T_{av} in Equation (1) represents a cross-modal transparency score. $O(t)$, $P(i)$ and $Q(f)$ are single-modal transparency models in terms of the transmittance t, the refractive i and the peak frequency of sound f and they are expressed by the Equations (2) to (4). The transparency model of the transmittance t, the refractive i, or the peak frequency of sound f was developed by approximating the relationship between the parameters and the transparency perception. A cross-modal transparency model T_{av} was constructed from the linear sum of these transparency models. In the model, a, b, c, and d in the each equation represent coefficients.

VALIDATION EXPERIMENT

A validation experiment was conducted to confirm the feasibility of the cross-modal transparency perception model. The evaluation experiment in the previous section was carried out with either the transmittance or the refractive index as fixed values. On the other hand, this validation experiment uses a stimuli with randomly combining all parameters in order to verify the cross-modal perception of the transparency. There are 10 experimental stimuli in total. The combination of parameters was decided so that the predicted value was distributed from low to high values. The experimental setting is the same as in the previous evaluation experiment.

Figure 7 shows the results of the model validation experiment. The light blue bar is the evaluation value obtained in the validation experiment, and the yellow bar is the predicted value obtained from the cross-modal transparency model shown in Equation (1). Error bars are standard deviations between subjects. The correlation between the experimental result and the predicted value was 0.9. In each Test ID, a t-test was conducted with a significance level of 5% on the evaluated and the predicted values. As a result, there were two significant differences observed, No. 1 and No. 2, and no significant difference was found in the other items. From this analysis, it is said that our cross-modal transparency perception model can predict the perceptual transparency with good accuracy.

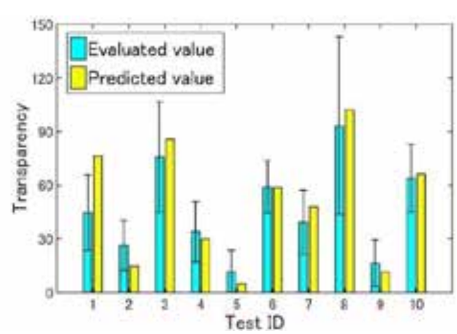


Figure 7. Evaluation value in validation experiment and predicted value from our model

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CONCLUSIONS

In this research, we investigated the cross-modal perception of transparency. For the purpose of the development of the cross-modal model for sound effects and CG, evaluation experiments were carried out using CG images with changing the transmittance and the refractive indexes and sound effects with various frequency features. As a result, it was found that by changing the combination of image and sound feature quantities, the transparency perception was changed. Next, based on the experimental results, a model for predicting transparency in cross-modal was developed from the transmittance, the refractive (which are the image feature amount) and the peak frequency (which is the sound feature quantity). A validation experiment was carried out using a stimuli with various combinations of the transmittance, the refractive and the peak frequency of sound. The results showed our cross-modal transparency model provided good accuracy. Thus, it was confirmed that it is possible to manipulate CG and sounds based on our model for corresponding to the desired human perception of transparency.

ACKNOWLEDGEMENT

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THE STUDY OF BACKGROUND COLOR SUITABLE FOR THAI SIGN LANGUAGE ON TV SCREEN

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Keywords: Background color, Thai Sign Language, TV screen

ABSTRACT

In this study, the viewing of deaf on television are relating interpreter while they watched news broadcasts. The study shows that deaf viewers focus on the interpreter who are on the suitable background, hearing audience is very clear on the blue color. In contrast of the deaf who satisfied the red, yellow and orange to make the deaf viewers watch the information as soon as interpreter on screen well. The warm tone is significantly proportions more than cool tone when the deaf audiences were watching the interpreter.

INTRODUCTION

In examining the context to the research question, the aspects are considered, of the briefly sign language by deaf education in Thailand. The schooling for the physically disabled began between 1950 – 1952, the school for deaf was established by M.R. Semsri Kasemsri who was responsible for convincing the government of the need for formal education for deaf people. For establishing the school of deaf Lady Kamala Krirksh was responsible for establishing the network of schools and teaching curriculum. Although most hearing people view deafness merely as a pathological disorder, but the deaf persons use whom sign language is the main language of communication typically view themselves as belonging to a cultural minority.

After 1994, the establishment of educational facilities for the deaf was growing by international awareness of human rights, Ministry of Education set up special education school as a positive overt activity is therefore a recent history that underpin the current system. Thai sign language use for deaf people around the country located by the special schools for example Setsatain School for the Deaf in Bangkok, Nontaburi School for the Deaf in Nontaburi, Chonburi School for the Deaf in Bangsan Chonburi, and Anusarn Sunthorn school in Chiang Mai.

The Thai sign language were development by Lady Kamala Krirksh who brought with her from American sign language when she studied at Gullaudet. From these Thai sign language formulated by speak and sign called Sign Thai. In the first, it was not dependent from spoken or written. After that the Thai sign language developed to communicate combined of sign (hand shapes), gesture, and facial expression then Thai sign language became their own language by own morphology, own syntax, and own semantics. The Thai sign language was recognized in the field of special education. In August 1999, the Ministry of Education formally recognized Thai Sign Language as the Nation Language of the Deaf People. [1]

In 2012, the television accessibility was designed on the rights of persons with disabilities then National Broadcasting and Telecommunications Commission deployed the Broadcasting Act of Radio and Television encouraged and protected the rights of the disabled in Thailand. The roadmap of broadcasting master plan also set out guidelines for compliance with established a facilities for the disabled; visually impaired and hearing impaired accessed the television program via Audio description, Closed captions, and Sign language. [2]

In Thailand, the viewing of deaf on television are watching only hearing interpreters. The small picture size of sign language perform by interpreter on screen implied presenting a visual language on visual media in the same time. Then subtitling is not necessarily done specifically for Deaf or hard-of-hearing audiences, but may be also offered to hearing audiences who use for some reason benefit from a written script. Then the deaf audience watching for the little screen of interpreter and background colors contrast and combination was importance to grant accessibility of sign language on screen. The different aspects could impact color interactions, background color and the signer's clothes color. There is no standardization of color for screening of sign language background color thus TV programs use any colors of background by each TV station.

Figure 1. screen of sign language

Objective

The purpose of research was selected the good color suitable for background that signer or interpreter who wore a dark blue suit. The result was shown that blue tone and green tone were better than reddish background. The color combination could greatly affect perception, accessibility, and readability.

Hypothesis

Ho: the tone of color background stratified independent between deaf and hearing

H1: the satisfying are related of tone of color background between them

Methodology

This research study primarily focuses on the topic of background color is suitable for the deaf audience. The quasi experiment is applied by using group post – test only design method. The experiment performs into the deaf and hearing groups. The experimental, the subjects are 25 deaf for participants, designed to select the 1 – 6 background colors of interpreter with blue, green, orange, yellow, red, and purple background for testing. Then deaf choose the most satisfy color and the second color and the third color of background color that suitable for the interpreter. Then set the subjects 25 hearing for participants, is designed to select the same apparatus. The deaf participants from Setsatian school for deaf and the hearing students from Faculty of Mass Communication Technology Rajamangala University of Technology Thanyaburi. The result is collected immediately after watching a stimulus. Means and percentage, frequency were used to analysis the data. The chi square test is a statistics to analyze the relation of satisfy color between them.

Result

The results of the testing the stratified of color background factors to interpreters on TV the hearing and the deaf is shown in the table 1 - 3.

First priority color background		type		Total
		deaf	hearing	
blue	Count	13	13	26
	% within first	50.0%	50.0%	100.0%
green	Count	1	5	6
	% within first	16.7%	83.3%	100.0%
yellow	Count	7	5	12
	% within first	58.3%	41.7%	100.0%
orange	Count	3	2	5
	% within first	60.0%	40.0%	100.0%
purple	Count	1	0	1
	% within first	100.0%	.0%	100.0%
Total	Count	25	25	50
	% within first	50.0%	50.0%	100.0%

Table1

The blue color that the deaf and the hearing selected 13 and 13. It is the most satisfying color background of interpreter. There are fifty percent when compare with the deaf and the hearing. The green color is selected 1 from the deaf and 5 from the hearing. The yellow is selected 7 from the deaf and 5 from the hearing. The orange is select 3 from the deaf and 2 from the hearing. The purple is selected from the deaf only 1 while the hearing don't select. The red is not selected from any one. The result showed in table 1.

Second priority color background		type		Total
		deaf	hearing	
blue	Count	5	4	9
	% within second	55.6%	44.4%	100.0%
green	Count	5	7	12
	% within second	41.7%	58.3%	100.0%
yellow	Count	4	4	8
	% within second	50.0%	50.0%	100.0%
orange	Count	4	2	6
	% within second	66.7%	33.3%	100.0%
red	Count	3	1	4
	% within second	75.0%	25.0%	100.0%
purple	Count	4	7	11
	% within second	36.4%	63.6%	100.0%
Total	Count	25	25	50
	% within second	50.0%	50.0%	100.0%

Table2

The result of table 2 is shown that the second satisfying color background of interpreter. The blue color that the deaf and the hearing selected 5 and 4. There are almost fifty percent when compare with the deaf and the hearing. The green color is selected 5 from the deaf and 7 from the hearing. The yellow is selected 4 from the deaf and 4 from the hearing are fifty percent when compare with the both. The orange is select 4 from the deaf and 2 from the hearing. The red is selected 3 the deaf and 1 from the hearing. The purple is selected 4 from the deaf and 7 from the hearing.

Third priority color background		type		Total
		deaf	hearing	
blue	Count	1	3	4
	% within third	25.0%	75.0%	100.0%
green	Count	5	5	10
	% within third	50.0%	50.0%	100.0%
yellow	Count	6	3	9
	% within third	66.7%	33.3%	100.0%
orange	Count	5	4	9
	% within third	55.6%	44.4%	100.0%
red	Count	6	5	11
	% within third	54.5%	45.5%	100.0%
purple	Count	2	5	7
	% within third	28.6%	71.4%	100.0%
Total	Count	25	25	50
	% within third	50.0%	50.0%	100.0%

Table3

The third satisfying color background of interpreter. The blue is select 1 from the deaf and 3 from the hearing. The green color that the deaf and the hearing selected 5 and 5 there are fifty percent when compare with the both. The yellow is selected 6 from the deaf and 3 from the hearing. The orange is selected 5 from the deaf and 4 from the hearing there are almost fifty percent. The red is not selected 6 the deaf and 5 from the hearing. there are almost fifty percent when compare with the both. The purple is selected 2 from the deaf and 5 from the hearing. The result showed in the table 3.

The stratified of color wheel for background. The color wheel is consist of cool tone consist of Blue, Green, Purple and the warm tone consist of Red, Orange and Yellow.[3] Between the deaf and the hearing in order to selected the most satisfy color, the second color and the third color of background that suitable for the interpreter. To test the hypothesis, the chi square inferential statistics used to test about stratified of color wheel for background between the deaf and the hearing in table 4 – 9

Crosstab

			First priority		Total
			Warm tone	Cool tone	
type	deaf	Count	10	15	25
		% within type	40.0%	60.0%	100.0%
	hearing	Count	7	18	25
		% within type	28.0%	72.0%	100.0%
Total		Count	17	33	50
		% within type	34.0%	66.0%	100.0%

Table 4

The result is shown in table 4 the first priority color background that the deaf selected is warm tone (40.0%) It is opposite the hearing because of selected warm tone (28.0%). Accept Red is not selected by the both. Then the chi square showed not significant of the Pearson Chi-Square test (.370) that is shown in table 5.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.802[a]	1	.370		
Continuity Correction[b]	.357	1	.550		
Likelihood Ratio	.805	1	.370		
Fisher's Exact Test				.551	.276
Linear-by-Linear Association	.786	1	.375		
N of Valid Cases	50				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 8.50.

b. Computed only for a 2x2 table

Table 5

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Crosstab

			Second priority		Total
			Warm tone	Cool tone	
type	deaf	Count	11	14	25
		% within type	44.0%	56.0%	100.0%
	hearing	Count	7	18	25
		% within type	28.0%	72.0%	100.0%
Total		Count	18	32	50
		% within type	36.0%	64.0%	100.0%

Table 6

The result is shown in table 6 the second priority color background that the deaf selected is warm tone (44.0%) It is opposite the hearing because of selected warm tone (28.0%) Then the chi square showed not significant of the Pearson Chi-Square test (.239) that is shown in table 7.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.389[a]	1	.239		
Continuity Correction[b]	.781	1	.377		
Likelihood Ratio	1.398	1	.237		
Fisher's Exact Test				.377	.189
Linear-by-Linear Association	1.361	1	.243		
N of Valid Cases	50				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 9.00.

b. Computed only for a 2x2 table

Table 7

POSTER SESSION

Crosstab

			Third priority		Total
			Warm tone	Cool tone	
type	deaf	Count	17	8	25
		% within type	68.0%	32.0%	100.0%
	hearing	Count	12	13	25
		% within type	48.0%	52.0%	100.0%
Total		Count	29	21	50
		% within type	58.0%	42.0%	100.0%

Table 8

The result is shown in table 8 the third priority color background that the deaf selected warm tone (68.0%) It is more than that the hearing selected a few of number opposite the hearing (48.0%) The chi square showed not significant of the Pearson Chi-Square test (.152) that is shown in table 9.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.053[a]	1	.152		
Continuity Correction[b]	1.314	1	.252		
Likelihood Ratio	2.068	1	.150		
Fisher's Exact Test				.252	.126
Linear-by-Linear Association	2.011	1	.156		
N of Valid Cases	50				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 10.50.

b. Computed only for a 2x2 table

Table 9

Conclusion and discussion

The study showed that some deaf want background to be warm tone, because it made the interpreter look brighter for watching information source. The sign language is their own language, and the deaf audience look in to their verbal sign on the screen. The picture size is too small, sometime the harmony of cool tone is not use full for seeing. The environment from the interpreter is accessed via the hand shape, gesture, and facial communication. This context is a grammatically language seem a semantics.

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POSTER SESSION

KANSEI EVALUATION OF COLOR IMAGES PRESENTED IN COLOR GAMUTS WITH DIFFERENT RED PRIMARIES

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Keywords: Color gamut, Red primary, Display, KANSEI evaluation, SD method

ABSTRACT

This study is to investigate influence of color gamut on KANSEI evaluation of color images. We focused on the expansion of color gamut in red area using four different monochromatic red primaries of 610nm, 620nm, 630nm, and 640nm. In the experiment, two sets of 15 color images (Group 1 and 2) were used as test stimuli. Five adjective pairs, “Deep color-Pale color”, “Beautiful-Unbeautiful” “Like-Dislike”, “Impressive-Mundane”, and “Natural-Unnatural”, were used in the KANSEI evaluation. The red primaries of 630nm and 640nm provides deep color and impressive feeling, but the most unnatural. Similar tendency is observed in both groups.

INTRODUCTION

Recently, super-wide color gamut display are being spread to our everyday life because of development of advanced display technology. In 2012, BT2020 was established for UHDTV broadcast. Its RGB primaries are equivalent to the monochromatic wavelength of 467nm, 532nm and 630nm and has 1.89 times compared to conventional gamut (BT709) It can reproduce super-wide color gamut by using monochromatic wavelength. On the other hand, DCI-P3 has been already implement in upper models of wide display and mobile phones. The wide gamut area, 25% larger than sRGB, is mentioned as the advantage of DCI-P3. It is true that the wider the color gamut, the higher the color reproduction capability. However, few studies have been done to investigate the best color-gamut from KANSEI evaluation point of view.

We had investigated the best blue and green primaries using different blue and green wavelengths as primary and carrying out the KANSEI evaluation experiment [1,2]. Result of the blue experiment, 470nm was the highest evaluation. And result of green experiment, there were not significant difference among wavelengths, found that evaluation depends on contents. Along the stream of our previous studies, the present study focuses on the red primary and investigates the best red primary and investigate influence of color display by employing different reddish wavelengths as red primaries by conducting subjective evaluation experiment.

EXPERIMENT

Apparatus

Figure 1 shows the apparatus. Each of the test color images were displayed on the screen using two projectors, one is for the variable red primary, and the other is for the green and blue primaries. Interference filter (IF) of λp = 610nm, 620nm, 630nm, and 640nm were inserted in front of the lower projector to achieve different red primaries. White point of different red primary conditions was set nearly the same by inserting appropriate ND filters in front of the projectors 1 and 2. Images from the two projectors were carefully superimposed on screen. As for observers, we used 10 males and females with normal color vision.

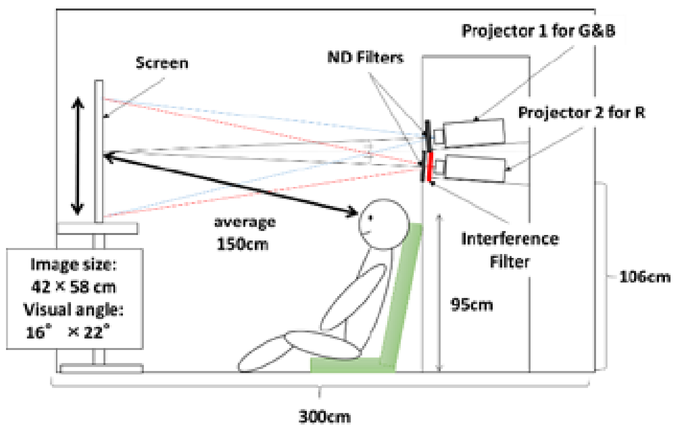

Figure 1. Experimental apparatus

Test images

Two sets (Group 1 and Group 2) of 15 color images were used as test stimuli in this experiment. Fifteen images are representatives of red, green, blue, yellow, orange, red-green, green-blue, yellow-blue, yellow-green, red-blue, pink, purple, multi-colors, monochromatic, and skin groups according to the criteria based on categorical color analysis [3].

Figure 2 shows the scale employed in the KANSEI evaluation. Five adjective pairs, "Deep color-Pale color", "Beautiful-Dirty", "Like-Dislike", "Impressive-Mundane" and "Natural-Unnatural", were selected based on previous studies [4,5]. Observers were asked to evaluate each test images for each adjective pair by marking proper position on a seven point scale (-3 to 3) between the bipolar indicated in Figure 2.

Figure 3 shows the flow of experimental procedure. Observers took 5 minutes dark adaption in the beginning of each session. Then the first test image was presented, and subjective evaluations were conducted. Test images were continuously presented during evaluation. After inserting uniform gray image about 5 sec, the next test image was presented and the evaluation was done again. Red primary was changed every 7 or 8 test images. In a session, 60 images were randomly presented.

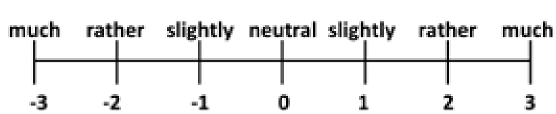

Figure 2. Subjective scale used in the SD method

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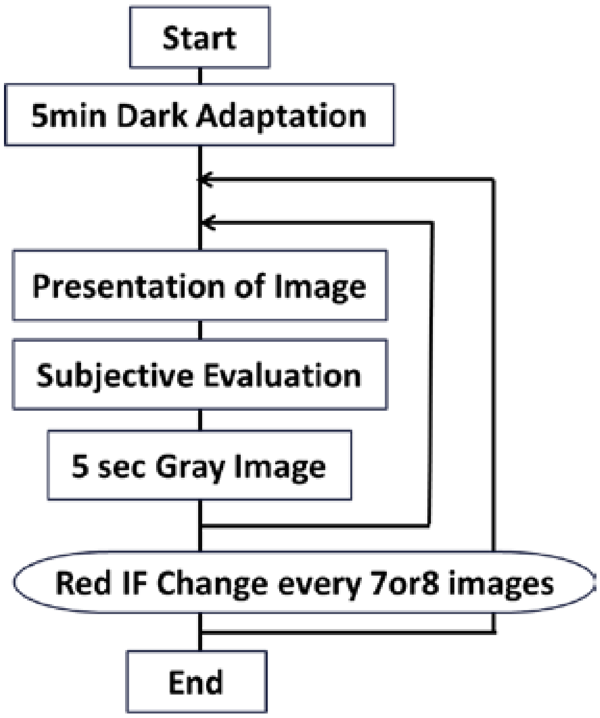

Figure 3. Experimental procedure

RESULTS

Figure 4 and 5 show results of "Impressive-Mundane" of Group 1, and Group 2, respectively, for all images. Average scores of 20 observers are plotted. Focusing on the images including red, i.e., red, red-blue, red-green, and multi-colors, differences among different red primary conditions are noticeable. In both results, 630nm and 640nm primary conditions show higher scores and 610nm primary indicate the lowest.

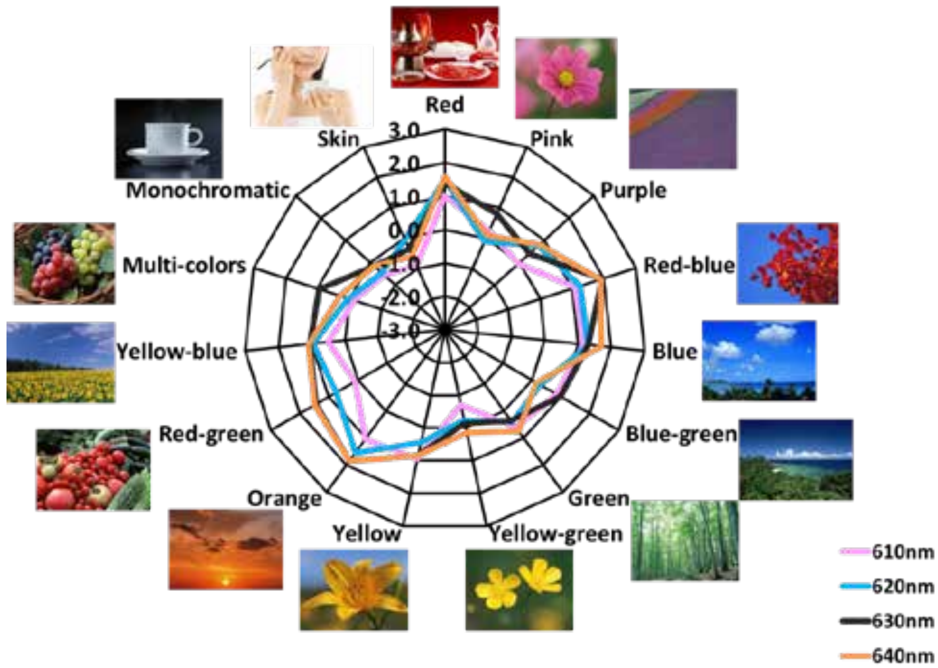

Figure 4. Result of "Impressive-Mundane" of group 1

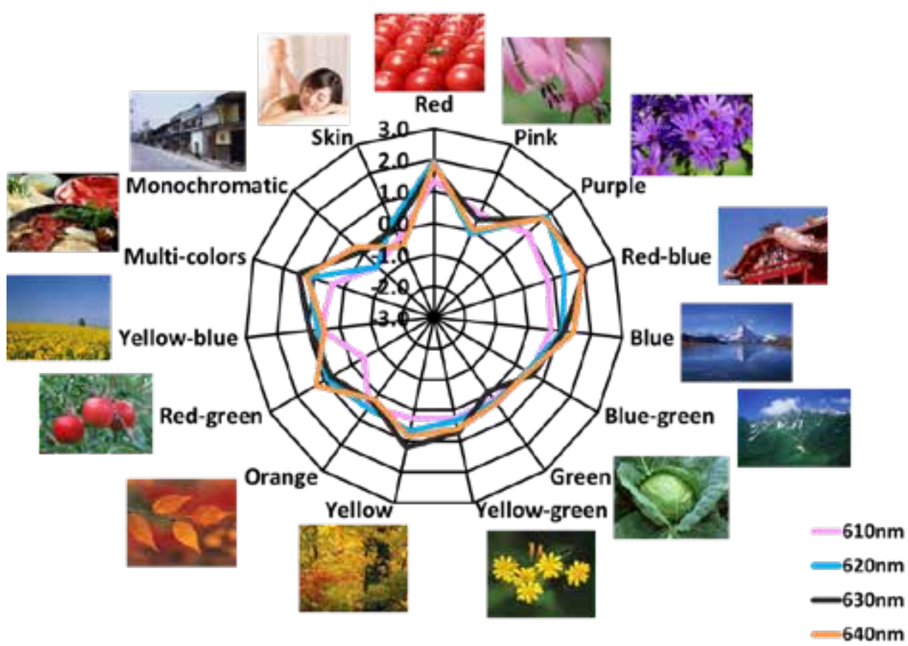

Figure 5. Result of "Impressive-Mundane" of group 2

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Because the results of Group1 and Group2 show similar tendency, average scores of the images including red in two groups (Figure 6) was calculated. Results of red "Impressive-Mundane", "Natural-Unnatural", and "Deep color-Pale color" are indicated in Figures 7, 8, and 9, respectively. In Figure 7, the longer the wavelength of the red primary, the lower the rating score. Significant difference is found between 610nm and 640nm primary conditions for all images. Contrary to that, in Figure 8 and Figure 9, the longer wavelength primaries, 630nm and 640nm, indicate higher rating scores. Significant difference is found between 610nm and 640nm primary conditions for all images except red in Figure 8. In the results of "Beautiful-Dirty" and "Like-Dislike", no significant difference was found among different red primary conditions.

Figure 6. Reddish images

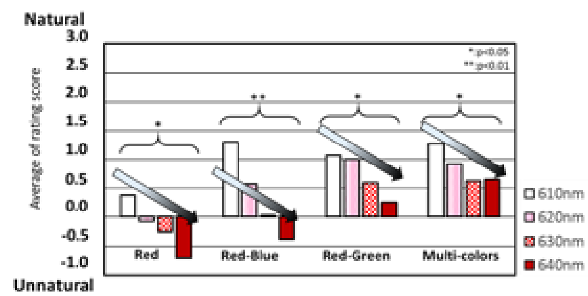

Figure 7. Result of "Natural-Unnatural"

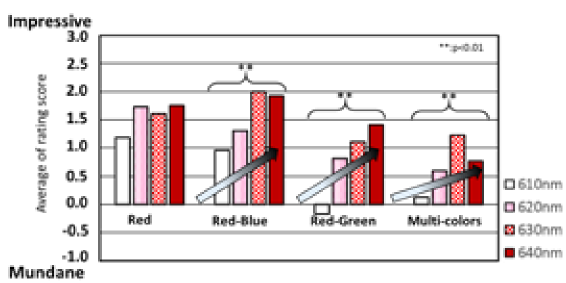

Figure 8. Result of "Impressive-Mundane"

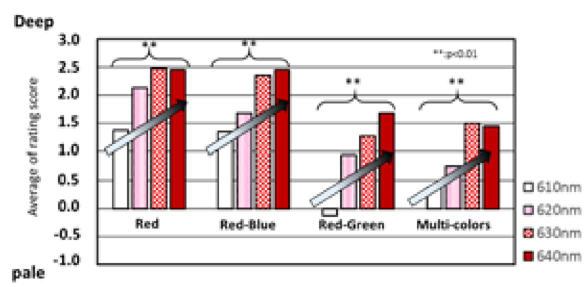

Figure 9. Result of "Deep color-Pale color"

CONCLUTION

Opposite tendency is observed between the results of "Natural-Unnatural" and "Deep color-Pale color" or "Impressive-Mundane" in the rating scores in different red primary conditions. In the former, 610nm primary condition is the best and 640nm condition is the worst, while in the latter, either 630nm or 640nm primary condition shows the highest score and 610nm condition the lowest. These results indicate that the color gamuts with the red primary of 630nm, which is the BT.2020 primary, and with 640nm, further longer wavelength, provide deep color and impressive feeling, but less natural. On the other hand, the red primary of 610nm, which is the closest to the DCI-P3 primary, gives neither a deep red appearance nor impressive, but it appears more natural for most observers. KANSEI evaluation seems to depend on the appearance of whole image, which is based on color appearance of each pixel, that strongly depends on its chromaticity and luminance. Triad relation of color gamut, i.e., pixel distribution in a color space, pixel-based color appearance, and KANSEI evaluation is to be investigated.

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THE CHARACTERISTICS OF THE HAPPY FAMILY ON THAI CULTURE CONTEXT

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Keywords: Happy Thai families, Family well-being, Family involvement.

ABSTRACT

Since the social sustainability is based on family units, this research aims to study the crucial components of happiness among Thai families. The samples were collected from 120 Thai people as a representative of the family. The open-ended questionnaire was used as a tool for analyzing exploratory factors of the principal component extraction method. The results have shown that there were two factors namely: family-involvement and family well-being. The family-involvement factor involve being relationship-oriented and the family well-being involved economic and social values oriented with a reliability test between 0.925 and 0.693 respectively.

INTRODUCTION

In the capitalist economic paradigm, the goal is economic value and most people focus on their careers in order to gain a better source of income to respond to such factors. Even though countries have high gross revenues, they still face problems. The use of a misery index in various countries indicated that Thailand has an index value of 2.5. Meanwhile, although other countries such as South Korea and Denmark have a higher average income in comparison to Thailand, but also have lower happiness index in figure1 (Boomberg study results, 2017, https://www.bloomberg.com). The index indicated that the happiness of Thai families did not only have an economic dimension but there was another dimension involved, namely: leadership, self-involvement, and interpersonal relationships between family members. Thus, the analysis to extract these crucial characteristics for managing a strong society is the main point of the study.

Source: https://www.bloomberg.com

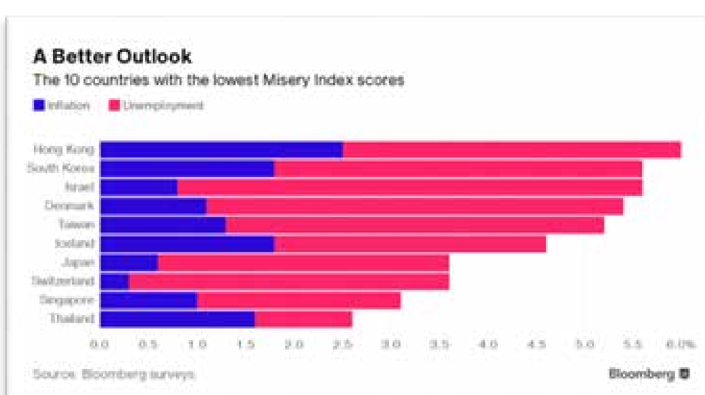

Figure 1. Misery index scores of 10 happiest countries in 2017

The happiness of Thai families can be differentiated from other nations in the context of happiness such as respect, generous sharing, and creating core values of the family. The creation of strong family member relationships is essential for solidifying the bonds to maintain harmonious familial structures and bonds. This extends to a further issue which is regarding how we intend to resolve the management and maintenance of family bonds. The happiness among Thai families in the managerial sense requires knowledge about the components of family happiness. This is similar to the measurement of a balance-score card in business, organizational success, or triple bottom lines in social organization. If the key success factors of Thai happy families are known, then the family leader will be able to manage his/her family. According to previous research, the lack of knowledge on an employee's intrinsic value ultimately contributes to an overall imbalance and deficiency in family factors. This severely impacts employee job performance.

LITERATURE REVIEW

"Happiness" involves a level of satisfaction and fulfillment in life. It means the level at which a person judges the quality of life overall in terms of satisfaction at the level of recognition that they achieve their goals or have their wants and needs met. It consists of mind, knowledge, thought, and level of feeling (Veenhoven, 1996). Martin (2000) exaggerated that what contributes to increased levels of happiness is the need for a better social relationship than the average person, cheerfulness, good emotions, and positive thinking. In the emotional dimension based on the concept of Manion (2003): happiness is the physical and mental condition that consists of positive thinking and a cheerful spirit by expressing both body and spoken language. It is a language that is full of creative power and the desire to contribute to happy activities and exude a positive force. It also involves the desire to pave a pathway of through generosity to those in their lives be it through people in family, work and society (Layard, 2005).

Family studies in various dimensions, such as the cultural dimension of Hofstede (1991) have been able to simplify the five dimensions that contribute to overall employee performance. Hofstede (1983) performed comparative research of culture in different countries by 116,000 IBM employees from around the world. He has summarized the difference in five dimensions:

1. Power distance: It is inequality, particularly status differences. Thai culture is highly divisive between those who have an elevated professional status in organizations, e.g. father and son, boss and subordinate, etc. Kanjana (2012) has a comparable value of the indicator between Germany, Japan and Thailand as follows: 35, 54 and 64. The index is used to measure the acceptance of inequality (respect for seniority or hierarchy in society, honor those with higher organizational positions, decentralization from supervisors to subordinates). The higher the index, the higher the inequality. Those with high positions are the sole decision makers. Those in lower positions are responsible for fulfilling orders. In the case of a Thai family organization, which in the past had high index values, nowadays, the value has decreased due to environmental factors.

2. Individualism/Collectivism: Individuals in each society have a concept and a lifestyle of their own, and contributes to forms of socioeconomic inequality. People of some societies do not take into account the social norms and practices or the feelings of the people around and hold legal rights (individualism), whereas people in east culture tend to be socially oriented (collectivism). They are concerned about the feelings of others or of the group, rather than the law alone, e.g. Thai families have a lot of support among relatives or family members. This culture is like a double coin. The positive aspect is to make members love each other in the society, but the negative aspect is the patronage system.

3. Masculine/Feminine: The dimension of gender roles separates men and women, meaning this in itself influences how society dictates their way of life. It is focused on the success of work depending on one's gender. In society, it is often given that family leaders often being the "father," has to work to nourish the family. While female culture refers to the success of the value of life, the housewife is often assigned to take care of the family.

In Thai society, Thai men give value and importance of income, return and progress of work while women focus on interpersonal relationships and social environments. High index means that men play more roles than women and society is highly competitive. Culture is constantly changing. This index value in three countries, Germany, Japan and Thailand are 66, 95 and 34 respectively. The figures show that Thai society is less valuable than Germany and Japan since Thai women go to work same as men.

4. Uncertainty avoidance: Uncertainty management in the future by avoiding risk and creating stability and security. This index value in three countries, Germany, Japan and Thailand are 65, 92 and 64 respectively. Japan has a value of 92 that means the Japanese are very strict with discipline and planning. In Thailand, this index is neutral. It means that Thai family leaders must focus on building relationships among family members.

5. Short-term/Long-term orientation: The dimension of collaboration means that the person assess the other by considering of the personal relationship in a short time or a long lasting. The long-term orientation, person is familiar with difficult because they must take time to study the other, but when they close to anyone with a long relationship. On the other hand, Short-term orientation person is friendly with no deep bondage.

Understanding the cultural differences in each society and family is very important both in terms of management, communication and coexistence. Thai culture family is often expected by the society. The father must be a strong leader in making the right decision for the family. It is responsible for the main problems of the family. The role of the mother is to be a good follower and take care of the needs of the family rather than their own needs.

Pinyuchon & Grey (1997) studied six factors influencing Thai families were ***Religious beliefs:*** Most Thai Buddhists who teach Karma. Good people will be good to their parents, who give birth. Children will obey and respect their father and mother. ***Rural and urban society***: Families of rural communities differ from those living in cities because families in the city have less time to eat together. ***Family relationship***: Most Thai families find only two generations living in the same house. ***Social value:*** The children will live in their parents' homes in Thai family cultures until they get married. This affects the amount of communication within the family. Thai family Parents are always examples and never make mistakes and always consider their child as children in the eyes of parent. The child can not do anything without permission or advice from the parent. ***Role of men and women:*** Thai families tend to focus on men because they are family leaders. ***Sexuality:*** Thai families consider sex as a matter of concealment.

From research on various dimensions of "happiness in Thai family" in both cause and effect are the attributes of happiness. This study analyzes the composition of the happiness index in the Thai family.

METHODOLOGY

The study was conducted by collecting 120 sampling units; family located in Bangkok. Our study was a pilot project, and the data was the measurement of the structural interview for the happiness in the family theme. Data analysis using factor analysis to explore the key factors and lisrel as a co-variance based SEM was used to test model fit.

RESULTS

A total of 13 variables were used to analyze the components of happiness in the Thai family by the principal component technique with discarding 4 non-significance relevance variables as shown in table 1.

Rotated Component Matrix[a]		
	Component	
	1	2
Cronbach's Alpha	**0.925**	
A Help/share activities	-0.893	
H Time together	0.699	
I Adaptation	0.691	
J Honesty	0.516	
B Justice	-0.499	
Cronbach's Alpha		**0.693**
D Economy / Security		0.707
K Society		0.686
E Health		0.575
M Descendants		0.547
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.		
a. Rotation converged in 3 iterations.		

Table 1. The results of the analysis of Thai family happiness factors.

From Table 1, Factors of rationality, forgiveness and communication variables were cut by using factor analysis and named the factors as follows:-

Factor 1 Family-Involvement consists of help/share activities, time together, adaptation, honesty, and justice which corresponds to the four main principles in Buddhism.

Factor 2 Family Well-Being consists of economy/security, society, health, and descendants (Financial + Health + Emotion)

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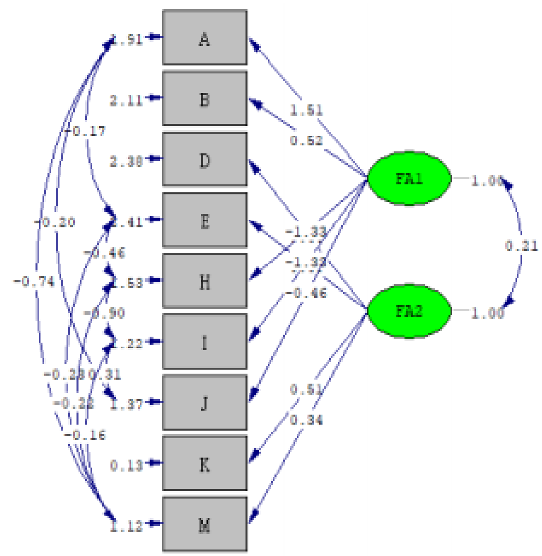
The result of confirmatory analysis with Lisrel



Chi-Square=36.09, df=17, P-value=0.00446, RMSEA=0.095

Index	Value	Standard	Reference
Chi Square	36.09	-	-
Degree of Freedom	17	-	-
χ^2 / df	2.122	< 3	Wheaton et al. (1977 Kline (1998); Ullman (2001) Tabachnick and Fidell, (2007)
RMSEA	0.095	< 0.08	Browne & Cudeck(1993)
P value	0.044	> 0.05	p= 0.05; p= 0.01 (Lomax ,2004)
NFI	0.90	> 0.90	Byrne, (1994) Schumacker & Lomax(2004)
CFI	0.92	> 0.93	Byrne, (1994)
GFI	0.94	0.90	Byrne, (1994):Schumacker & Lomax (2004)
AGFI	0.89	> 0.90	Byrne, (1994)
IFI	0.94	> 0.90	Anderson & Gerbing, (1993); Marsh, Balla, & McDonald, (1988) ;Hu & Bentler, (1995)
RMR	0.076	< 0.08	Browne & Cudeck, (1993)

Table 2. Goodness of fit index of Thai family happiness factors.

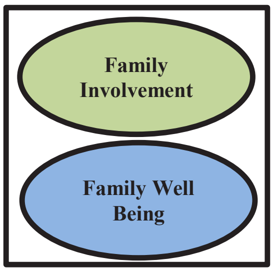
The overall of fit index using co-variance based analysis were good with respect to theoretical threshold.

Test results of goodness of fit index

Models are consistent with empirical data. Chi-square goodness of fit statistic is 23.92 at 14 degrees of freedom were statistically significant at .05 level. The relative chi-square (χ^2/df) is 1.71 (less than 3) which is shown empirical data are consistent with structural model of the researcher. Goodness of fit index (GFI) is .96 (greater than .90 and almost to 1). Adjusted goodness of fit index (AGFI) is .89 which is the only value that is not passed (the criterion of AGFI is greater than .90). Compared goodness of fit index (CFI) is .95 (greater than .93). Root mean square residual (RMR) is .076 and root mean square error of approximation (RMSEA) is .066 (less than .08) indicate that the component model is consistent with the empirical data.

DISCUSSION

The results of the analysis of factors contributing to the happiness of Thai families shows the first element is family involvement which shows the roles and interactions within the family, help/share activities, time together, adaptation and honesty. The second element is family well-being which is the basis of the family. It consists of economy/security, society, health, and descendants. Research results can be used to create happiness indicators into two sub-factors.



HAPPY THAI FAMILY

FUTURE WORK

Research should be done to study the components of happiness in other cultures by comparing with Thailand. Furthermore, a driven study to manage family happiness in the context of mediator and moderator variables should be done.

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CHROMATIC THRESHOLD FOR TOTAL COLOR-IMAGE IMPRESSION

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Keywords: colored image; KANSEI evaluation; chroma; categorical color; CIELAB

ABSTRACT

As a first step, to investigate the psychological importance of color in image for human observers, the threshold degree of chroma for various color images was measured in this study. We did color naming experiment. In this experiment, 9 different images, each of them was classified into one of the 15 color category in our previous study,[1] were employed as test images. The subject watched test stimuli on the display, and selected the representative color of the images among 14 categories. We call the metric chroma that gives 50% of achromatic responses "Border Chroma between Achromatic and Chromatic Impression (BCACI)". Results so far obtained indicate that BCACIs of test images expressed in the metric chroma C_{ab}^* are in the same range except "pink" and "purple" images of which BCACIs are lower than those of others. In the next step, relation between C_{ab}^* and KANSEI evaluation to be investigated.

INTRODUCTION

Our life is quite rich in color because of the development of technologies in printing, display, everyday objects, and arts, etc. color reproduction of the display. Especially in imaging field, humans had developed eagerly to add colors to images in movie, TV, and PC. Images with colors are generally called "chromatic image". On the other hand, images that are composed of only monochromatic color, called "monochromatic image", still exist. Despite of passionate seek of chromatic image in the broadcast and imaging technology, psychological research why humans demand colors is not systematically investigated. Some studies have reported that a change of chroma influence psychological evaluation and visual comfort of images.[2,3] However, these studies did not show the threshold degree of chroma that gives observers "chromatic image" impression. In other words, to what extent of chroma is needed for human observers to perceive that the presented image is chromatic, has not been studied. As a first step, to investigate the psychological importance of color in image for human observers, the threshold degree of chroma for various color images was measured in this study.

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EXPERIMENT

Test Stimuli

Nine different images representing the following color names, "red", "green", "orange", "yellow", "pink", "blue", "purple", "red and green", and, "yellow and blue", as shown Figure 1, were used as the original images. Color names are based on our previous study.[4] In that study, each pixel was classified into color category in any one of 14 colors, "red", "brown", "pink", "orange", "yellow", "green", "blue", "light blue", "purple", "black", "dark gray", "gray", "light gray" and "white" based on categorical color database. In addition to those, category of "skin color" was added. Then more than 2000 color images were classified into 15 color groups based on the percentage of above categorical colors in the image, and classification was examined psychophysical experiment.[3] In this study, 9 different images indicated in Figure 1 were chosen as original test images that were employed as test stimuli in our previous studies on KANSEI evaluation.[5,6,7] For each of the original test images, low chroma images were made. Each pixel of original image was multiplied by multiplying factor k based on metric chroma C_{ab}^* in the CIELAB space, while lightness L^* is kept constant. Multiplying factor k ranges from 0 to 0.2. For each of original images, over 8 different C_{ab}^* images were prepared. Test stimuli of red are shown in Figure 2.

Viewing Condition
Test stimulus was presented on the display (EIZO ColorEdge CG277) with the visual distance of 120cm. Display and observer's seat were set up in a booth covered by black curtain.

Color Naming Experiment
Observer took 5-min dark adaptation at the beginning of each session. A test stimulus was presented and the observer was asked to choose one color name among 14 color names described in *Test Stimuli* section above by checking the corresponding color name among 14 color names written in the answer sheet. Test stimulus was presented continuously until the observer made the response. This is called on trial here, and between trials, uniform gray image (R, G, B = 38) was presented about 3 sec. Total of 97 images (8 to 10 C_{ab}^* images for 9 different images shown in Figure 1) were used as test stimuli. One test stimulus was presented 3 times throughout a session, and 2 sessions were repeated for each observer. As a total, 582 trials were done for each observer. Test stimuli were presented in a random order.

Figure 1. Original images for test stimuli. Color name indicated below the picture is named in our previous study.[4]

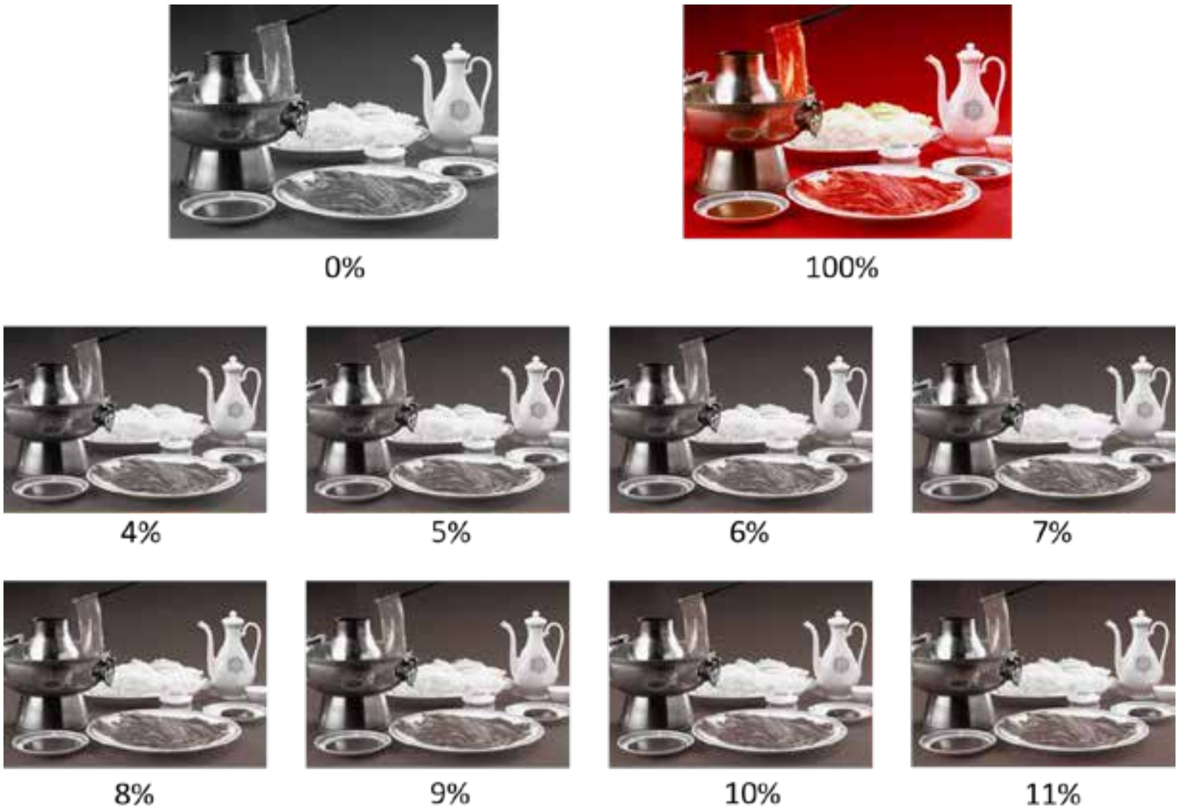

Figure 2. Test stimuli of the red images. 100% image was indicated in the figure, but not included in the test stimuli.

Observers

A total of 20 subjects in their twenties with normal color vision examined by Ishihara Chart participated the experiment.

RESULTS

Border Chroma between Achromatic and Chromatic (BCACI)

When we made test stimuli, we calculated L^*, a^*, b^*, and C_{ab}^* using a white point (R, G, B = 255) as a reference white. However, colorimetric values depend on individual display. So, we measured chromaticity and luminance of whole image using 2D colorimeter (CA-2500, Konica Minolta) for all test stimuli and a uniform white image. According to the colorimetry, average value of (a*, b*) of k=0 images shifted from (0,0) with slightly different values among different color images. Let ($a_{0,i,j}^*$, $b_{0,i,j}^*$) be the average (a^*, b^*) values of k=0 image of color i (i=red, green, orange, yellow, pink, blue, purple, red and green, and, yellow and blue) in the jth measurement of colorimetry (j =1 to 4). Average value of 4 times of measurements was employed as the new origin of color i, and C_{ab}^* was recalculated for each of the test stimuli pixel by pixel in the image taken by the 2D colorimeter. Then average value of C_{ab}^* was derived and it is called "effective value of C_{ab}^*" here. Multiplying factor k expressed in % and corresponding effective values of C_{ab}^*, expressed as $C_{ab,eff}^*$ for red image are indicated in Table 1. Due to the differences among four times measurements, $C_{ab,eff}^*$ for k=0 is not 0.

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Table 1. Relation between test stimulus and effective value in the case of red image

Multiplying factor k [%]	Effective value of metric chroma ($C_{ab,eff}^*$)
0	6.05
4	6.74
5	7.13
6	7.53
7	7.98
8	8.49
9	9.05
10	9.43
11	10.02
100	56.65

In the data analysis, we counted the number of achromatic responses for one test stimulus. Achromatic responses here mean that observer's choice was one of the following color names, "gray", "white", "black", or "black and white" in the answer sheet. Maximum number of achromatic response is 6 and minimum number is 0 because one test stimulus was presented 6 times. It is plotted against the $C_{ab,eff}^*$, and $C_{ab,eff}^*$ that gives 50% of achromatic response is determined by fitting the results using the equation 1 which is called BCACI, Border Chroma between Achromatic and Chromatic Impression.

$$y = \frac{a}{1+e^{m(x-c)}} \tag{1}$$

In Eq. (1), y is a number of the achromatic responses, x is the effective value of metric chroma, a is 6 (the maximum of y) and m is the slope. Figure 3 shows the result of red image for one observer.

Figure 4 and Figure 5 are the number of each color responses for all of subjects in the case of red image. Increasing the effective value, the number of achromatic responses reduced and chromatic responses increased. In Figure 5, not only red, but also pink, orange and brown responses appear, and the total of them is plotted as chromatic responses by black circles.

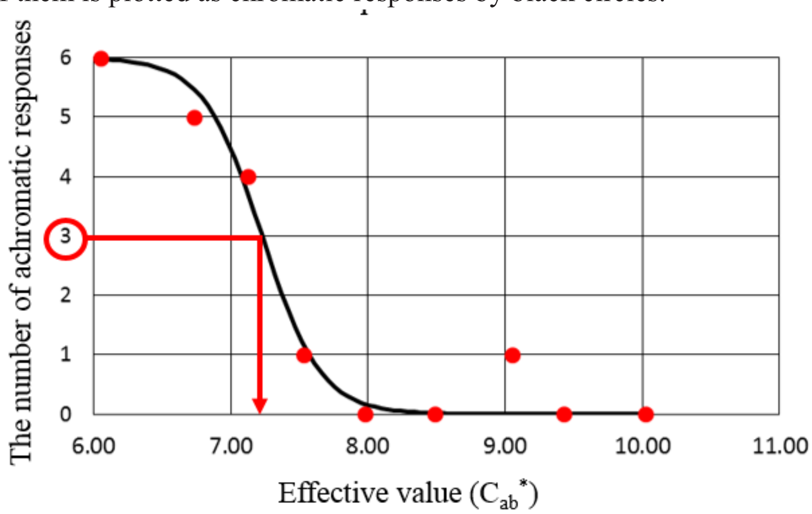

Figure 3. Example of the achromatic responses and the curve fitting

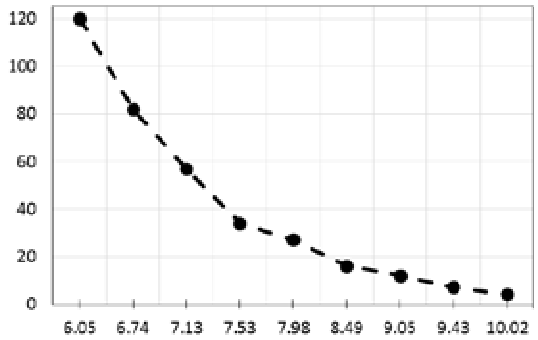

Figure 4. Number of achromatic resposes (red image)

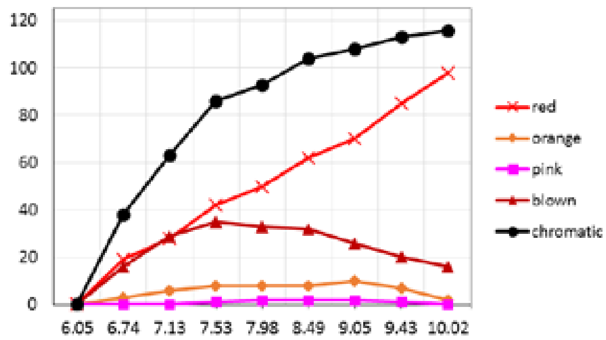

Figure 5. Number of chromatic responses (red image)

We calculated average of BCACI at all of observers for each of the test images. It is shown in Figure 6. Vertical bars indicate standard error among observers. Results so far obtained indicate that BCACIs are in the same range around 7 except "pink" and "purple" images of which BCACIs are lower than those of others. In other words, when the metric chroma C_{ab}^* exceed 7, observer's perception of the whole image turns from achromatic to chromatic. Reason why the BCACIs of "pink" and "purple" are lower than other test images is not known.

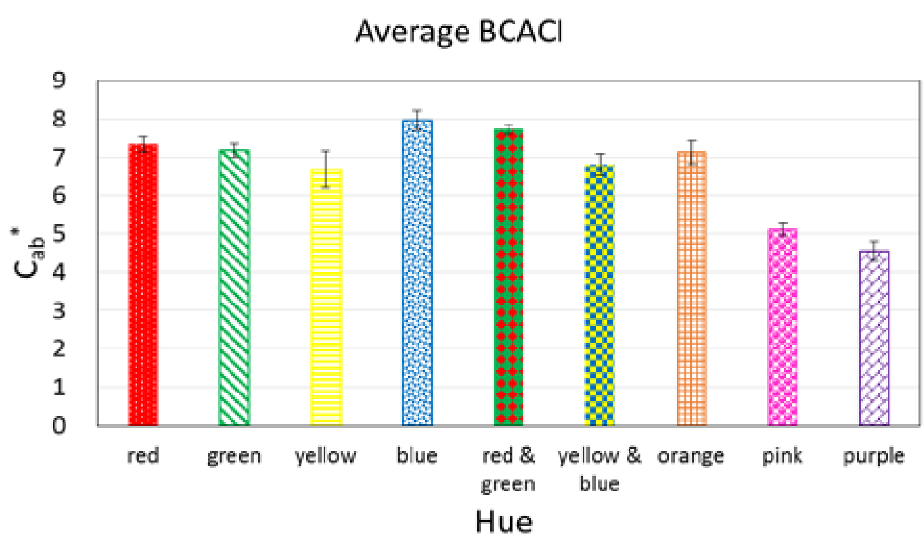

Figure 6. Results of average BCACI (n=20)

CONCLUSION

In this research, using 9 test images, representative color of each of them were previously determined psychophysically, BCACI, Border Chroma between Achromatic and Chromatic Impression, was measured. Results showed that BCACIs of test images expressed in the effective metric chroma $C_{ab,eff}^*$ are in the same range around 7 except "pink" and "purple" images of which BCACIs are lower than those of others. In the next step, it is necessary to investigate whether the value of BCACI depends on representative color or content of image. Our interests are also in revealing the relation between average metric chroma and KANSEI evaluation of image.

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AUTOMOTIVE EXTERIOR AND COLOR MATCHING METHOD BASED ON KANSEI ENGINEERING

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Keywords: Kansei Engineering: Automotive Exterior and Color Matching: Semantic Difference Method: Principal Component Analysis: Morphology and Color

ABSTRACT

Based on the basic theory of Kansei engineering, the semantic difference method is used to quantify perceptual vocabulary, and principal component analysis is used to convert multiple perceptual lexical variables into preferred comprehensive variables. Firstly, we studied the matching relationship between pure form and color, and found that there is a corresponding relationship between form and color. Then, based on five different models of a certain brand, we analyze the perceptual evaluation of the target group. The method of comparing the proportions of the main components before and after the load was obtained, and finally the relationship between the body exterior and the color matching of five different models based on important vocabularies was obtained. The research results have improved the objectivity and scientificity of the body color design, compared with the existing car company's body color plan, and can provide new evaluation methods for enterprises to develop color plans.

INTRODUCTION

With the development of economy and society, the automobile consumer market is becoming more and more mature. The automobile shape and color have gradually become key factors in consumers' purchases of automobiles. According to the survey, more than 75% of Chinese consumers think that the appearance of the car is the primary determinant when they want to buy cars [1]. When people observe the product for the first time, the order of visual sensation is: the color of the product is about 80% of the visual sensation; the shape is about 20% [2]. The shape and color of the car have a very important impact on sales. Therefore, to solve the matching problem between the shape and color, a systematic and objective method of cognitive analysis and guidance is needed.

1 RESEARCH STATUS OF KANSEI ENGINEERING AND AUTOMOBILE SHAPE AND COLOR

1.1 Kansei Engineering

Kansei engineering is a consumer-oriented technology of product development that uses engineering research methods to explore the relationship between human sensibility and the design characteristics of objects. It can transform consumers' perceptual demand and images into practical design of product details. [3-4].

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1.2 Status of automobile shape and color research literature review

In the research of the automobile shape, the theory of Kansei engineering is mainly utilized by constructing the relationship between shape and intentional vocabulary by using semantic differential analysis, combining with principal components analysis, artificial neural network, cluster analysis, etc. Dimensional analysis and eye tracking form a thermograph and extract the values for quantitative analysis. Some researchers proposed the user's intention to drive the car model based on genetic algorithm. Gene evolution thoughts and method flow; in the study of color imagery, the Likert scale is mainly used in China, while the foreign countries focus on gray theory or BP neural network to study the relationship between color and image. The two main influencing factors of automobile consumption should have a certain matching relationship between shape decoration and color.

In general, the research above has the following shortcomings: 1) The various elements of the automobile are usually related to each other, and the simple collection of the evaluations of each shape element can't lead to a complete and comprehensive result. 2) There are so many factors influencing the automobile that it is difficult to analyze the separate influence of each factor such as the shape and the color. Therefore, it is necessary to study the matching relationship singly between shape and color.

Aiming at the problems above, this paper proposes a method of automobile shape and color matching evaluation based on Kansei engineering. Through the study of automobile shape and color, it is proposed that there is a certain matching relationship between automobile shape and color. Then construct the matching relationship between the automobile shape and color by the SD method and principal components analysis.

2 MATCHING RALATIONSHIP BETWEEN SHAPE AND COLOR

The behavior of users' buying cars is influenced by many factors. Therefore, when exploring the influence of the shape and color on automobile consumption, it is necessary to eliminate influences made by other factors as much as possible. In response to this problem, this paper first conducts experiments about matching between shapes and colors to explore whether there is a matching relationship between the shape and color. Some representative shapes and colors are selected, to explore whether there is a matching relationship between shape and color by the matching method.

2.1 Selection of shapes and colors

As for the shapes, Wang Lin, a morphologist, believes that shapes can be divided into geometric shape, organic shape and physical structure shape. Therefore, 6 geometric shapes and 6 organic shapes are selected in this paper.

As for the colors, Mundell [5] found that the most popular automobile colors are blue, gray and red. Considering expert interviews, market color, car sales and other factors, experiments were carried out in 10 colors of black, white, dark gray, light gray, dark blue, light blue, red, pink, yellow and champagne, with yellow and pink cars being the worst sales in car market.

2.2 Experimental content

In order to understand whether there is a certain matching relationship between shape and color, each of the 12 shapes are matched with the 10 colors and experimented with paired test, which is a paper-and-pen test that requests the subject to match between the images and the language description.

There were 10 people in this experiment, including 5 males and 5 females, all of whom had no visual abnormalities. All of them were college students aged 20-29 years old, who have general sense about shapes and colors.

The selected 12 shapes were numbered as 1~12, and achromatic processing (Figure 1) was performed. In each shape, 10 colors of the shape were randomly arranged and integrated into 12 pictures (Figure 2). The experiment requires the subject to first observe the achromatic picture, and have a certain understanding of the shape. Then, in each picture, select the color that they think matches the pattern and does not match, write the picture number, and perform statistics.

Figure 1. achromatic form

Figure 2. Example of a colored pattern

2.3 Analysis of matching between the shapes and the colors

In this paper, the results of the experiment 1 are analyzed as follows.

It can be seen from the results shown in Table 1 that shape 1-12 have the best matching and least matching colors respectively.

Table 1: Analysis of color matching of each form

form	The most frequently appearing color	
	match	mismatch
1	Dark Gray	Pink
2	Dark Blue/Black	White
3	Black	White/Light Gray
4	Dark Gary	Pink
5	Dark Gray/Black	Champagne
6	Dark Gary	Light Gary
7	Black	White
8	Dark Blue/Dark Gary	Champagne
9	Dark Gary	Black
10	Black/Dark Gary	White
11	Dark Gary	White
12	Dark Blue	White/Black/Pink/Champagne

from the results of the test, the test results in the table 1 show an obvious state of clustering. Therefore, this paper proposes a certain correspondence between shape and color.

3RESEARCH ON THE RELATIONSHIP BETWEEN AUTOMOBILE SHAPE AND COLOR MATCHING

through Experiment 1, a certain correspondence between shape and color was proposed. By this analogy, the car shape, a kind of shape, has a certain matching relationship with the color. In this experiment, 5 car shapes in the images are desaturated and evaluated using the semantically differential method. Then the different colors of the same car shape are evaluated separately.

3.1 Selection of different car shapes and perceptual words

In order to explore the matching relationship between shape and color for specific people, the perceptual vocabulary is quantified by the semantically differential method and converted this paper based on the basic theory of perceptual engineering, quantifies perceptual vocabulary by semantic difference method, and uses principal component analysis to convert multiple perceptual vocabulary variables into preferred ones. Comprehensive variables.

In this paper, 5 different best-selling automobile shapes from the same brand are selected and numbered as A, B, C, D, and E. they are decolorated as (Figure 3). Subsequently, each shape is matched with the color 1-10 that are mentioned above to make up a picture of the 10 colors of each shape, for a total of 50 pictures of different models and different colors (Figure 4).

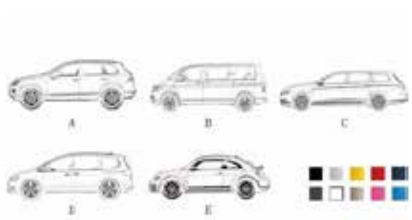

Figure 3. A best-selling model of a brand Figure 4 A. car different color example diagram

Through the comparison of domestic and foreign literatures and case analysis, referring to the color trend, combining the results of expert interviews and using the method of factor analysis, six groups of perceptual words that can clearly describe the color samples of the economic automobile body were finally selected as perceptual indicators. They are represented as: A1~A1' (business-leisure); A2~A2' (luxury-simple); A3~A3' (elegant-civilian); A4~A4' (idyllic-urban A5~A5' (smart-slow); A6~A6' (low-key-publicized), which is composed of a perceptual semantic set A, summarized as:

$$A = \{ A1 \sim A1', A2 \sim A2', \ldots, A6 \sim A6' \} \quad (1)$$

3.2 Experimental content

First, the semantic difference method is used to the experiment of the automobile shape color sensitivity evaluation. The experiment used 5-degree scoring standard.

a 5-level scale is used in the experiment to collect the degree of coincidence between the subjects' evaluation and the perceptual vocabulary, six sets of inductive indicators on the 50 body color samples of the five automobile shapes. Taking A1~A1' (business-leisure) as an example, the five levels of the scale are numbered as 1, 2, 3, 4, and 5, respectively, corresponding to "very casual", "casual", "general (for example: this group of vocabulary does not resonate with the subject) "business" and "very business" .

Each subject's experiment is divided into five groups: A, B, C, D, and E, which correspond to the 5 kinds of automobile shapes: A, B, C, D, and E. The experiment required the subject to observe 5 achromatic automobile shapes to understand the shape of the car. Subsequently, the subject needed to grade the 10 colors of the automobile shape in each group at six sets of words. For example, when conducting a experiment about the automobile shape A, the subject first observes the shape of the automobile A and understands the shape of it. Then the subject will grade it, using the 5-level scale which contains 6 groups of words. Then and so on, the grades of the 10 colors of the automobile shape A (A-1, A-2, A-3, A-4, A-5, A-6, A-7, A-8, A-9, A1 -0) are performed in 6 sets of evaluation vocabularies.

3.3 Principal component analysis of achromatic data

In this paper, the subjects are chosen from the target population, all of whom are college students aged 20-29 years old. All of them are potential consumers of cars who have private cars or driver licenses or car purchase intentions , and they are also the major consumers for the future automobile consumer market. All subjects tested have no visual abnormalities, effective data is selected, including 10 males and 20 females. Using SPSS20.0 software, principal component analysis was performed on the experimental data of 30 subjects. Two groups of vocabulary words representing most of the perceptual information were extracted from the six groups of vocabulary. Take the A-type car as an example.

In this paper, the principal component analysis method was used to analyze the perceptual evaluation data of 30 models of A models. The specific results are as follows

Table 2: Total Variance Explained

Ingredients	Initial eigenvalue					Extract square sum loading
	Total	Variance	Accumulation	Total	Variance	Accumulation
1	2.038	43.971%	43.971%	2.038	43.971%	43.971%
2	1.412	33.539%	77.510%	1.412	33.539%	77.510%
3	.933	10.550%	88.060%			
4	.883	4.708%	92.769%			
5	.395	4.577%	97.346%			
6	.339	2.654%	100.000%			

According to the results of the total variance explained in table 2, the first two principal components are extracted through principal component analysis, and the cumulative contribution of variances of the 4 principal components is 77.51%, which means that most information of the original data is covered. In this paper, combined with the component load matrix, the results of principal component analysis are summarized as follows:

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Table 3: Principal component analysis

Factor	vocabulary	Principal component load	Eigenvalues	Explained variation %	Cumulative variation %
1	business	-0.605	2.038	43.971	43.272
	luxurious	0.635			
	elegant	0.709			
2	Pastoral	0.813	1.412	33.539	77.510
	wise	0.684			
	Low-key	0.852			

According to the results in table 3, words with higher principal component load values are the key words, so it can be seen that the key words of automobile A are low-profile and pastoral. These words represent consumers' prominent emotional intention to automobile A.

After calculation, the prominent intention words of automobile A are: low-key, rural; the prominent intention words of automobile B are: low-key, wise; the prominent intention words of automobile care: luxurious, wise; prominent intention words of automobile D are: luxurious, pastoral; the prominent intention words of automobile E are: elegant, pastoral. The vocabulary above respectively indicates the consumer's prominent intentions for the automobile shape A, B, C, D, E .

3.4 Principal component analysis of colored data

In the experiment, the 5 automobile shapes are matched with 10 different colors for perceptual evaluation, and compared with the data obtained by the previous achromatic group. Take the automobile shape A as an example:

the principal component analysis of the achromatic data is carried out, and the key words are: low-key, rural. The principal component analysis of the automobile shape A in the 10 colors, A-1 to A-10, and the principal component values of the two groups of words, low-key and pastoral, are obtained. If the principal component values are improved in this experiment, it indicates that this kind of color is matched with the automobile shape A, otherwise, they do not match. The principal component values obtained by principal component analysis of the automobile shape A in the 10 colors, A-1 to A-10, are as follows:

Table 4 :Sorting results of component analysis of type A vehicles of different colors

Color		A1	A2	A2	A4	A5	A6	A8	A9	A10	A0
Principal compone nt load	Low-key	0.7 91	0.96 6	0.72 9	- 0.817	0.9 04	- 0.770	0.6 74	0.72 7	0.78 8	0.85 2
	Pastoral	0.6 21	0.82 9	0.73 4	0.700	0.5 07	0.791	0.7 66	0.85 1	0.72 4	0.81 3

As can be seen from the results in table 12, in the 10 colors, A-1 to A-10, a-2 has higher principal component values than that without color, indicating that A-2 is the most matching color among A1 to A10 for the automobile shape A.

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4 CONCLUSIONS AND PROSPECTS

In this paper, 12 forms are taken as examples to explore the matching relation between forms and colors, that is, different forms should have their corresponding colors. Taking five typical automobile shapes under a certain brand as an example, this paper explores a set of research ideas on the intention cognition of the matching relation between shape color and the form, which indicates that different automobile shape should have the most matching shape color. According to the uniform intention vocabulary and mapping relation, we can get the most suitable colors of different shapes. Comparing with the existing automobile shape color scheme of automobile enterprises, that is, customize according to sales volume, popular color in the market and a small number of high-end customization; This method can provide theoretical support for the enterprise to determine color scheme according to the actual different models and reduce the cost for the enterprise.

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CULTURAL COMPETENCE OF HOSPITALITY INDUSTRY EMPLOYEES

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Keywords: Cultural Competence, Hospitality Industry, Employees

ABSTRACT

The purposes of this research were: 1) to study the level of cultural competence of hospitality employees; and 2) to compare the level of cultural competence. The sample comprised 272 hospitality employees, categorized by their genders, expertise and job status. The research variable was cultural competence, indicated by 3 variables, which were cultural awareness, cultural knowledge, and cultural skill. The research tool was a surveyed questionnaire. Data were analyzed using descriptive statistics, t-test and one-way ANOVA.

The results were as follows: 1) Hospitality employees have high level of cultural competence score which is 4.16 2) Prospective employees and current employees have the same level of cultural competence scores which are 4.13 and 4.24 respectively. The scores of both genders are the same. The employees in hotel and resort management have significantly higher level of cultural performance score than employees in culinary arts and kitchen management, tourism management, spa management and MICE and events management (p-value = 0.05). Current employees have significantly higher levels of cultural performance score than prospective employees (p-value = 0.05)

INTRODUCTION

Nowadays the world is rapidly changing in many aspects which resulted in relocation for various purposes, for instances; job search, education, tourism, etc. In many liberal countries, for example; Thailand has become a multicultural society because of the arrival of tourists from different races with different cultural backgrounds.

In addition to the ASEAN Economic Community (AEC), hospitality industry was jointly announced for the economic benefit of the ASEAN countries on 31 December 2015. The aims and purposes are to corporately accelerate the economic growth, social progress and cultural development in the region through joint endeavour in order to strengthen the foundation for a prosperous and peaceful community of Southeast Asian nations. These will lead Thailand, a country with a strong hospitality and tourism industry background to become a major business provider in the market which is going to make huge revenue to the country.

With this massive expansion of the hospitality and tourism industry trend, Thailand needs to consider about Cultural competence in addition to prepare in English language, regional languages, knowledge and skills. Cultural competence is an important key in the workplace of people with diverse backgrounds in terms of language, religion and culture. Cultural competence will prepare people with the essential skills to resolve conflicts from miscommunication, stress management, culture sensitivity and cross cultures awareness (McDonald et al., 2008). In

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accordance with Zakaria (2000), cultural competence also enhances the individual's ability to cope with unexpected or unclear events. This will reduce the tension associated with falling into a new culture unfamiliar or culture shock.

Higher education institutions that provide hospitality curriculum are responsible for training quality human resources to the hospitality industry. It is mandatory for them to understand the level of cultural competence of their students in order to understand the conditions and design the suitable course for development.

In short, the researcher decided to study cultural competence of hospitality industry personnel, both currently in the hospitality industry and to-be in the hospitality industry who are students studying in a field related to hospitality industry. This information is going to be used as a guideline to design a curriculum for the cultural competence development in preparation for the opening of the ASEAN Economic Community (AEC).

Objective

1. To study the level of cultural competence of hospitality industry personnel.

2. To compare the level of cultural competence of personnel in the hospitality industry by gender, a field of study and status.

Definition of Terms

Cultural competence refers to knowledge, skills, and attitudes that enable the person to perform tasks in a diverse environment or culture. This consists of Cultural Awareness, Cultural Knowledge and Cultural Skills (Chantarasanon, 2010).

1.1 Cultural Awareness defines a person's perception, comprehension, and understanding to one another with the different background, attitudes and values and expresses themselves to be ready to face the difficulty with a culture different from one's own culture.

1.1.1 Cultural Diversity refers to recognizing and accepting the differences and similarities of cultures.

1.1.2 Being Flexibility and Recognition of the Value of other Cultures; defines accepting and adjusting their ideas in accordance with culture.

1.1.3 Being Considerate defines to be sympathetic to others.

1.2 Cultural Knowledge, defines a perception of culture. The ability to understand why people are and behave in certain way, be ready to learn new culture and be flexible with culture diversity.

1.2.1 Knowledge of Main Culture, defines knowledge of the national language, values and culture of Thai society.

1.2.2 Knowledge of Universal Culture, defines knowledge in term of international languages, for instances; English, cross culture knowledge, universal values and universal behavior.

1.3 Cultural Skill, defines skill of living happily on their own main culture of each society, be able to recognize other culture precisely, be adaptable by considering culture thoroughly and manage cross cultural impact in a sensible way.

1.3.1 Cultural Sensibility refers to the quick perception when facing with culture.

1.3.2 Understand of Oneself, is the ability to understand their backgrounds based on general beliefs and understand their own cultural basis.

1.3.3 Understand of Others, is the ability to understand the background of other people from different cultures.

1.3.4 Being Visionary, defines being able to have situation awareness.

1.3.5 Being Adaptable, defines being able to accept and adjust their mindset to be in line with society and environmental transformation.

At this point cultural competence refers to the scores from the cultural competence test, which consists of three elements; 1) Cultural awareness 2) Cultural knowledge and 3) Cultural skills

Culture competence

The word "cultural competence" is derived from the word “Culture” and the word “Competence” transform into “Cultural Competence”. Then it becomes widespread into nursing care provider industry which is a group that provides assistance to people with diverse cultures and backgrounds.

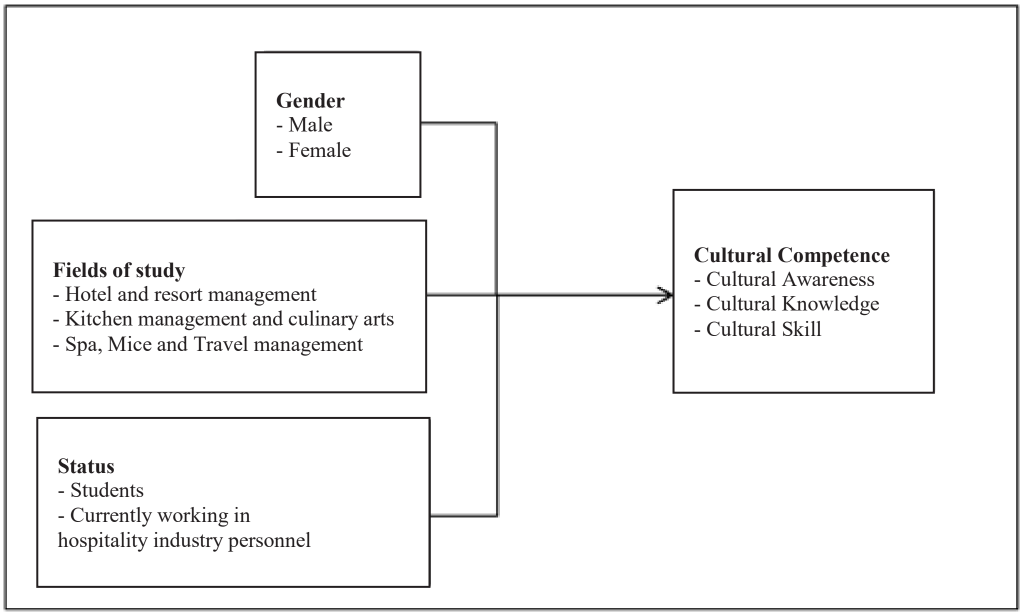
Cultural competence is a set of congruent behaviors, attitudes, and policies that come together in a system or agency or among professionals. This enables the system, agency, or professionals to work effectively in cross-cultural situations (Cross et al.,1989). The key success of evaluating barriers and cultural differences in interpersonal services, people and organization is communication strategy (Clair & Mc Kenry.,1999). It is a process in which each person responds in a respectful and proper manner to other people in every culture, language, race, ethical, religious and other diversity factors. Understand and appreciate people, family, and community individually as well as give respect to others (National Association of Social Workers, NASW.,2001)

From the definition of cultural competence mentioned above. Researcher can summarize that cultural competence is each of individual ability which is integrated into a group of behaviors so that they are capable to express themselves in multicultural environment effectively. There are three elements; cultural awareness, cultural knowledge and cultural skills

Research Method

This study is a survey research. Data collection and analysis were conducted in two groups of 272 hospitality personnel who are currently working in hospitality industry and 185 students who involved in the hospitality fields of study. Stratified Randomized sampling was used to collect data using questionnaires. Data collection through the online questionnaire from the Google form website for students in the fields study of hospitality and use questionnaire links via social networking feeds, and chat programs for current hospitality industry personnel. The research tool is a cultural competence measure for hospitality industry personnel, which was adapted from a cultural competence test for secondary school students (Chantarasanon, 2010). This has been reduced from 87 items from 10 elements to 30 items, based on the weight of the top three factor loading from each category then adapted to the sample groups and the context of the hospitality industry. Data analysis was performed by statistical analysis including mean, standard deviation, T-test analysis and one-way ANOVA. Dunnett T3 is a statistic for post hoc test.

Conceptual framework



Finding

1. The level of cultural competence of the personnel in the hospitality industry is quite high in all aspects. Rating the score was found that the level of cultural competence of the personnel in the hospitality industry is at a high level ($\bar{x}$ = 4.16). When ranked, cultural awareness and cultural knowledge are equal ($\bar{x}$ = 4.17), followed by cultural skills ($\bar{x}$ = 4.15) as shown in table 1 below.

Table 1: The cultural competence of the personnel in the hospitality industry

Cultural Competence	$\bar{x}$	SD	MIN	MAX	Rank
Cultural awareness	4.17	0.43	3	5	quite high
Cultural knowledge	4.17	0.51	2.83	5	quite high
Cultural skill	4.15	0.46	2.87	5	quite high
Cultural competence	**4.16**	**0.41**	**3.09**	**5**	**quite high**

2. Comparative analysis of cultural competence by gender, fields of study and status found that gender factor does not affect cultural competence while fields of study and status factors have statistically significant effect at 0.05 as shown in Table 2.

Table 2: Comparative analysis of cultural competence by gender, fields of study and status

variables	$\bar{x}$	SD	P value
Gender			
Male	4.15	.39	0.55
Female	4.18	.42	
Fields of study			
Hotel and resort management	4.29	0.34	0.00**
Kitchen management and culinary arts	4.13	0.42	
Spa, MICE, and Travel management	4.05	0.44	
Status			
Students	4.13	0.41	0.04**
Currently working in hospitality industry personnel	4.24	0.40	

** p-value < 0.05

According to Table 2, it was found that gender does not affect the level of cultural competence of the hospitality industry personnel while the fields of study level affect the cultural competence of the hospitality industry personnel. When multiple comparisons by Dunnett T3, the results of the paired comparison showed that there are two different fields of study groups; 1. hotel and resort management with kitchen and culinary arts management 2. hotel and resort management with Spa, MICE, and Travel management (p-value = 0.01, 0.00 respectively). The hotel and resort management have a higher level of cultural competence than the other two. It was found that hospitality personnel have a significant level of cultural competence between the personnel entering the hospitality industry (students) and those who are currently working in the hospitality industry at the .05 level of significance.

Summary

1. The results showed that hospitality personnel have a high level of cultural competence. Students who are studying in the fields of hospitality industry and those are going to-be in hospitality industry may be affected by the fact there will be opportunities to learn about the meaning, importance and role of the hospitality industry. In addition, students who study in hospitality industry need to practice in the workplace or real hospitality industrial organization over a period of time. From this performance in the real place, students will gain knowledge and experience in dealing with problems that may arise from cultural differences. And in the part of people who are currently working in the hospitality industry. This can be the result of work. To deal, care, support and services of people with cultural differences, this gives them an opportunity to learn and gain experience in the areas of knowledge, skills and attitudes towards cultural diversity. For these reasons, students in the field of hospitality industry have a higher level of cultural competence compared to other students and personnel in other fields. In accordance with Puncreobutr's research (2014), the cultural competence in the ASEAN community of Thai graduates is at a moderate level.

2. According to cultural competence comparison of hospitality personnel who are different in gender, fields of study and status, the researcher wants to discuss as follows;

2.1 The results of the study on the cultural competence of hospitality personnel in different genders showed that male and female do not have different level of cultural competence due to students and staffs who are working in the hospitality industry have the opportunity to learn and have experience with similar cultures both of male and female. In contrast, considering the average, it is found that in hospitality industry, females have higher level of cultural competence than male. This is in accordance with the research of Chantarasenanon (2010), who conducted a study on the cultural competence of secondary school students, found that female students have significantly higher cultural competence than male students at 0.01 level.

2.2 The results of the study on cultural competence on personnel in the hospitality industry in different fields of study showed that the personnel in hotel and resort management field of study have significantly different level of cultural competence from those who are in the fields of Kitchen Management and Culinary Arts and also Spa, MICE, and Travel management. The personnel in hotel and resort management fields have a higher level of cultural performance than the other two. The reason could be that the hotel personnel will have more work related to communicate with people than other personnel. When communicating, there is a greater chance of encountering cultural diversity and there is a clear opportunity to learn and develop this competence. And also, students who study in hotel and resort management must attend internship program on their curriculum which involves practicing interaction with other people, for instances food service and beverage section, Front-end section and human resources etc. This result is also in accordance with Luckmann (1999) that things that can affect cultural patterns and behaviors are gender, education, occupation, social class, experience, personal beliefs and apprenticeship.

2.3 The results of the study on the cultural competence of personnel in different fields of study showed that students who study in hospitality-related field have a different level of cultural competence comparing to those who are currently working in the hospitality industry. Those who are currently working in the hospitality industry are at a higher level of cultural competence. This is due to more experience of facing many cultural differences. This is in accordance with Pope-Davis 's research (1997) on the level of cultural competence of 120 nursing students who care for diverse patients, found that experience has a statistically significant effect on the level of knowledge and cultural competence.

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POSTER SESSION

REGIONAL CHARACTERISTICS ON PREFERENCES OF CEREMONIAL RED COLOR IN JAPAN – COMPARISON BETWEEN THE WEST AND THE EAST –

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Keywords: color culture, color preference, ceremonial costume, Japan

ABSTRACT

This research investigates regional cultural diversity in Japan through the regional characteristics on preferences of ceremonial red color. It was found in our previous study that there is a subtle difference between preferences of traditional red colors for wedding costumes in Hiroshima and Okinawa, and a cultural difference between mainland Japan and Okinawa was discussed. In this paper, the research is extended, including another previous study of ours, to the comparison between the west and the east in mainland Japan. The results indicate that Morioka, the central city in north-east Japan, is typically in the East according to the preference of lower chroma. The results also indicate that Nagoya, the central city in central Japan, is in the West according to the color preference.

INTRODUCTION

The objective of this research project is investigating regional cultural diversity in Japan. Our project does not study international cultural difference [1] but the regional diversity through the difference in preferences on red colors for ceremonial costumes. The red color is prominent in the traditional wedding costume in Japan and it is still used together with modern white costume in wedding ceremonies.

In our previous study [3] in the project, we measured subtle differences of color preferences in Hiroshima, one of the centers of west Japan, and Okinawa for traditional red colors used for wedding costumes. Okinawa is well known as its history and culture that are different from mainland Japan, and the traditional costume for women in wedding ceremonies in Okinawa has been generally influenced by the costume in Chinese Continent. Okinawa's *Bingata* dyeing method is particularly suitable for generating the red color in wedding costume. In our experiments, we selected three typical colors which appeared most frequently in *Bingata* also selected 15 red colors nearest to the three typical Okinawa red colors from a set of traditional colors of mainland Japan, shown in [4]. Each of these 15 red colors in the mainland and the three *Bingata* red colors was painted in an illustration of the traditional wear for wedding ceremonies. We showed the set to the respondents and each respondent answered the three most preferred illustrations in the order of the preference. We found through the experiment that there is a significant difference in the preference of saturation and brightness between Okinawa and mainland respondents. The difference may arise from Okinawa's characteristic subtropical climate. An obvious difference in saturation and brightness of colors.

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We are now extending our investigation on the difference of color preferences in Japan to the comparison between the western and the eastern regions in Japan. It has been traditionally said that more vivid color or color with higher chroma is preferred in the West than in the East. We extended the target region to Kanto and applied the same test in our previous study [5]. Our results suggested that the bright and pale tones are preferred than the brilliant tone in Kanto, and the preferred chroma is lower and the brightness is higher in Kanto than in Hiroshima and Okinawa.

In this paper, we extend the target region further to Morioka, a typical city in the northeast part of Japan, and Nagoya, the metropolis in the central Japan. We made the same sensory test as in [3,5] for university students. It is observed that our results support the traditional observation on the difference between the West and the East. The results indicate that Morioka is typically in the East according to the preference of lower chroma. The results also indicate that Nagoya is in the West according to the color preference. It is also interesting that the results by female high school students in Morioka have a different tendency from those by the university students there. It may suggest a relationship between age and color preferences.

EXPERIMENTS

Each of these 15 colors and the three ceremonial red colors in Okinawa's *Bingata* was painted in an illustration of the traditional wear for wedding ceremonies as shown in Figure 1. Table 1 shows the 18 red color name and the colorimetric values of by L*a*b*.

Each respondent selected the favorite 3 colors from the sample illustrations, showing the order of preference, and evaluated the visual impressions about evaluation items shown in Table 2.

RESULT AND DISCUSSION

The illustration No.11 and No.13 were selected as the most favorite color by the respondents in Okinawa [3]. On the other hand, No.10 and No.11 were selected in Hiroshima [3], and No.8 and No.14 were selected as the most favorite color and No.16 as the next in Kanto [5] as shown in Fig.2. These results were already discussed in previous our study [3][5], Okinawa respondents prefer especially higher brightness than Hiroshima respondents do, and rather higher saturation. In other words, there is a tendency that Okinawa respondents prefer brilliant reds, while Hiroshima respondents prefer the red colors which are noticeable under the contrast of black color. The preference of Okinawa people might be explained by means of its subtropical climate with bright sunlight. Although including cultural influence, similar reason could be discussed to the results in Kanto and Kansai area, shown in Fig.2 and 3 respectively [5].

In this paper, we have added the results of Morioka and Nagoya. The former city is in the northeast area of the main island of Japan called Tohoku area; the latter city is metropolis in the central Japan. As shown in Fig.4 and Fig.5, Respondents in Nagoya preferred No.13 while Tohoku area's respondents preferred No.14. These results show that the preference in Nagoya is similar to that of Okinawa in the range of red hue and saturation, while the preference in Morioka, Tohoku area, is similar to that of Kanto area. However, comparing the range of brightness, the preference in Kansai and Kanto include the dark range of reds, while the results of Nagoya and Morioka biased to the bright range.

Figure 1. Samples: the 18 KIMONO illustrations used for sensory test

Table 1: Color samples: No., name, colorimetric value

Sample No.	Color Name	Colorimetric Values (10º D65)		
		L*	a*	b*
1	Agate	35.27	34.76	13.34
2	Turkey red	40.48	41.68	14.19
3	Enji (臙脂)	36.10	37.67	9.69
4	Wine red	35.29	36.09	10.09
5	Copper red	41.47	41.21	24.68
6	Persian red	32.42	27.51	11.53
7	Akne-iro (茜色)	42.51	42.63	16.57
8	Benihi (紅緋)	53.75	43.80	30.36
9	Cardinal	43.51	44.27	13.76
10	Beni-iro (紅色)	41.65	52.71	15.28
11	Carmine	41.80	52.93	16.70
12	Shu-iro (朱色)	54.04	48.07	30.29
13	Shojohi (猩々緋)	44.83	52.68	23.66
14	Shinshu (真朱)	56.59	38.81	12.45
15	Ni-iro (丹色)	49.99	41.59	35.46
16	*Bingata* (紅型) 1	45.38	54.17	28.61
17	*Bingata* (紅型) 2	45.00	55.73	20.01
18	*Bingata* (紅型) 3	45.22	55.23	23.01

Table 2: Sensory evaluation items

	Item	3 2 1 0 1 2 3	Opposite
(1)	Elegant	|-----|-----|-----|-----|-----|-----|	Vulgar
(2)	Manish	|-----|-----|-----|-----|-----|-----|	Feminine
(3)	Average	|-----|-----|-----|-----|-----|-----|	Unexpected
(4)	Mature	|-----|-----|-----|-----|-----|-----|	Childish
(5)	Static	|-----|-----|-----|-----|-----|-----|	Dynamic
(6)	Flashy	|-----|-----|-----|-----|-----|-----|	Modest
(7)	Modern	|-----|-----|-----|-----|-----|-----|	Classical
(8)	Bright	|-----|-----|-----|-----|-----|-----|	Dark
(9)	Deepness	|-----|-----|-----|-----|-----|-----|	Shallow
(10)	Strong	|-----|-----|-----|-----|-----|-----|	Weak
(11)	Fresh	|-----|-----|-----|-----|-----|-----|	Antique
(12)	Exotic	|-----|-----|-----|-----|-----|-----|	Traditional (Japanese)

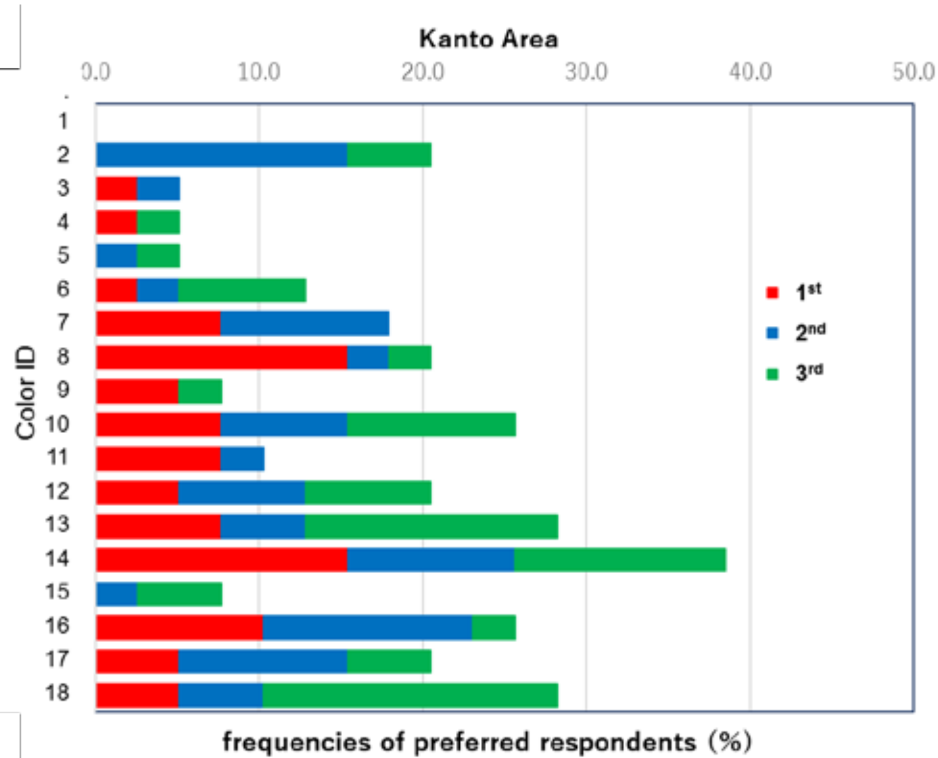

Figure 2. The case of Kanto area: Results of frequencies of preferred respondents

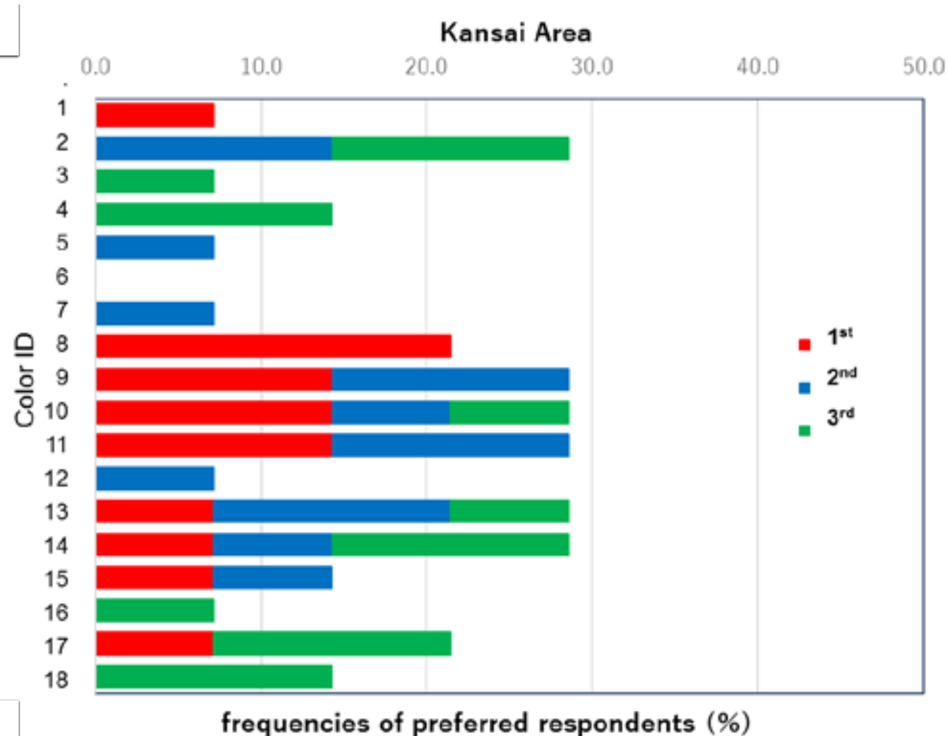

Figure 3. The case of Kansai area: Results of frequencies of preferred respondents

POSTER SESSION

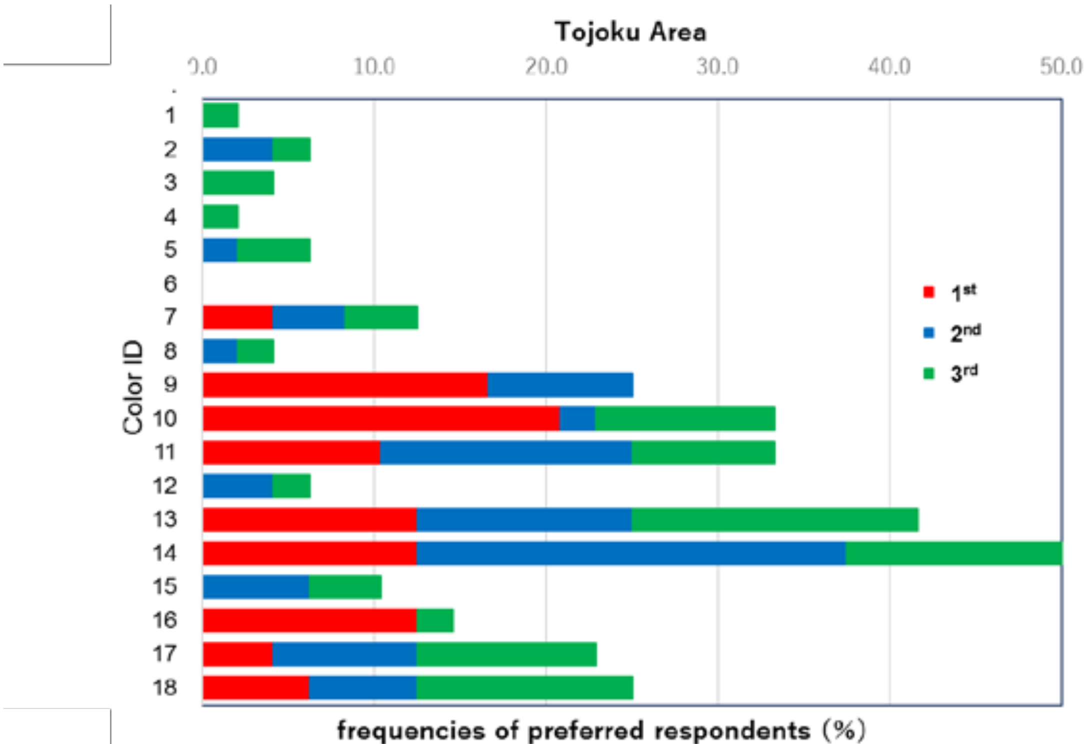

Figure 4. The case of Tohoku area: Results of frequencies of preferred respondents

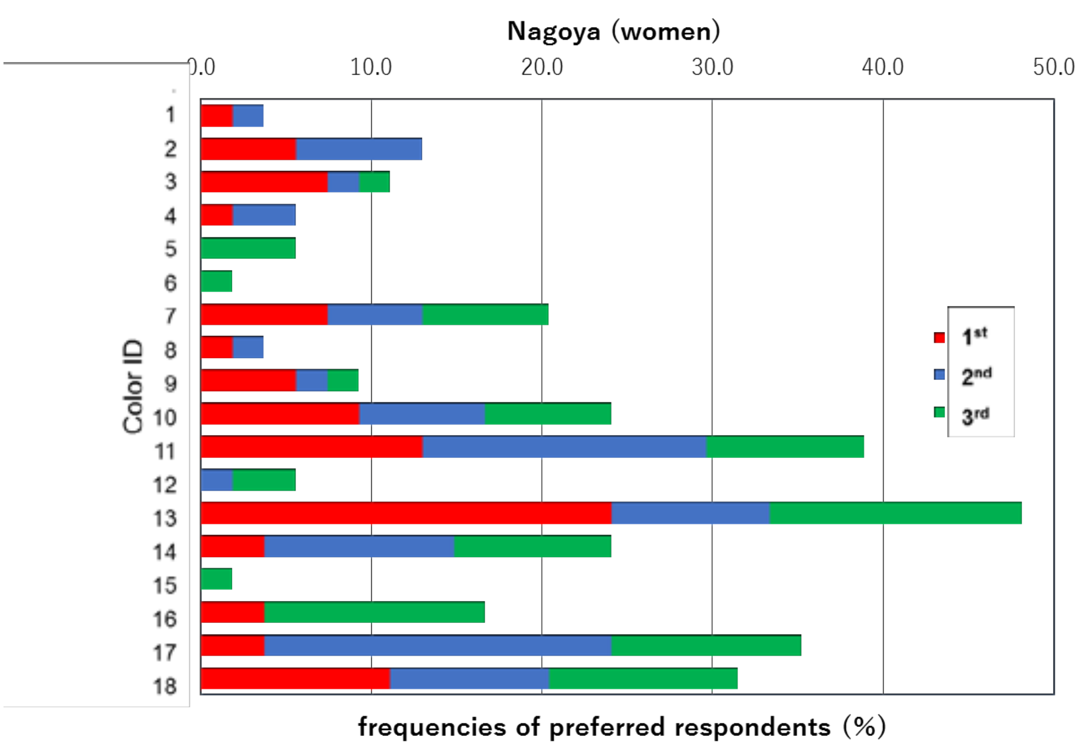

Figure 5. The case of Nagoya: Results of frequencies of preferred respondents

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CONCLUSIONS

This research is clearly shown that there is regional difference of red-color-preference in spite of restricted hues, in same country, although the numbers of respondents are limited. It is worthwhile to make the same experiments and investigation at various regions in Japan and find the difference of culture in color preference, because the other areas also have some notable cultural features.

ACKNOWLEDGEMENT

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Color names not expressible by 11 basic colors for Thai People

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Keywords: Thai color name, Eleven basic color term, Thai people, Munsell color chips

ABSTRACT

This research aimed to study Thai color name by using the 330 color chips from Munsell Book of Color which matched with the World Color Survey, WCS. The categorized 11 basics color terms and local Thai lexicon were used to carry out the experiment. Normal color vision of eleven subjects who are students at faculty of Mass Communication Technology MCT, Rajamangala University of Technology Thanyaburi RMUTT participated to this experiment. Each subject did color naming only one session. The result showed that besides the 11 basic colors they often used additional color terms such as Fha (sky), Neer (skin), Ban-yen (Magenta), Keaw-kima (olive color). They are typical color names used in Thai language.

INTRODUCTION

The basic 11 colors term was invented by Berlin and Kay in 1969. They found that even different in languages or different in vocabularies the total universal inventory of exactly eleven basic color categories existed.[1)] However, the recent researchers suspected whether eleven color terms can be used for any language and any object color or. In 2017 Kuriki et al. found the candidate twelve Japanese colors term.[2)] Many color terms in Thailand vzry amoong domiciles of people. Moreover, they often used the name of objects, for examples Keaw (green) – kima (excrement from a horse) and Roeung (yellow) - fucktong (pumpkin). The typical color terms of Thai people were investigated in this experiment with the first and the second years students of Rajamangala University of Technology Thanyaburi, faculty of Mass Communication Technology.

EXPERIMENT

The experimental booth was built with 150 cm wide, 90 cm high, and 60 cm deep. Six lamps of the 40-W Toshiba Fluorescent Daylight (D_{65}) 18W/T8/EX-D were attached at the ceiling as shown in the Fig.1 to make the averaged illuminance at 2645 lx by measuring at four positions on the table of the booth by illuminance spectrophotometer CL-500A Konica Minolta. The wall inside the booth was pasted by white wall paper of about N9 (L^* = 94) and of chromaticities x = 0.306, y = 0.321. The table was pasted by a gray cardboard of x = 0.330, y = 0.340 and L^* = 51.

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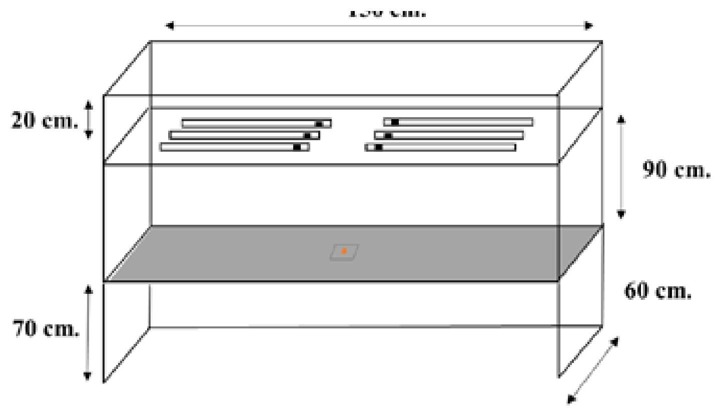
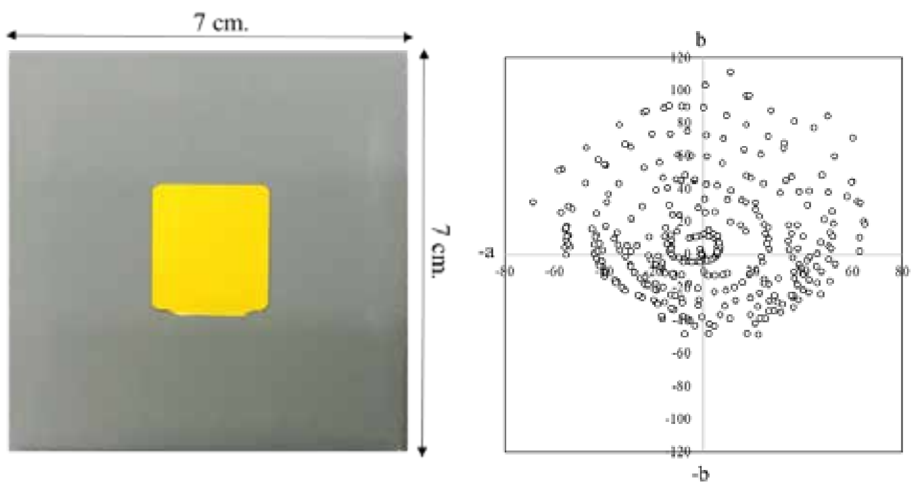


Figure 1 The experimental booth.

Stimuli

The 330 color chips were selected from the Munsell Book of Color glossy ed., X-Rite, Inc. Each chip was mounted at the center on a cardboard square 7 x 7 cm^2 covered with gray matte paper approximating N5 in the Munsell value. Figure 2(a) shows a sample from 330 chips and Fig 2(b) shows all the 330 color chips on the CIEa*b* diagram. The color of Munsell chips covered all the hues but at the greenish blue, blue and purple they had lower saturation than red, yellow and green direction. The lightness L* varied from 20 to 98.



(a) (b)

Figure 2 A sample of color chip (a) and the 330 color chips showed in a*b* (b)

Procedure

The experiment was done in a dark room as shown in the Fig. 3. The subjects used a single Thai color name or monolexemic color term to name each color chip. The compound color terms such as Keaw-Aom-Namgean (greenish-blue) or modified word by adding the adjective in the front or behind the color name such as Keaw-on (light green) were not allowed in the experiment. However, the color name of the type of any object that could generate color name were allowed to use. To summarize subjects were asked to do color naming firstly by using single term by using 11 basic colors (Berlin and Kay:1969), red, green, blue, yellow, orange, pink, purple, brown, black, white, and gray and secondly by using the local name that they are familiar to be used. The experimenter presented the color chip one by one. It was only one session for each subject and it took about 1 hour to finish the whole experiment. Eleven subjects (7 females and 4 males) from Rajamangala

University of Technology Thanyaburi participated in the experiment. All the subjects had the normal color vision by Panel D15 test.

Figure 3 Showing the atmosphere while obtaining the color name

RESULTS AND DISCUSSION

Figure 4 shows the individual results from 11 subjects, the abscissa represented 11 basic colors and others and the ordinate frequency of each color name. The high frequency was obtained for green, purple, pink and others. Numbers of others differed among subjects. For example, the subject BT showed others only 4, but the subject NN showed 69. Figure 5 shows the total responses from 11 subjects, totalling 3,630 responses altogether. Others had 438 responses or about 12% from the total responses. "Others" that had very high frequency among "others" was "Fha" in Thai name or "Sky" in English, the percentage of "Fha" was about 60% or 1,037 responses. The second "orthers" was "Neer" or "Skin color or beige color" which showed the percentage of 7.5. However, "others" which was typical Thai color name was also shown such as Cream, Cram (indigo), Loed-moo (dark red), Mint, Peach, Old-rose, Ke-ma (olive green), Kha-ki (light brown), Gom (Navy blue), Sad (vivid orange), Lemon, Num-ta-lay (ocean), It (brick). Based on the "others" names that we obtained we like to propose the name of "Fha" into 11 basic colors term for Thai people. For the typical "others" color names, we need to be obtained data from more subjects.

POSTER SESSION

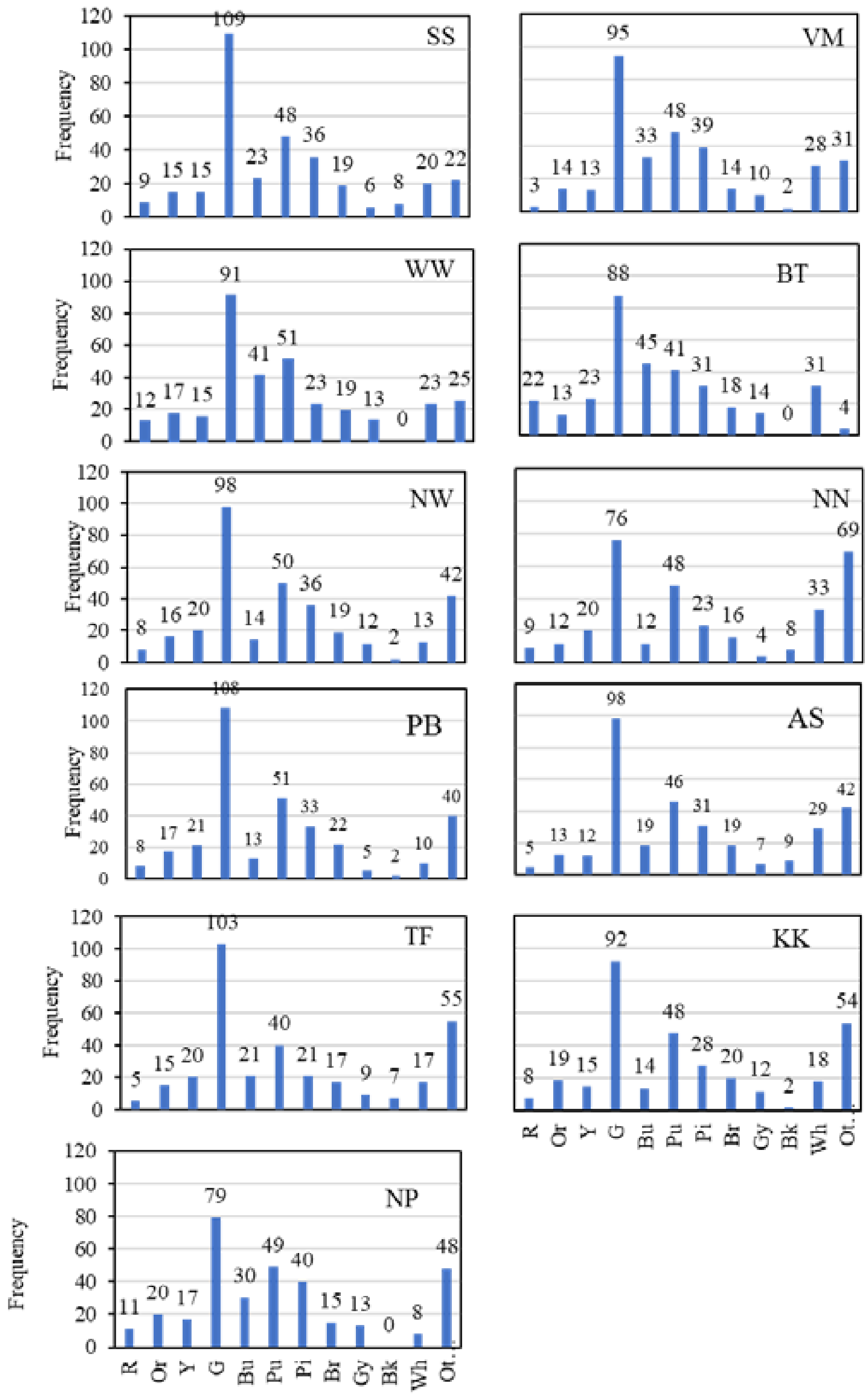


Figure 4 Individual results of 11 subjects

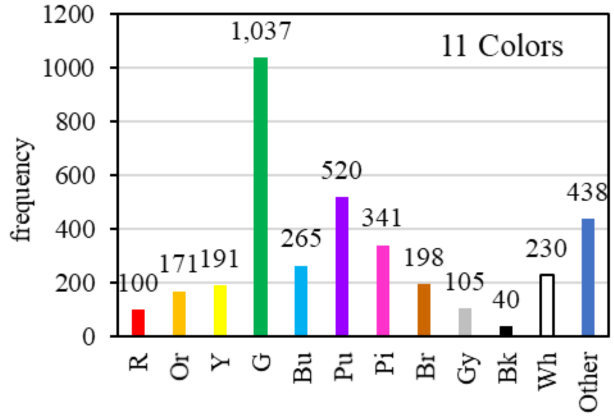


Figure 5 The total responses of 11 subjects

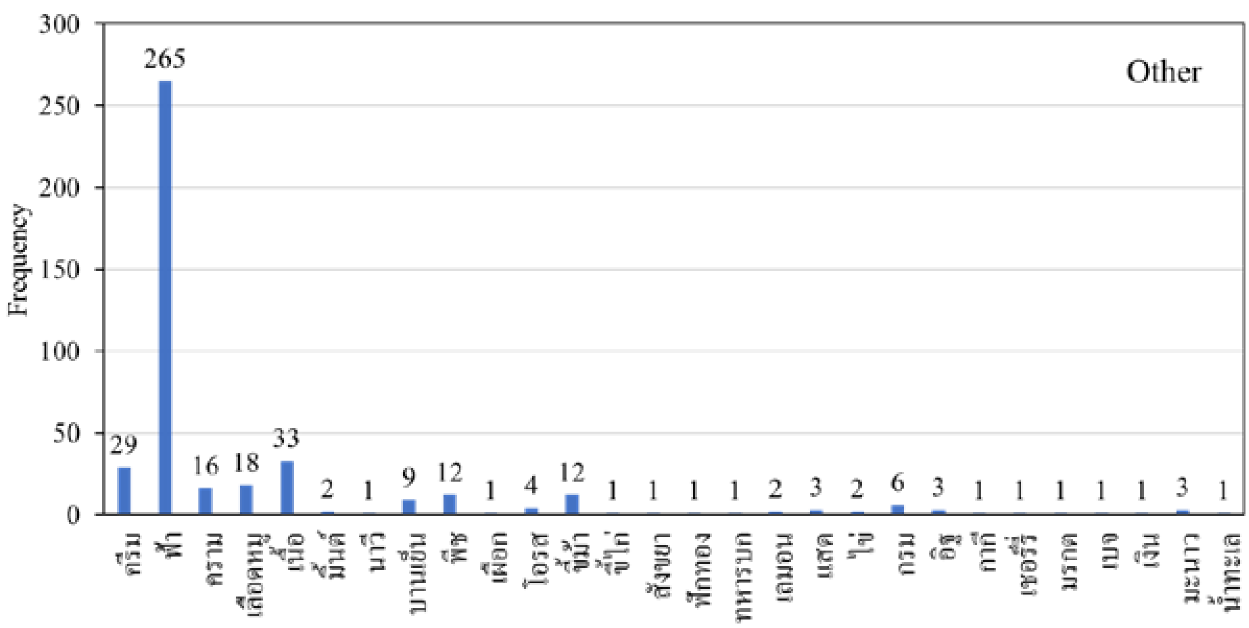


Figure 6 Color name used in the others beside the 11 colors basic color term of Thai people

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POSTER SESSION

STUDIES ON EFFECTS OF TEMPORAL COLOR TRANSITION ON HARMONY OF THREE-COLOR COMBINATIONS

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Keywords: Color arrangement, Color harmony, Temporal transition

ABSTRACT

"Resolution" in music theory means the move of a chord from a dissonance to a consonance, so deeper satisfaction is provided to listeners than in only using the consonant chord. The authors had assumed that there was an analogy between temporal tonal transition in musical perception and temporal color transition in visual perception.

In this study, many pairs of the dissonant and consonant colors in three-color combinations were used, and the condition for the enhancement of color harmony was researched through experimentations. Dissonant color arrangements on an LCD were gradually changed to consonant color arrangement, the score of the "beauty" for color harmony for the consonance was quantified by a sensory test. The score was compared both with and without the dissonance that was displayed immediately before the consonance. As a result, the effect of "resolution" was seen in several color combinations. However its reason still remained unclear.

INTRODUCTION

In music theory, "resolution" is one of the most important structures of musical pieces [1] [2]. The "resolution" of chords means a temporal progress from a dissonance to a consonance. It induces deeper satisfaction in listeners than in only using consonant chords. The authors assumed that there was a similar phenomenon between the temporal tonal transition of chords in musical perception and the temporal transition of color arrangements in visual perception. Our previous experimental results [3] showed that the consonance of color arrangements could be enhanced by a "pivoted" transition, in which some appearance parameters such as hues and color tones were preserved, from a dissonance in comparison to a static presentation of the original arrangement. In our subsequent following experiments, it was found that, in the case of using the consonance with too high a harmony, the harmonious rate did not increase even if the dissonance was displayed immediately before the consonance.

In this paper, the authors used new three-colors combinations based on color harmony theory, measured the score of the "beauty" of color harmony with a sensory test, and compared between the with and without effects of "resolution".

METHOD

Thirty tricolor combinations were prepared as the consonance from the Color Combination Image Scale by the Nippon Color & Design Research Institute Inc. [4], as shown on the left side of

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Table 1. These combinations were placed around the two-dimensional surface of the Color Combination Image Scale, which indicated that each tricolor gave a different emotion to us. Every dissonance on the right side of Table 1 was generated by replacing one of three colors in each consonance with either a different brightness or a different chroma.

Observers examined experimental stimuli on an LCD screen as in Figure 1. Figure 2 shows the visual stimuli for observers, in which a dissonant color arrangement gradually changed to a consonant one in ten seconds (Figure 2.3). After seeing each stimulus, each observer scored the "beauty" of the color harmony on the consonance, which was quantified by a rating scale ranging from 0 to 10. Three students with normal color vision participated as test subjects.

RESULTS AND DISCUSSION

The six graphs in Figure 3 show the results of the score of "beauty" for six pairs of color combinations taken from the thirty pairs in Table 1. The vertical axis indicates the score of the "beauty" by the three test subjects. The horizontal axis indicates the three different visual stimuli. The first and second symbols show the result when an observer examined only the dissonance and consonance for ten seconds. The third symbol shows the score for the consonance after color transition from the dissonance to the consonance.

First, in the case of No.14 and No.19, the scores of "beauty" on the consonance were not higher than those on the dissonance, which indicates that these pairs of consonance and dissonance were not suitable for our research of "resolution".

Table 1: Pairs of consonance and dissonance in tricolor arrangement

No.	Consonance	Dissonance	No.	Consonance	Dissonance	No.	Consonance	Dissonance
1			11			21		
2			12			22		
3			13			23		
4			14			24		
5			15			25		
6			16			26		
7			17			27		
8			18			28		
9			19			29		
10			20			30		

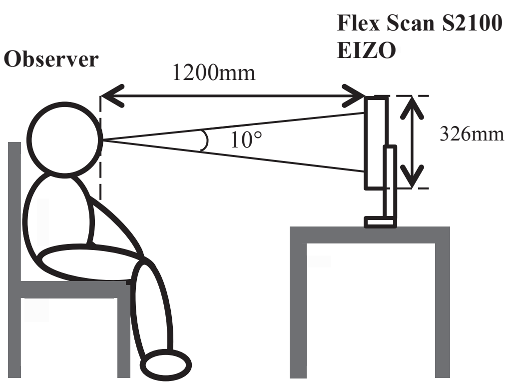

Figure 1: Experimental environment

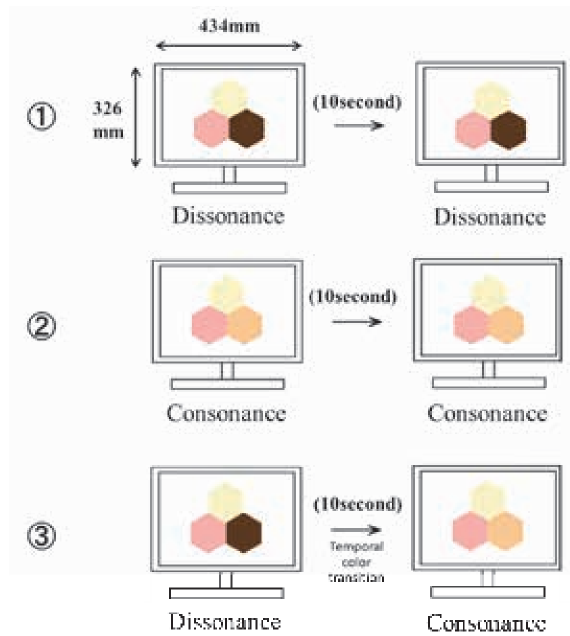

Figure 2: Temporal color transition

In No.5 and No.10, the authors found an improvement between the dissonance and consonance, but there was no improvement on the consonance after color transition. Therefore, the effect of "resolution" did not occur for No.5 or No.10.

In contrast, in the case of No.17 and No.29, an improvement between the dissonance and consonance was seen, and also the effect of "resolution" was confirmed. The consonance of No.29 consists of two achromatic colors and one chromatic color, and No.17 also had the same condition. The authors will need to confirm these conditions in detail more to arise at a "resolution"

CONCLUSION

We measured the "beauty" for harmony of the consonance of thirty tricolor combinations, and each score was compared both with and without the dissonance, which was displayed immediately before the consonance. As a result, two pairs of color arrangements were successful in "resolution" out of thirty pairs. However it could not clear that why and how the color harmony increases.

As the next step, further research is required to reveal whether the term "beauty" was appropriate to our experiment. It will be a forthcoming task to clarify these conditions, in detail to improve the effects of "resolution".

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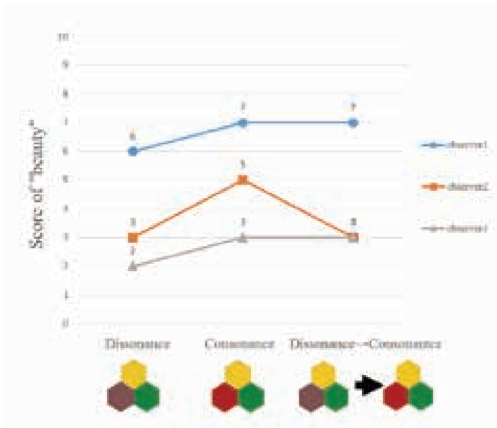
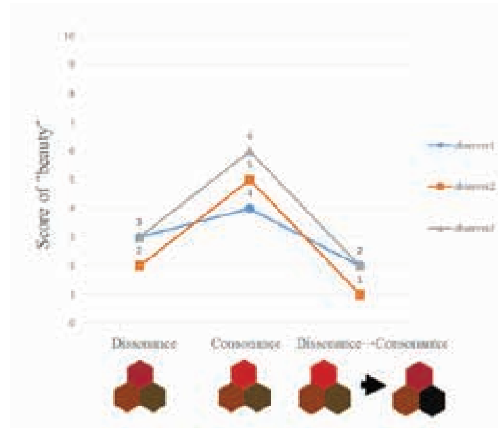


a) No.5



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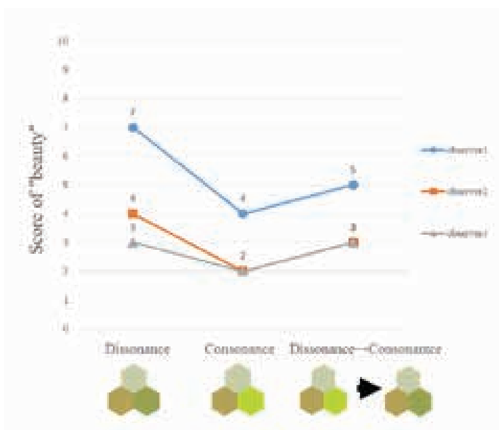
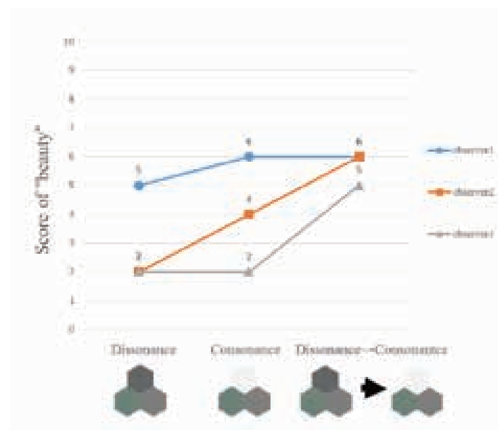
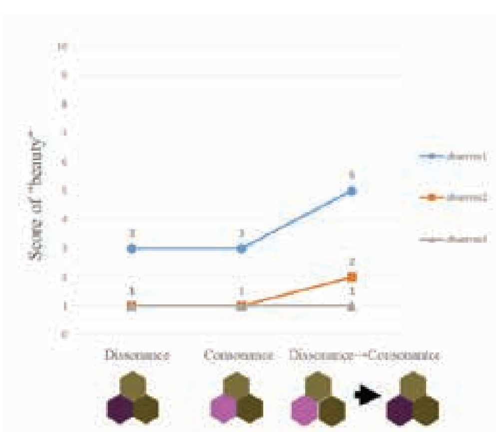


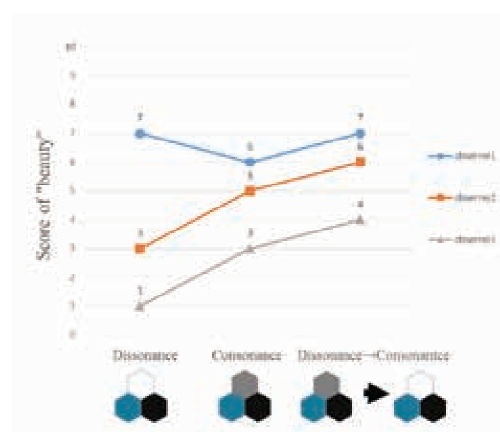
c) No.14



d) No.17



e) No.19



f) No.29

Figure 3: Results of the score of "beauty" on color arrangemet

UNATTRACTIVE COLORS BY COLOR MEMORY OF THAI TEENAGERS

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Keywords: Unattractive Color, Color Memory

Several studies reported that color enhances brand recognition or customer awareness. The desire of purchasing can be improved by the attraction of the package color. For health hazardous products such as cigarette, some color can attract the customer and diminish the negative feeling of that product. In this research, we aimed to identify the unattractive colors by using color memory techniques. The subjects were 120 teenagers, aged between 15 and 22 years old. They were 60 males and 60 females. The subject's task was to find the most unattractive color of each three colors (gray, brown and olive green). All unattractive color values were plotted in CIE1931 xy chromaticity diagram. The region of unattractive brown and olive green in CIE xy chromaticity diagram was partially overlapped. The average xy chromaticities of unattractive gray, brown and olive green were (0.322, 0.342), (0.437, 0.419), and (0.381, 0.468) respectively. The average luminance of unattractive gray, brown and olive green was 28.4, 14.0 and 17.9 cd/m^2 respectively. We can see that the characteristic of most unattractive color was dark or dull color. Especially, in the case of brown and olive green, the luminance of 87% of these unattractive colors was in the range of 1-25 cd/m^2.

INTRODUCTION

Previous research revealed that people make a judgement within 90 seconds of their initial interactions with products and 62-90% of the assessment is based on colors alone.[1] Color enhances brand recognition or customer awareness. The desire to purchase can be improved by the attraction of the package color. Most of the research normally investigated the color which stimulate the positive perception to the customer. In case of the health hazardous products such as cigarette, some colors can also attract the customer and diminish the negative feeling of that product.[2][3] For example, some smokers misperceived that cigarette with light blue package is fresh, clean and less hazardous. Therefore, this research aimed to identify the unattractive colors which can decrease the attractiveness and desire to purchase the health hazardous product. We used color memory techniques because there was less limitation about the selection of color sample. The research was divided in two parts. The first part was a preliminary survey. Each subject was asked to name their unattractive colors. For the second part, each subject was asked to present their own unattractive color on a monitor. Color values of those colors were measured in term of CIE Yxy.

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PRELIMINARY SURVEYS

The preliminary survey was aimed to collect the name of unattractive colors. The subjects were 214 students in the Faculty of Mass Communication Technology, Rajamangala University of Technology Thanyaburi. The questionnaire was composed of two questions. For the first question, the subjects were asked to give the name of the most unattractive color. There was no limitation about the color name. They might answer specific color name or color with some adjectives. For example, the answer can be either *"yellowish green"* or *"Khiao Kheema"*. For the second question, the subjects were asked to categorize the answer of the question one into 12 Thai basic color terms. The 12 Thai basic color terms were modified based on the 11 basic color terms proposed by Berlin and Kay.[4] The 12 Thai color terms were "*Dang (red), Khiao (green), Fa (blue), Leung (yellow), Nam-tan (brown), Chomphu (pink), Som (orange), Muang (purple), Tao (gray), Dam (black), Khao (white) and Nam-ngen (navy blue). Nam-ngen (navy blue)* was added because the meaning of blue for Thai people can be both "*Fa"* and "*Nam-ngen"*.

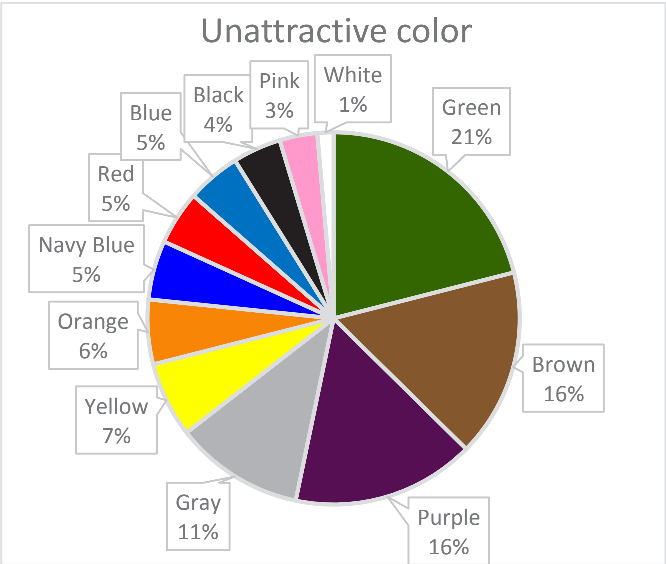


Figure 1. Unattractive Color Categorized into 12 Thai Basic Colors.

The result of the preliminary survey was showed in Figure 1. Green, brown, purple and gray were reported as the top 4 of the most unattractive color. It was not surprising that many subjects feel gray and brown were the most unattractive color. On the contrary, 21% of the subjects specified that green was the most unattractive color. This results contradicted to the general perception because green is normally related to nature, freshness or pleasantness. We then investigated the name of green color from question 1. We found that more than 50% of answers were "*Khiao Kheema (olive green)"*. This "*Khiao Kheema"* or olive green is a mixture between green, yellow and black. It appears as a dark, dull, ambiguous and ugly color. In case of purple, there is no the name of purple which was the majority of answer. So we discarded the term purple now and will investigate more in the future work. Based on this result, we decided to use gray, brown and olive green as the color term for the main experiment.

MAIN EXPERIMENT

The objective of the main experiment was to specify the representatives of three unattractive color terms from the preliminary survey. We asked the subjects to present their unattractive color by mixing color to match the unattractive color in their memory.

Subject

The subjects were 120 undergraduates from the Faculty of Mass Communication Technology. All of them had normal color vision.

Apparatus

The apparatus was two rooms (a test room and a subject room) separated by a wall. Inside the test room, an LED monitor (EIZO Color Edge CG247X) was placed and connected to a PC. This monitor was used for presenting colors. The test room was covered by a black curtain to eliminate external light. In the subject room, the internal wall was covered by a white wall paper. The illuminance of the subject room was measured by a chroma meter (Konica Minolta CL-200A) and was kept constant at 300 lux. A 25.5 cm × 25.5 cm gray background was attached to the front wall which connected to the test room. At the center of this gray background, there was a 5 cm × 5 cm aperture. When the subject looked through this aperture, the color which presenting on the LED monitor appeared as if it was attached on the wall. The distance between the front wall and the subject's eye was fixed at 1.47 m.

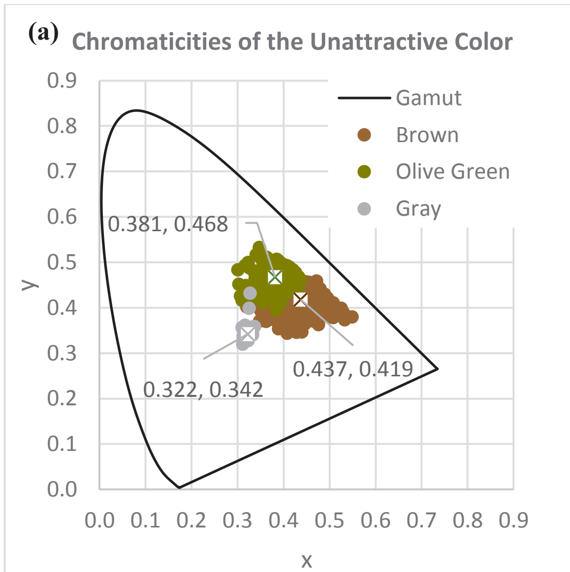
Experimental Procedure

The subjects stayed in the experimental room for two minute adaptation, before starting experiment. The subjects' task was to adjust the color on the wall by using a keyboard and a mouse. In each trial, the experimenter randomly selected one of these three color terms (gray, olive green and brown). The subjects adjusted the color until they found the most unattractive color which corresponded to the given color term. For example, if the experimenter selected "gray", the subjects had to adjust the color until they found their most unattractive gray. When the adjustment finished, the experimenter used a chroma meter to measure luminance and xy chromaticity of that color. The procedure repeated until all three color terms were selected for five times. Each subject had to complete totally 15 trials.

RESULT

CIE1931 xy chromaticities of the unattractive olive green, brown, gray were plotted in the chromaticity diagram as shown in Figure 2 (a). The result exhibited that the region of unattractive brown and the region of unattractive olive green were partially overlapped. The unattractive brown and unattractive olive green of many subjects were almost similar. Some color were ambiguous to categorize between brown and olive green. We asked the subjects what their unattractive brown and unattractive olive green were related to. Most of the subjects reported that those colors were related to unpleasant things such as pus, phlegm, dry blood flake and wound.

Luminances of the unattractive colors were plotted against the x chromaticity as shown in Figure 2 (b). The luminances of unattractive brown and olive green were not high. 87% of unattractive brown and olive green had luminance lower than 25 cd/m^2. In case of unattractive gray, range of luminance was high. The luminance of unattractive gray varied between 1-120 cd/m^2. However, 80% of subjects set the luminance of unattractive gray at lower than 40 cd/m^2. This means the dark gray was more unattractive than the light gray.



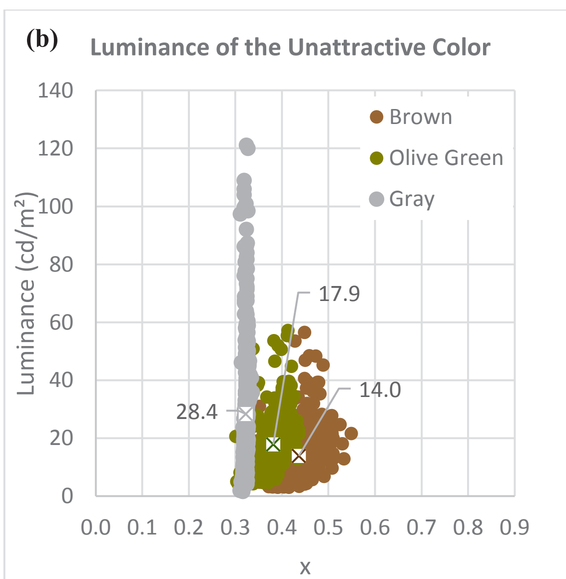


Figure 2. (a) xy Chromaticity and (b) Luminance of Unattractive Color

CONCLUSION

Table 1. Average Luminance and Chromaticity of the Unattractive Color

Color	Luminance (cd/m^2)	x	y
Olive Green	17.9	0.381	0.468
Brown	14.0	0.437	0.419
Gray	28.4	0.322	0.342

The characteristics of unattractive colors were dark and dull. The luminances of 87% of these unattractive colors were in the range of 1-25 cd/m^2. Sometimes brown and olive green are the colors that was ambiguous to classify the color name. The average color values of three unattractive colors were shown in Table 1. For the future work, this three unattractive colors will be applied on package for testing their effectiveness on reducing the desire of purchasing.

ACKNOWLEDGEMENT

We would like to thank all the subjects who voluntarily participated in this research.

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INFLUENCE OF CHROMATICITY OF ILLUMINATION ON IMPRESSION OF A LIVING ROOM

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Keywords: Correlated color temperature, duv, Blackbody locus, Impression evaluation

ABSTRACT

Normally, the color of light source is represented with the correlated color temperature (CCT) on the blackbody locus. It is possible to generate various other chromaticities of the same color temperature, which are not on the blackbody locus, by adding redness or greenness. It is known that it can alter the impression of space. Many studies have reported that the chromaticities and the illuminances of light source influence the impression of the space. However, the effects of CCT and duv on the spatial impression have not been fully explored. This study investigated the influence of the CCT and duv of the light source on the impression of the living room. As a result of factor analysis on 47 adjective pairs, four factors were extracted. The peaks were different for all evaluation factors and tasks. This suggests that the optimal illumination condition differs for each scene.

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INTRODUCTION

Many studies have reported that the chromaticities and the illuminances of illumination influence the impression evaluation of space[1)]. For example, the Kruithof curve[2)] showed a region of illuminance levels and color temperatures that are evaluated as comfortable or pleasing to an observer. This is currently widely used in the field of lighting design.

Due to the recent rapid development of the light emitting diode (LED), the role of lighting has been expanding: Not only illuminating the area but also controlling the mood for the room. The color of light sources is usually represented with correlated color temperature (CCT) on the blackbody locus. It is possible to generate various other chromaticities of the colored light, which are not on the blackbody locus by adding redness or greenness. This shift in the chromaticity of light can be represented with the deviation from the blackbody locus (duv), and it is known that the impression of space changes depending on the chromaticities. Few studies have focused on the changes of duv, and the influence of CCT and duv on the spatial impression has not been fully explored. Thus, this study investigated the influence of the CCT and duv of the illumination on the impression of the living room under different tasks.

IMPRESSION EVALUATION EXPERIMENT

Methods and conditions

The experiment was conducted in a 2400 mm square booth which simulated a living room as shown in Figure 1. In order to simulate the living room, there was a sofa, a table and a television in the booth. The wall was covered with white wall paper, while the floor was covered with a brown carpet. Four color tunable LED light sources (LEDCube, THOUSLITE) were set on the ceiling as lighting devices. Twelve combinations of lighting conditions, four CCTs (2300 K, 3000 K, 4000 K, and 5000 K) and three duvs (0, 0.005, and 0.01) were conducted. The illuminance level was fixed to be 200 lx on the table. Figure 2 shows the chromaticities of the light on the CIE xy chromaticity diagram.

In each trial, the subject spent 5 minutes under a randomly selected illumination condition. During this 5 minutes, subjects performed one of the following tasks: “watching a video” or “reading a book”. We prepared a paperback book and a video that contained natural scenes. As these tasks assume to let the subject relax in the living room, both contents avoided including scenes which may cause excitation. The subject then evaluated the impression of the living room for 47 adjective pairs using 7 level scales. Ten subjects, 5 males and 5 females, all in their twenties participated in this experiment.

Figure 1. **Experiment booth**

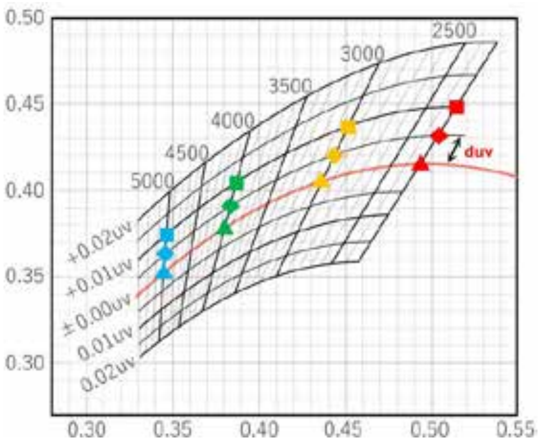

Figure 2. **The color of light stimuli on CIE xy chromaticity diagram**

Experiment results and factor analysis

First, factor analysis of the 47 adjective pairs obtained by experiments for each task were conducted, and evaluation factors were examined in order to clarify the effects of the color of lighting on the impression of the living room. Four evaluation factors were extracted for each task although there were differences in contribution rate and composition adjective pairs. Table 1 shows the contribution rate of each factor.

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Table 1. The contribution rate of each factor

	Watching	Reading
Factor 1	0.346	0.151
Factor 2	0.142	0.142
Factor 3	0.092	0.121
Factor 4	0.069	0.079

Next, in order to examine the relationships between each factor and the color of light stimuli, a part of the factor score in the watching task is shown in Figure 3. Color maps for each factor are shown in Figure 4. Figure 4 showed that there are different evaluation peaks for all factors and tasks. This means that there are different optimal lighting conditions for each scene.

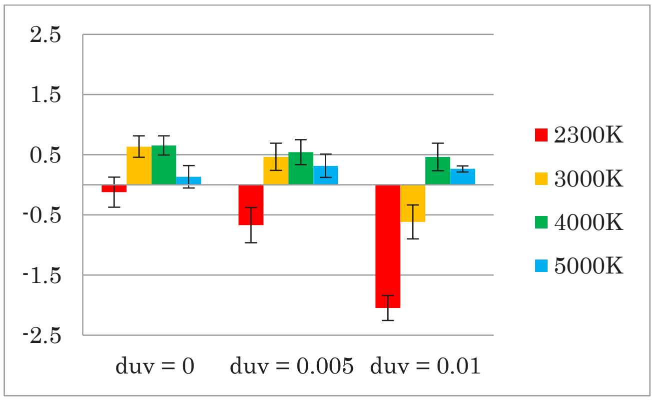

Figure 3. Facter Score of factor 1

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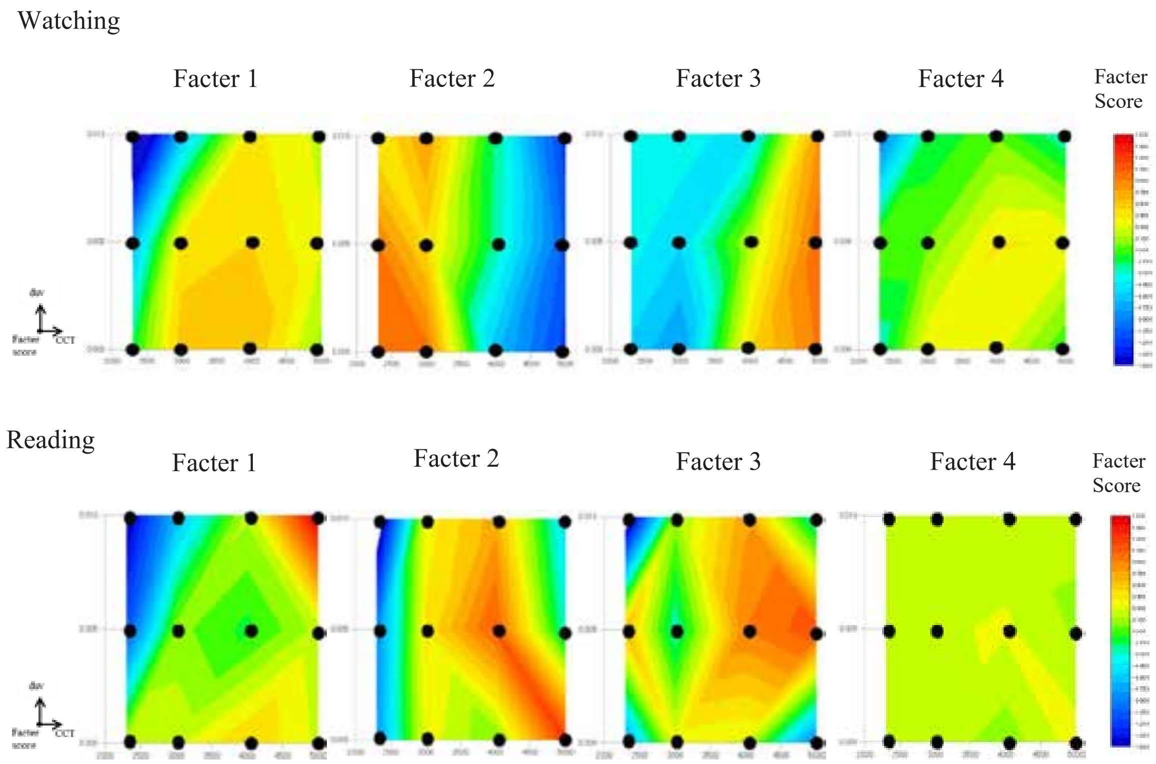

Figure 4. Color maps for each factor

DISCUSSION

Our experiments showed that there existed different peaks depending on the factors and tasks. There are two possible causes, effect of the difference in task and that of the difference in adjective pair constituting evaluation factor. In order to examined which causes are more influential, we investigated the difference in evaluation of the same adjective pair for each task. In this analysis, we examined three adjective pairs which had relatively high factor contribution rates that were included in Factor 1 in each task. Color map of these results are shown in Figure 5. As a result, there were no significant difference in the evaluation peaks as shown in Figure 4, and we found that they showed relatively the same trend. This suggested that the large difference in the results of this study were due to adjective pairs constituting the evaluation factors.

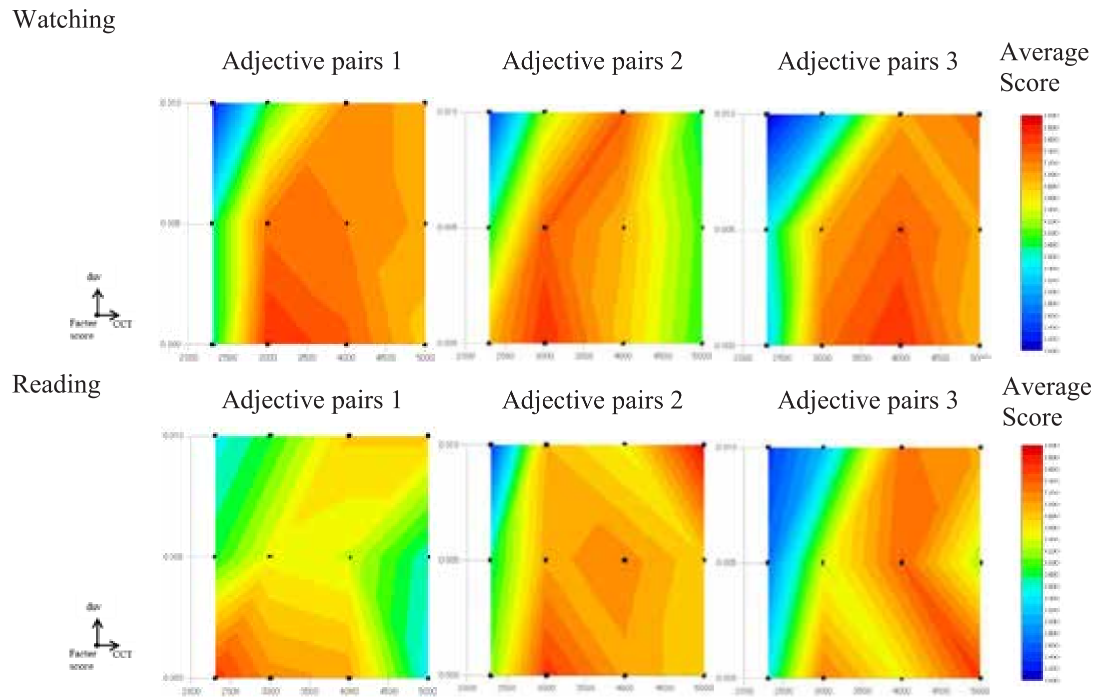

Figure 5. Color maps for discussion

SUMMARY

This study investigated the influence on the impression of the living room due to the difference in the color of lighting stimuli. We found that the evaluation peaks are different for all evaluation factors and tasks. This suggests that there are different optimal lighting conditions for each scene. We also examined the differences between these evaluations. the results suggested that the main cause is the influence of adjective pairs constituting the evaluation factor, and we found that if the adjective pair is same, the similar evaluation trend is shown although the task is changed.

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CREATIVE COLOR STYLE FOR 3D PROJECTION MAPPING

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Keywords: model, color palate, color psychology, 3D projection mapping, audience

ABSTRACT

In the field of productions, color is one of the most important things to create a minuteness work and impress the audience. People have their own favorite colors and feel the colors they seen. In the present study, colors have been used on 3D Projection Mapping to define appropriate color which make the 3D Projection Mapping more prominent and attractive. Process of doing the experiment start by preparing a 3D Projection Mapping color palette for design beforehand. Then five colors from color psychology template; a color wheel indicated the meaning of different colors, were projected on the 3D simulate model by projector in a dark room. The different color of the same model pattern design was presented to the observers assessed which color is the most appropriate for the 3D Projection Mapping model designed by ratings on a questionnaire using Likert scale. The scores are divided into five levels; five for the highest and one for lowest respectively. Green is the best for mapping and purple is the worst for mapping. The purpose of the creative color designs for 3D Projection Mapping is searching for the most advisable color to use with 3D Projection Mapping Project and the result can be used in another 3D Projection Mapping in the future and production working.

INTRODUCE

Projector is an output device that can take images generated by a computer or Blu-ray player and reproduce them onto a screen, wall, or other surface. Typically, the surface projected onto is large, flat, and lightly colored. For example, you could use a projector to show a presentation on a large screen so that everyone in the room can see it. Projectors can produce either still or moving images. A projector is often about the size of a toaster and weighs only a few pounds. Projector make a popular with Projection Mapping can be used for advertising, live concerts, theater, gaming, computing, decoration and anything else you can think of. Specialized software or just some elbow grease can be used to align the virtual content and the physical objects. For more information see our Software sections

To investigate the appropriate color for 3D Projection Mapping, I used high quality projector for investigate the 3D Projection Mapping color for organization working and brand advertise or any events. Since 3D Projection Mapping come to Thailand, we always saw a 3D Projection Mapping but no one do a research about colors popular or appropriate color for Projection Mapping.

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METHODOLOGY

In this Experiment, we have three apparatus for investigate colors. first I used SONY VPL-DW241 Projector. After that we will put suit fashion model design for this experiment with white shirt for display and human body for mapping.

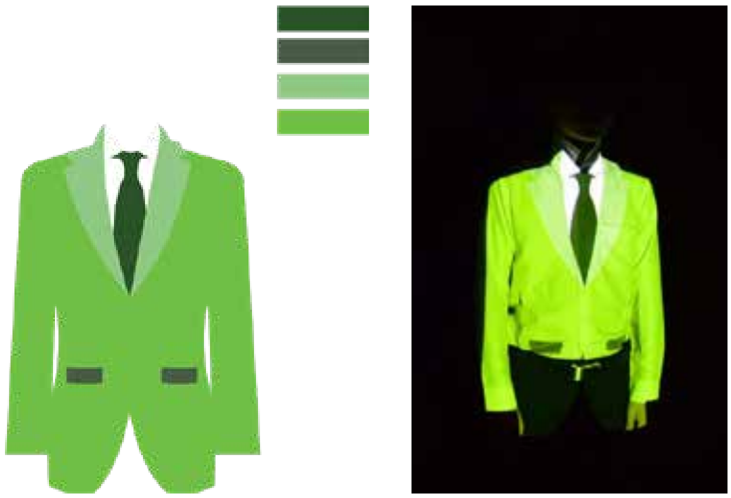

Figure 1. Distortion between suit model and mapping experiment.

The experiment was conducted in the dark room. that provide a darkness don't have any colors or light insert. Before we do this experiment, we made 5 fashion suit models (purple, red, blue, green and yellow) for the experiment. Instead of projecting on a screen light is mapped onto human body or our screen with white shirt for color cast didn't happen. We put projector in the desk and adjust until we got the appropriate mapping. We used ISO 800 for taking pictures to investigate the appropriate color for 3D Projection Mapping

After that, we will use all of experiment photo to do a creative color design for 3D Projection Mapping Research. The observers were asked about what is the best colors for 3D projection Mapping and what is the worst colors for 3D Projection Mapping. Resolving from 30 observers who participated in this research depending on absoluteness or personal favorite and distortion color between model and mapping when they do research.

RESULTS AND DISCUSSION

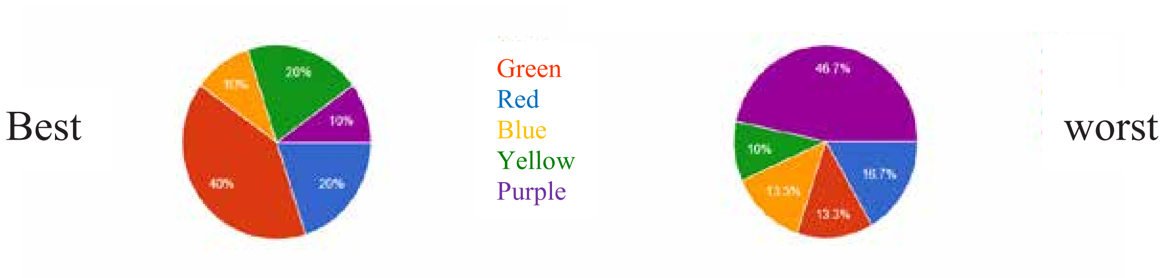

Figure 2. best and worst color for 3D Projection Mapping

Important things about our research is how distortion between suit model and mapping experiment impact to another people who do a research and this research have an interesting answer. Green is the best color for working with 3D Projection Mapping (12 or 40% from people who do a research answer green) and purple is the worst color for working with 3D Projection Mapping (14 or 46.7% from people who do a research answer purple) There for, our research conclusion is that, to provide the appropriate color for 3D Projection Mapping, green is the best color for working with 3D Projection Mapping.

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WEB DESIGN FOR STUDENT AFFAIR OF FACULTY OF MASS COMMUNICATION TECHNOLOGY RAJAMANGALA UNIVERSITY OF TECHNOLOGY THANYABURI

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Keywords: Public relations, Website, student development department, Website design

POSTER SESSION

ABSTRACT

This research is specifically aimed to design a website of the student development department and survey the satisfaction of students as users in using website of the student development department, faculty of Mass communication technology, Rajamangala University of Technology Thanyaburi.

The method used in this research had been run by using 942 of the first year students who were studying in 6 various majors of the faculty of Mass communication technology, Rajamangala University of Technology Thanyaburi during academic year of 2015 as the sample group according to the information of the student admission policy of the faculty of Mass communication technology (academic year 2015). Which data collected using of the sampling method according to Taro Yamane. From whole 942 students, the deviation level was determined for 5 percent which meant 280.77. Therefore, we used a sample group of 300 students in order to evaluate the satisfaction of the students to the website which was designed by whole population as well as the tool used in the process consists of the student development department website, the assessing form for the requirement of sample group and questionnaires of the satisfaction for the sample group, in which the statistical methods used for analysis include the calculation of the percentage, average, standard deviation and sampling method of Taro Yamane.

The conclusion of the analytic result in quality of the media which was addressed by the information specialist shows that in term of content and information presentation are shown as excellent quality and the information presentation in public relations is shown as good quality level. The satisfaction analysis result from the sample group in usage of the student development department website found that in term of website content, design and usage show highly satisfied by students.

INTRODUCTION

Publications in the form of electronic documents. Different types of applications may be both images and text. Or may have a sound. [1] The presentation of information on the Internet is done by creating a web site, a multi-dimensional document on the Internet where each page can be linked. Access to information is widespread. And the clear understanding of the operation of all government agencies and private sector. The public relations to disseminate information, because the publicity is a creative work, resulting in knowledge. Affect the right understanding, can create favorable feelings (Favorable opinions) between agencies. [2] This will bring awareness. Trust in faith, cooperation, and good relationships. Make the operation of the unit. Achieve goals well.

The organization in a public relations manner. Publish information related to the public to the public. It also has access to masses. It is another kind of education that can be [3] Student Development Division Rajamangala University of Technology Thanyaburi has a vision of being a leading professional organization in student development. The mission is to promote student development activities. To have the characteristics of graduate students. By organizing activities, services and welfare. The quality of life of students. [4] The production of graduates is socially responsible and possesses the characteristics of graduates who desperately desire it. It is a complex process that requires the faculty, the faculty, and the students themselves. If any party has a problem or is not ready. Teaching or production of graduates can not be fully realized. Higher education requires a media outlet to help students adjust quickly. Originally, the Faculty of Mass Communication Technology had a central website for presenting information. Academic Faculty Structure And student activities But today the central site of the Faculty of Mass Communication Technology. The only part of the activity is Student Development. Faculty of Mass Communication Technology There should be additional information in the other sections, such as the preparation of activities to participate or the activities of the Faculty of Mass Communication Technology. Event Duration Examples of useful project writing of senior Students will be able to view the public relations materials in the scholarship. Arts and Culture Welfare Other handbook related to student activities and student development. The website also categorizes the parent network. The details of the event. For parents to feel comfortable. Because of the problem, some parents do not understand and can not follow the students. This leads to controversy between the parents and students. Therefore, creating a parental network section will give you a better understanding of the details. It is a medium of interaction between members of the student development department and the direct parent. It also creates a good corporate image. The quality and standard of higher education institutions are so high that higher education institutes must be able to provide the public relations materials to the student development department.

EXPERIMENT

Population used in this research is the Faculty of Mass Communication Technology. There are 942 students in Rajamangala University of Technology Thanyaburi.

Researchers will measure satisfaction from First year students in the academic year 2015, the 6 faculties of the Faculty of Mass Communication Technology. Based on data from the 2011 Faculty of Mass Communication Technology, the data were collected by using the appropriate sampling method of Taro Yamane, with a total population of 942 persons. The error rate of 5% was 280.77. The sample will be used to measure the satisfaction of the media.

When the researcher has successfully installed the program. The researcher has adjusted the experimental details. And the parameters of the program and in the system add-ons. To test whether the system will meet the most demanding applications. The researcher also gave the student development team and staff members of the Student Development Department. Faculty of Mass Communication Technology Tested for 1 month by daily access. By way of browsing through Firefox or Chrome web browser, Microsoft Eade

After the development of educational tools, Website Designing Media Student Development Faculty of Mass Communication Technology Nicely done The quality of the work was assessed by the experts.

The evaluation will be evaluated. The methodology for evaluating and analyzing data is as follows.

1) Prepare website media Student development and preparation of the equipment to prepare for the presentation of experts.

2) Describe the research that has been done. Experts are aware of the nature of the research and the workflow of the research.

3) Make a media presentation website. Student Development

4) After the experts visit the media site. Student Development Then the experts make a quality assessment by experts.

5) Collect the assessment form to collect data and analyze the results in the next step.

Data collection from the sample is as follows.

1) Prepare online and offline questionnaires for evaluation.

2) Explain the purpose of the research on online media and explain it for non-online groups.

3) Determine the URL for the sample to be used and evaluate the questionnaire.

4) The respondents were asked to answer the questionnaire based on the questionnaire generated by the questionnaire.

5) Collected questionnaires were collected to analyze the results.

RESULTS AND DISCUSSION

Web Design for Student Affair of Faculty of Mass Communication Technology Rajamangala University of Technology Thanyaburi The quality of the media is measured by 5 experts in the field of information content. Presentation of information Presentation of information on visual design promotion. The data were collected and evaluated for satisfaction with the media. "Website Design, Student Development Faculty of Mass Communication Technology. The population used in this study is First year students in the academic year 2015, the 6 faculties of the Faculty of Mass Communication Technology. Based on the plan for the Faculty of Mass Communication Technology, the data will be collected by the appropriate sampling method of Taro Yamane, with a population of 942. The error rate of 5% will be 280.77. The research used a sample of 300 people to measure the satisfaction of the media. All of them were randomly selected from a total of 300 people from all six branches. The sample size was 300. More than male There were 188 females (63%) and 112 males (37%). The students' needs survey before the design of the student development website by the media quality level of the content experts found that the font size. And the pattern is clear. And easy to read Very good. Since the researcher has studied the theory of background design, the most suitable background is the white background. In terms of presentation, it is found that the color characteristics of the presented text are appropriate. The level is very good. The fonts used are black, approximately 90 percent, and 10 percent will focus on the content you want to download documents to read the content most convenient. In the presentation of information in the public relations. Data presentation is easily accessible. The appropriateness of the link between each image. The design is interesting to pursue. Easy to use location marking. The quality is equal. The quality is very good. The image. The continuity of the images in the presentation is most appropriate, followed by the image is clear to the presentation. The quality is very good. The result of the assessment of the experts in the design of the website design is that the colors in the design of the media is appropriate. Template is beautiful, balanced and suitable for use. The quality is very good. The results of the media satisfaction evaluation. "Website Design, Student Development Faculty of Mass Communication Technology. The sample size was 300 persons. The data is accurate and clear. At the level of satisfaction. The samples of the website design showed that the colors, backgrounds, colors, text and colors of the illustrations were appropriate. Most satisfied Finally, in terms of usage, it is a source of information that meets the needs of users at a very satisfied level.

Faculty of Mass Communication Technology The objective is to design a student development website that meets the needs of students. The purpose was set. Make Website Design Student Development Faculty of Mass Communication Technology Rajamangala University of Technology Thanyaburi meets requirements.

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POSTER SESSION

WEB COLOR DESIGN FOR PRESENT RAJABONGKOD HOTEL TRAINING CENTER

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Keywords: Website, Color Design, Thai Tone, Public Relations

ABSTRACT

This research aimed to study in term of psychology of the Rajamangala University of Technology Thanyaburi, Faculty of Mass Communication Technology about web design color of Rajabongkod Hotel Training Center to improve the image to be more modern by using Thai Tone colors design. The findings revealed that the blue color group was the most modern at 23.62%, the second was a green color group at 21.14%, the third was a yellow color group at 20.57%, the fourth was a red color group at 17.71% and the less modern was a grayscale color group at 16.95% and the subjects believing the good design of website effects to deciding on using the services.

INTRODUCTION

The public relations in a new economic model Thailand 4.0 was the turning point of the communication in Thailand. Now a day, online media is often used in daily life, so it became a way to communicate in the digital platform. Surely, the website is a way for public relations to provide news and information to an audience because the website is easy to access information and can present into any device by the internet. For Rajabongkod Hotel Training Center; Rajamangala University of Technology Thanyaburi University hotel, the exterior of the building does not look modern and website not available for public relations, so it doesn't look good. To make it easier for users to access information and to improve the image of Rajabongkod Hotel Training Center to look more modern without spending a lot on rebuilding cost, we have designed the website using Thai tone color[1]; a color tone from the research of Dr.Pairoj Pittayamatee, Silpakorn University used digital device "Colour CAPSURE" of the Pantone corporation to measurement color from Thai old murals and then compare with Pantone book colors to get the value of C M Y K for modern color mixing to support that purpose. Five tones from Thai tone including red, yellow, green, blue, and grayscale were prepared for observers to select for design the website. There were doing an experiment to define color which suitable for the website and make the image of Rajabongkod Hotel Training Center to be modern.

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METHODOLOGY

STEP1: COLOUR SELECTION FROM SAMPLES

The subjects are 70 students from Rajamangala University of Technology Thanyaburi, Mass Communication Technology, Digital Media Technology selecting Thai tone colour which is expected to be the most fashionable and suitable for using on the website in each group of colour. The researcher applied the theory of the Color Wheel Analogous for selecting main colour. The main colours consist of red, yellow, green, blue and grayscale. Five colours were selected per one group of colour as following;

Red: From 26 colours to only 5 colours.

Yellow: From 15 colours to only 5 colours.

Green: From 28 colours to only 5 colours.

Blue: From 16 colours to 5 only colours.

Grayscale: From 31 colours to only 5 colours.

Figure 1. The example of yellow colors group selected from samples with 5 colors.

STEP2: COLOR SELECTION FOR WEBSITE DESIGN

The colours were ranking the top 5 selected from the the samples by each group of colour. They were analyzed by colour brightness through the RGB Colour Values (RGB). This method was to plus the value of R (Red), G (Green) and B (Blue). The values were normally from 0 to 255 where 0 means no brightness and 255 means the most brightness.

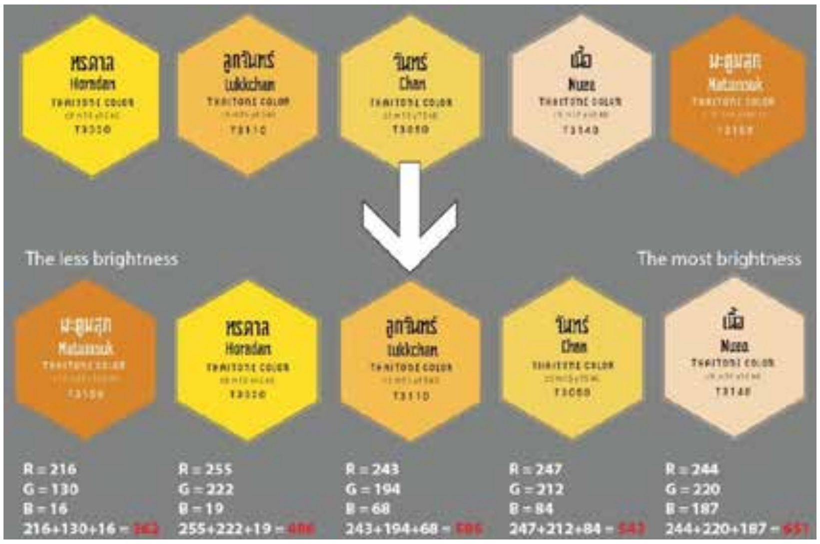

Figure 2. Sort the brightness values by RGB color values.

After sort the brightness values, the researcher had designed to select 3 colours from each group of colours. In order to avoid the users' confusion and easy to design the website, the colours were selected by the most brightness, the less brightness and the medium brightness for designing the website. This was also for the contrast comparison and easy to read the content.

Figure 3. Select the less brightness, medium brightness, most brightness to design a website.

STEP3: USING SELECTED COLOURS FOR THE WEBSITE DESIGN

The website was design with all 5 colours by arranging the same elements of the website as picture, font size and font family, and layout. The colours used in the design were as following;

The most brightness: Use for text color in menu bar, text and button color of footer.

The medium brightness: Use for icon color and button color when on mouse or click hover.

The less brightness: Use for background color of menu bar, background of footer and headline text.

Figure 4. Show the colors used in the web design as same elements.

STEP4: PRESENT THE WEBSITE TO BE SELECTED BY THE SAMPLES

The subjects were 35 students from Rajamangala University of Technology Thanyaburi Mass Communication Technology, Digital Media Technology choosing the website designed with 5 group of colours and with the same elements arranging. The subjects were expected to select the most modern ranked from 1 to 5. The scores were weighted as following;

5 point means modern ranked as 1st

4 point means modern ranked as 2nd

3 point means modern ranked as 3rd

2 point means modern ranked as 4th

1 point means modern ranked as 5th

POSTER SESSION

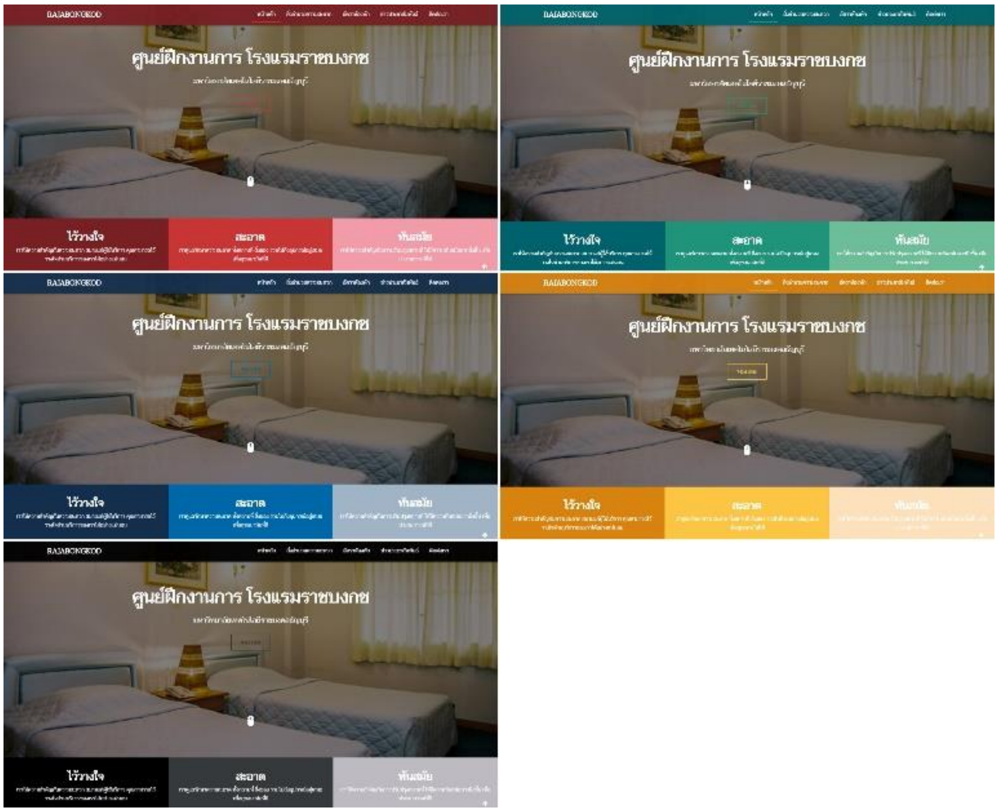

Figure 5. The results of web colors design with 5 color groups.

RESULTS AND DISCISSION

Regarding to the psychology of the students from Rajamangala University of Technology Thanyaburi, Mass Communication Technology, Digital Media Technology toward the Thai tone colors for website designing, the results showed that the most modern was blue with the total of 23.62 percent. The second was green with the total of 21.14 percent. The third was yellow with the total of 20.57 percent. The fourth was red with the total of 17.71 percent and the last was grayscale with the total of 16.95 percent.

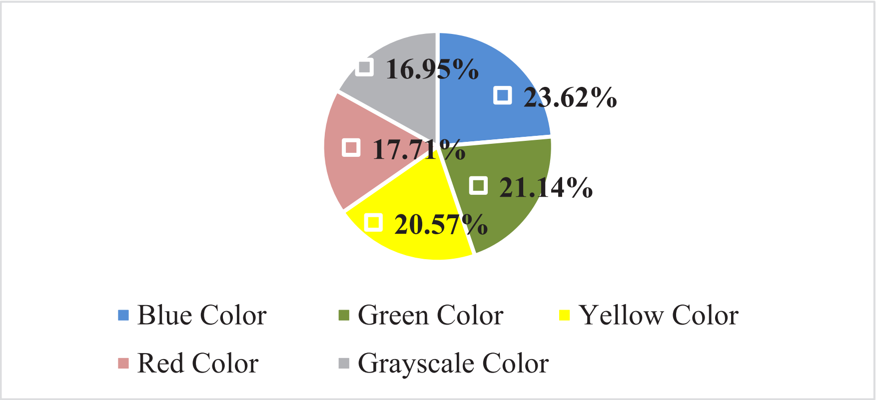

Figure 6. The results of the most modern color in website.

Based on the survey results, conclude that Thai tone color in 5 color group for web design of Rajabongkod Hotel Training Center. The blue color group affects the perception of samples to feeling this hotel is modern and useful more than other color groups. Finally, the subjects believing the good design of website effects to deciding on using the services.

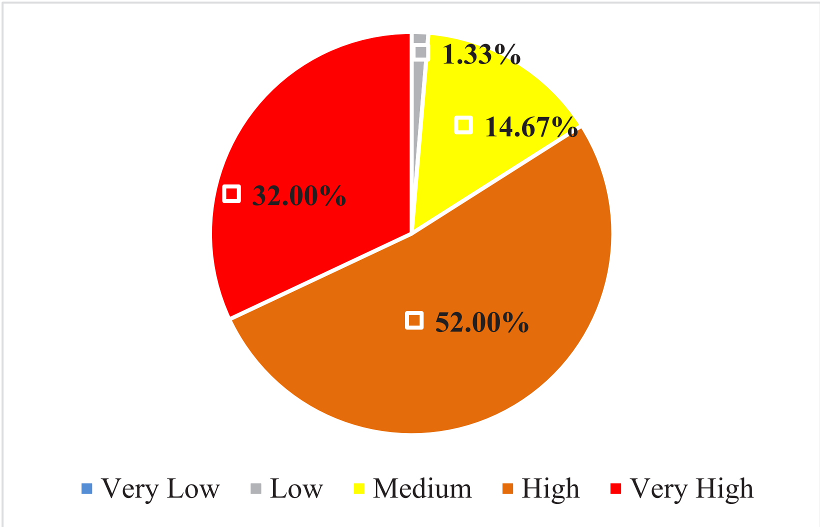

Figure 7. Show survey results of the sample believe the good design of website affects to them decide to use the services.

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AN EMPIRICAL STUDY ON ASSOCIATION OF COLORS WITH ADJECTIVES

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Keywords: Color association, adjective, CIELAB, Color volume

ABSTRACT

The objectives of this study are: (1) to understand the strength of association between adjectives and colors; (2) to analyze the volume of distribution of different adjectives in the CIELAB color space; (3) to analyze the correlation between adjectives and their volume of distribution in the CIELAB color space. Eighty adjectives were selected for the main experiment by a focus group. Twenty-two participants assessed the score for each of the given adjectives which could be associated with a color. The other thirty participants assessed the related single color with each of the given adjectives. A substantial amount of color values were distributed and calculated in the CIELAB color space. The findings of this study showed that the strength of association between eighty adjectives and their respective colors can be clearly divided into four groups, namely "extremely strong," "strong," "medium," and "weak." The intensity of an adjective indicated a significant negative correlation with the distribution volume of its associated color. In other words, adjectives with a clear meaning were often associated with similar colors by different participants. The colors associated with adjectives such as warm, sunshine, passionate, shine, and cool were more uniform; conversely, the colors associated with adjectives such as modern, graceful, steady, restful, and exalted were relatively variable. The results of this research can serve as reference for product designers in the selection of colors using adjectives.

INTRODUCTION

Frequent discussions and communication are necessary processes in the initial stage of a product design proposal. In the early product development stages, the designer and his/her client need to have repeated discussions in order to determine the product users and market positioning strategies. The use of adjectives is one of the practical ways to facilitate such discussions and communication in the product design process. Color is one of the most important design element for a product designer. A significant amount of studies indicate that color corresponds to human emotions. The selection of colors used in a product often has a corresponding relationship with the target market. Selecting the right adjectives can assist the designer to establish associations with a suitable color, eventually settling on the final color to be used in the product [1, 2, 3, 4]. Manav (2007) figured out that emotional response to colors change with value and saturation levels [5]. Kaya and Epps (2004) indicate that positive emotional responses were highest in primary hues, followed by intermediate and achromatic colors [6]. The color green mainly evoked positive emotions such as relaxation and comfort. In view of this, this study aims: (1) to understand the strength of association between adjectives and colors; (2) to analyze the volume of distribution of different adjectives in the CIELAB color space; (3) to analyze the correlation between adjectives and their volume of distribution in the CIELAB color space.

RESEARCH METHOD

Selection of the adjectives. The adjectives applied in this experiment were selected from a substantial amount of surveys in the product design field. In the first round, a total of 133 adjectives were selected. In the second stage, for the main experiment, the adjectives were reduced to 80 (see Table 1) by the focus group. The selection criterion included the adjectives which could be used in the practice of product design. The five members of the focus group were one senior product designer, one associate professor with a major in graphic design, one assistant professor of visual art and design, one senior graphic designer, and one senior project manager in product design.

Table 1: The list of 80 adjectives

No.	adjectives	No.	adjectives	No.	adjectives	No.	adjectives	No.	adjectives
01	Warm	17	Shine	33	Ornate	49	Showy	65	Mysterious
02	Intimate	18	Austere	34	Amiable	50	Graceful	66	Manmade
03	High tech	19	Wild	35	Vivid	51	Leisure	67	Steady
04	Professional	20	Happiness	36	Captivating	52	Agreeably	68	Youthful
05	Local	21	Prestige	37	Stable	53	Colorful	69	Dream
06	Cool	22	Sacred	38	Fascinating	54	Imagination	70	Sexy
07	Refined	23	Exalted	39	Leisurely	55	Populous	71	Purity
08	Artistic	24	Pure	40	Majestic	56	Funky	72	Joyful
09	Refreshing	25	Romantic	41	Antique	57	Clear	73	Dapper
10	Temperate	26	Nostalgic	42	Traditional	58	Light and pale	74	Sunshine
11	Heavy	27	Restful	43	Natural	59	Animated	75	Dry
12	Peaceful	28	Calm	44	Old	60	Active	76	Country
13	Ecological	29	Simple	45	Happy	61	Earnest	77	Fresh
14	Full of life	30	Complex	46	Modern	62	Rich	78	Brightness
15	Urbane	31	Friendly	47	Unadorned	63	Pastoral	79	Airy
16	Freedom	32	Classical	48	Passionate	64	Quiet	80	Feminine

Assessment of the adjectives. Concurrently, the research studied the strength of association between adjectives and colors by conducting an experiment with another group of 22 participants. The participants assessed the score (from 0 to 10, with 10 as the highest) for each of the given adjectives which could be associated with a color. The participants in this group included a senior product designer, one associate professor with a major in graphic design, 12 bachelor students from the department of visual art and design, and 8 bachelor students from the department of product design.

Volume calculation in the CIELAB color space. Using the experimental method, 30 participants were asked to select a single color in the calibrated monitor for each of the given adjectives. The task focused on "each adjective could associate with a single-color base according to the participant's intuition." The interface of color selection was the Adobe Photoshop CC software color palette (see the left side of figure 1). When each participant selected a single color, the *L*a*b** value for each of the given adjectives was automatically recorded. In order to analyze the volume of distribution of different adjectives in the CIELAB color space, a substantial amount of color values were collected and calculated (see the right side of figure 1). Each adjective corresponded to 30 CIELAB effective values from 30 participants. The group center point was established from the 30 CIELAB values by applying a median analysis in the CIELAB color space. The volume of 30 points was calculated by the sum of delta *E*, which is the sum of color difference values between each point and the center point, using the Visual Basic programming development platform. Although the *L*a*b** values were displayed in CIE*a*b** two dimension figure and each color point in RGB, which was transformed from CIELAB, the CIELAB values were also used to calculate the color difference. For example, a relatively small volume indicated that the colors associated with the 30 participants were extremely close to each other. Conversely, if the 30 participants selected different colors, the volume would be relatively large in the CIELAB space.

Data analysis. In order to understand the strength of color association between adjectives and colors, data were collected from an assessment of 22 participants. These participants assessed the integer score from 0 to 10. The average of each adjective was categorized as the first 10%, 11% to 25%, 26% to 50%, and 51% to 75%. For example, the first 10% group indicated “extremely strong,” while the 51% to 75% signified “weak.” The volumes of distribution of different adjectives were also analyzed in the CIELAB color space. The four groups were used to analyze the relative magnitude of volume. For example, the first 10% group indicated a “smaller” volume. On the other hand, it also indicated that the participants had selected similar colors for the same adjective. Finally, this study analyzed the correlation between adjectives and their volume of distribution in the CIELAB color space, based on the results of the descriptive statistics of the assessment and volume calculation data. This study further analyzed the degree of expressiveness of adjectives and its correlation with color volume (see figure 2).

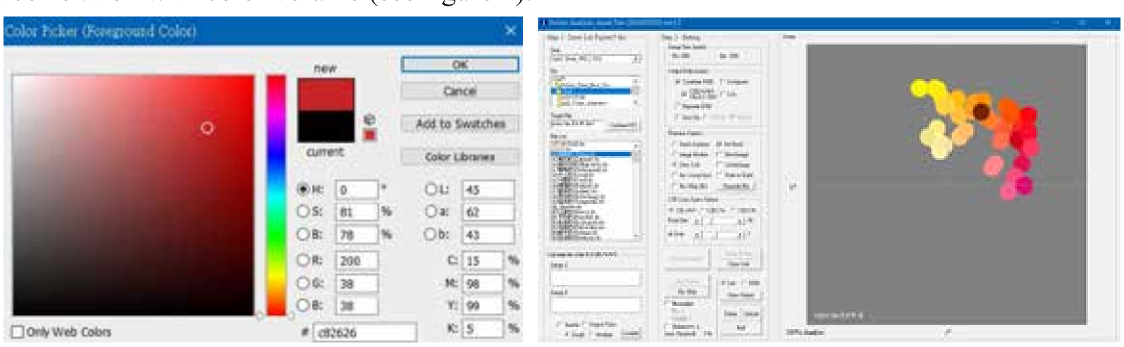

Figure 1: The interface of color selection (left side) and the distribution analysis on the CIELAB color space (right side)

Table 2: The four groups of different adjectives

Group	No.	Adjective	Average	Volume	Group	No.	Adjective	Average	Volume
Extremely strong (The first 10%)	01	Warm	9.318	3.183	Medium (26%~50%)	18	Austere	7.273	9.585
	74	Sunshine	8.864	4.842		03	High tech	6.182	3.540
	48	Passionate	8.455	3.244		72	Joyful	6.091	10.698
	17	Shine	8.045	3.028		10	Temperate	6.136	11.083
	06	Cool	8.045	5.216		76	Country	6.500	9.795
Strong	11	Heavy	7.318	6.744		70	Sexy	7.318	13.841

(11%~25%)	44	Old	7.864	4.440		42	Traditional	6.955	9.754
	43	Natural	7.909	9.974	Weak (51%~75%)	46	Modern	5.318	13.504
	13	Ecological	7.500	8.399		50	Graceful	5.318	12.189
	55	Populous	7.500	5.237		67	Steady	5.773	13.688
	41	Antique	7.455	7.488		27	Restful	5.727	10.370
	75	Dry	7.909	7.892		23	Exalted	5.182	12.302

RESULTS OF RESEARCH

The research findings showed that the strength of association between the 80 adjectives and their respective colors could be clearly divided into four groups, namely "extremely strong," "strong," "medium," and "weak." This association was further analyzed. Table 2 indicates the four groups of the different adjectives as well as the results of the average score and volume values. The first 10% indicate the "extremely strong" effects between adjectives and their respective colors, as well as pointed out the participants' similar color selection for the same adjectives (see figure 3). The 51% to 75% group points out the "weak" effects, meaning the participants selected different colors for the same adjectives (see figure 4).

Figure 2: The distribution of 80 adjectives on the CIELAB color space

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Using the Pearson's correlation analysis, the table also indicated the intensity of an adjective, demonstrating a significant negative correlation (r=-.72, p<.01) with the distribution volume of its associated color base. Adjectives such as warm, sunshine, passionate, cool, and shine were extremely strong in the results of smaller volume and higher assessments. In other words, adjectives with a clear meaning were often associated with similar colors by different participants. The strong adjectives were heavy, old, ecological, populous, natural, and antique. The medium group included austere, high tech, joyful, temperate, sexy, country, and traditional. The weak group included modern, graceful, steady, and restful.

Figure 3: The distribution of the first 10% group of adjectives on the CIE a*b*.
(from left to right is warm, sunshine, passionate, shine, and cool)

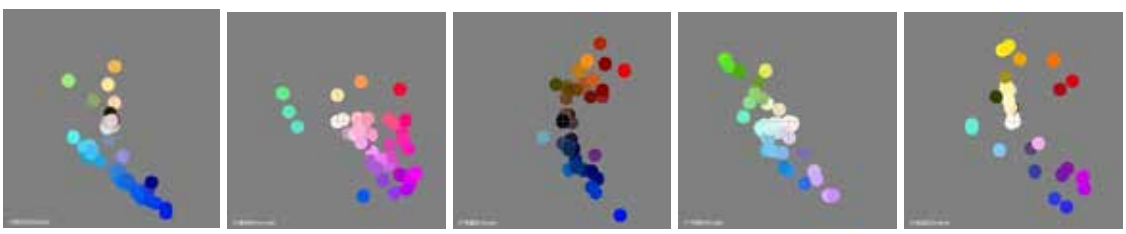

Figure 4: The distribution of the 51%~75% group of adjectives on the CIE a*b*.
(from left to right is modern, graceful, steady, restful, and exalted)

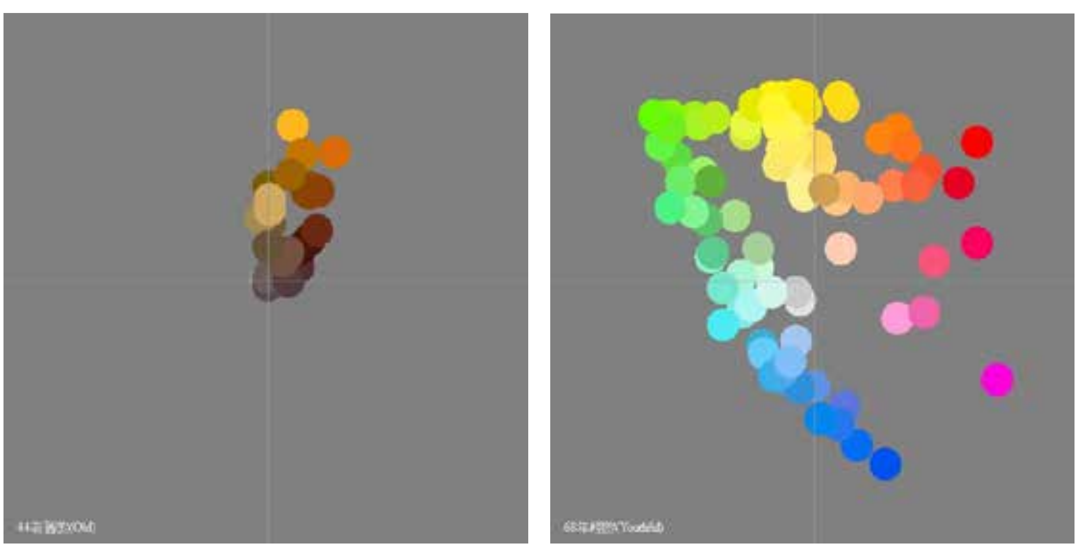

Figure 5: The distribution of two different adjectives on the CIE a*b*.
(The left is old, and the right is youthful)

The results also indicated the two different distribution shapes between old and youthful adjectives in the CIELAB color space. These two adjectives also indicated the differences with regards to semantics (see figure 5). The distribution of 'old' demonstrates a similar hue of variable lightness while "youthful" is a variety of hues with similar lightness levels. In other words, the adjective "old," with a clear meaning, is often associated with similar hues by different participants while the adjective "youthful" is associated with a different kind of daily life, thinking, variety, and so on. The features of variable hues include colorful (no. 53) and artistic (no. 08). The features of a similar hue include ecological (no. 13), shine (no. 17), high tech (no. 03), passionate (no. 48), populous (no. 55), sunshine (no. 74), antique (no. 41), and romantic (no. 25). The above adjectives are often associated with different colors.

DISCUSSION

The results of this research can serve as reference for product designers in the selection of colors using adjectives. For example, the colors associated with adjectives such as warm, sunshine, passionate, shine and cool are more uniform; conversely, the colors associated with adjectives such as modern, graceful, steady, restful, and exalted are relatively variable. Human beings experience emotion through perception and cognition. They also construct meaning through color. Adjectives are one of the best ways to find suitable colors. Both the experienced and inexperienced product designers are required to undertake the responsibility of a product's color selection. For example, the results of the "youthful" adjective indicated the selection of a variety of colors for the same adjective in this study. The product designer could use a variety of colors in a series of product appearances. Discussions and communication on product design are means of understanding and establishing suitable color selections. Hopefully, the results of this study will provide a foundation to the product designers and a simpler way to achieve their work requirements.

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DETERMINING THE COLOR FOR INFOGRAPHIC DESIGN TO SUITABLE FOR CONTENT.

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Keywords: Infographic, Infographic design, Color and design, Color Psychology.

ABSTRACT

Infographics were commonly used in varieties of media, including the public relations media; PR. There are a variety of colors used in the design of infographics. We want to determine the color that best fits the content presented by Infographics to be easy to understand, attractive and recognize the most received information by study the color theory in design and study the color psychology to help in the choice of colors. Then, the color of the study was designed for 5 samples of Infographics samples by keeping the same content and design but using different colors, after that the samples were assessed the satisfaction of the use of color in the infographics poster designs that appropriate for the topic of "Preparedness and Protection of Victims of Children to enter the justice process" by online surveys. The result obtained from the survey shows that, are appropriate to the content, appealing, easy to read, and resulting in the best information are green – blue and red - yellow and those who are interested can apply the color of the survey to the design of infographics that have the same or similar content.

INTRODUCTION

At present, Thai society is experiencing more violence in children. Violence happens both to the victim and the family. A problem of violence in children has been increasing proportions that are dangerous in Thailand which impacts victims of violence, family victims, and social environment such as neglect, or personal assault. Child Abuse, it is a common problem, In the group of girls aged 10-15 years, 90%. Secondary problem is sexual harassment and also find other problems. In the news presentation or educate concerned about the problems with children to parents or the general public in society from related organizations can not present the visual or the person in the event. Therefore, it is necessary to present information in the form of Infographic.

Infographics is the information or knowledge to summarize information. In the style of graphics designed as a slide or animation, can view and understand easily in quick and clear, can convey to the audience the meaning of all information. Infographic design is divided into two parts: First, data Information to be provided must have meaning interesting. The story is revealed to be true. The second part of the design accuracy, design must have a pattern, structure, function and beauty designed to be easy to understand, easy to use and practical.

A survey of Infographics used in public relations. There are a variety of colors used in the design of infographics. We want to customize the colors to suit the content presented by Infographic. It's easy to understand and attract parents. Parents are aware of these issues. The organizer cooperated with the Foundation for the Protection of Children's Rights to develop the infographics used in public relations and education, the topic is the preparation and protection of the injured children in the process of justice. The Protection of Children's Rights Foundation can be used to publicize and disseminate information to the public. Target audience 50 people aged 25-35 years, from followers of The Protection of Children's Rights Foundation's Facebook fan page.

The color scheme that will be used to design this infographics poster. It comes from the study of color theory in design and color psychology. In this theory there are several types of color schemes. Researchers choose the type of color harmony because it can apply more colors than other types and was used in the design of infographic graphics and study the theory of color psychology to help in the choice of colors and then used color of the study was designed for the same 5 samples of infographics but use different colors after that bring it to explore the satisfaction with the use of color in the design of infographics posters that are appropriate for the topic, "Preparedness and Protection of Victims of Children to enter the justice process. " use the online satisfaction assessment form. The first part is the general information, including age, occupation and children. The second part is satisfaction with content and design is measured by the Likert scale. The Likert Scale is divided into 5 levels, 5 is very good, 4 is good, 3 is moderate, 2 is good, 1 means improvement and the third part is the satisfaction with the use of colors in design that affect the feeling. The choices are 5 graphics infographics.

EXPERIMENT

Design and produce five poster graphics in accordance with the theory of color in the design. Four types of color Harmony and use the principle of color psychology to design five infographics posters, the variables are the same: content, layout, and design. Different variables are color. The first one is pink. The second is purple. The third is red - yellow. The fourth is green - blue and the fifth is pink - purple.

1

2

3

4

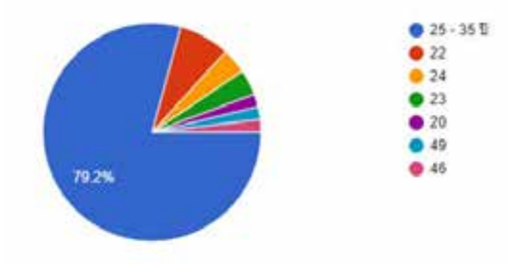
5

According to the first and second used the Total Value Harmony color, the third use Two Colors Mixing harmony, four and five used Sympel Harmony and third and fourth workpieces also used Harmony color casts (Tone), third is hot tone and fourth is cool tone. Then take all the pieces to satisfaction survey by providing a sample of online satisfaction surveys. Respondents responded by viewing the in-graphics poster from their own computer and maximum screen light setting after that when the sample has been completed, press the submit button and the information will be sent back to our e-mail.

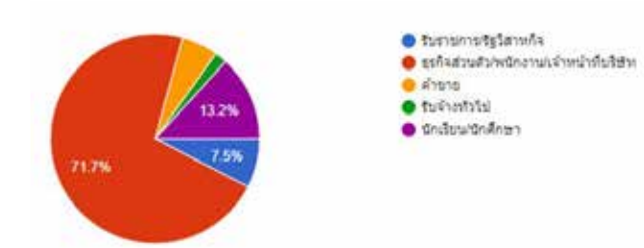
RESULT AND DISCISSION

The result of the satisfaction survey on the use of color in the design of the infographics poster is appropriate to the content. The results are showing that:

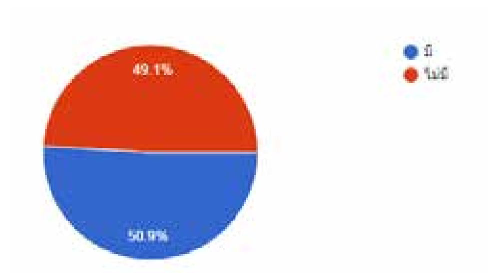
1. General information of the respondents 1.1 the age of the respondents: 79.2% are aged 25-35 17% were under the age of 25 and 3.8% were 35 years or older.



1.2 Occupation of respondents: 71.7% is Own business / Employee / Staff, 13.2% is students, 7.5% is Government / State Enterprises and the remainder is a trader and general contractor.

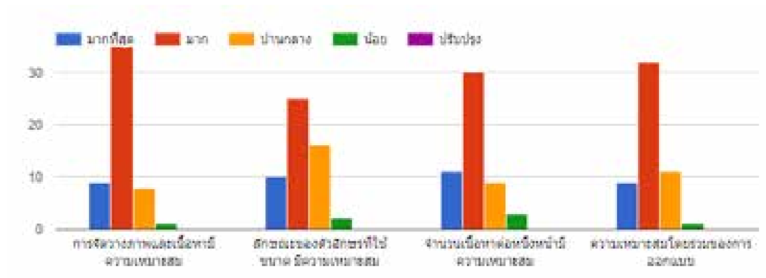


1.3 Having children: 50.9% had a child and 49.1% have no children.



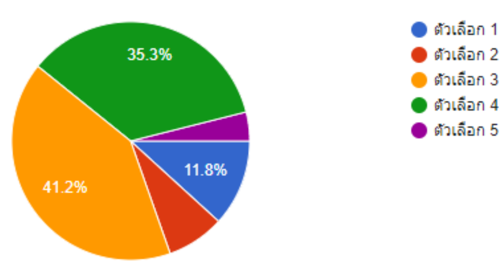
2. Content Satisfaction and Design 2.1 Content: Clarity of Content: most respondents were satisfied with the level 4 is good. Simplified and easy-to-understand language: most respondents were satisfied with the level 4 is good and appropriateness of content per page: most respondents were satisfied with the level 4 is good.

2.2 Design: The appropriateness of image placement and content: most respondents were satisfied with the level 4 is good. Appropriateness of character and size: most respondents were satisfied with the level 4 is good. Appropriateness of content per page: most respondents were satisfied with the level 4 is good. Overall suitability of design: most respondents were satisfied with the level 4 is good.

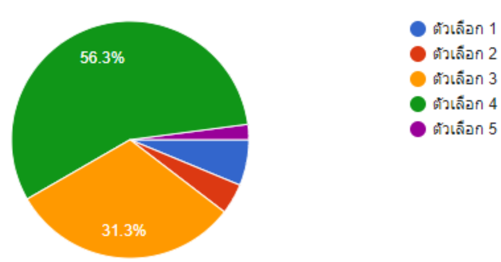


3. Satisfaction with the colors used in the design affects the feeling.

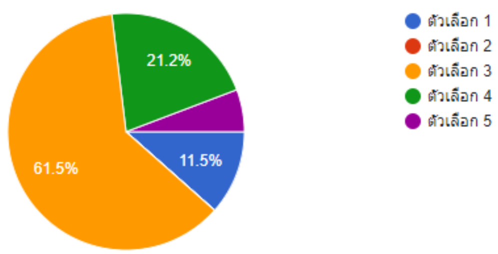
3.1 Which colors of infographics are the most appropriate for the topic and content: 41.2% of respondents choose red - yellow, 35.3% choose Green - blue and 11.8% choose pink.



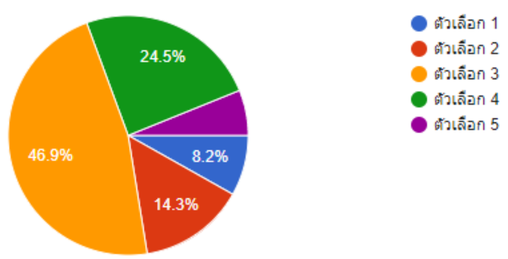
3.2 Which colors of poster graphics are easy to read and understand the most: 56.3% of respondents choose green - blue 31.3% choose red – yellow and the other three pieces are similarly selected.



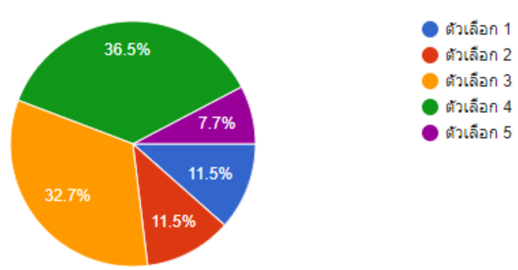
3.3 Which infographics media colors can attract the most attention: 61.5% respondents choose red – yellow, 21.2% choose green - blue and 11.5% choose pink



3.4 Which of the following infographics media colors help to address the most problematic topics: 46.9% respondents choose red – yellow, 24.5% choose green – blue, 14.3% choose purple and 8.2% choose pink



3.5 Which color of the poster artwork is suitable for content, attention, readability, and results in the best possible awareness of the above topic? 36.5% respondents choose green - blue 32.7% choose red - yellow 11.5% choose pink 11.5% choose purple and 7.7% choose pink - purple



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Most of the respondents were 25-35 years of age from the sample 53, half of whom had children in the family and have knowledge or understanding of Infographics. The purpose of the color is to fit the content of the topic. The colors that are most suitable for content and topics are red-yellow. An easy-to-read and understandable color is green-blue. The colors that can attract the best are red-yellow. The color that helps to realize the problem by the topic of the most content is red-yellow and the colors that are appropriate to the content, appealing, easy to read, and resulting in the best information are green – blue and red - yellow. Those who are interested can apply the color of the survey to the design of infographics that have the same or similar content and we will continue further study.

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PREFERRED COLOR FOR THE TOP BANNER BACKGROUND OF THE ACA2018 WEBSITE

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Keywords: Top banner background color, Preference, ACAwebsite, ACAlogo, CMYK, RGB

ABSTRACT

The purpose of this research is to investigate the best color of the top banner background of the ACA2018 website "www.aca2018.rmutt.ac.th" that gives the best appearance performance of the website. The top banner background color of website is very helpful of interface the viewer [1]. The website was created by software WordPress. The logo of ACA2018 conference was created by Suchada Kuntaros by the concept of Lanna (old name of ChiangMai) style and designed by using CMYK color tone (cyan, magenta, yellow and black). Five background colors are prepared, white (R=255, G=255, B=255), black (R=0, G=0, B=0), red (R=255, G=0, B=0), green (R=0, G=255, B=0) and blue (R=0, G=0, B=255). The brightness of the display was kept at 90 cd/m^2 in luminance. The subjects looked at the website on the monitor until 5 colors of background and he/she selected one color that they preferred the most on the online questionnaire. One hundred students of the faculty of Mass Communication Technology participated in the experiment. The result showed that the subjects most preferred white background, and black, blue, green, and red respectively. The subjects commented that they preferred white because the logo looked very colorful and easy to detect the logo easily.

INTRODUCTION

Color is an important feature to consider by consumers when come in the website for various data. The consumer's color preference influences on the website design.[1)] The understanding of consumer color responses for various website has been very complicated because consumers have developed a wide range of color associations for various website.[2)] Certain color is preferred in different cultures and meanings associated with color might vary from country to country.[3)] Color has a strong influence in creating brand image, including change the mood of consumers. It can be also contributed to differentiating website and creating positive or negative images about website.[4)] It is very important to explore the meanings and perceptions of chosen colors in every target website before launching new website. It has many kinds of the website such as interactive, one-way receiving, two-ways receiving the information on the website. The ACA2018 website is aimed to distribute information of the conference.

However, to design a website, it should be concern about detecting and easy to catch the logo or some importance sentences. In this paper we are interested the background color of the top banner which the ACA2018 logo is located. The ACA2018 logo is designed with the colorful as shown in Fig. 1 and I was wondering with color of the background are appropriated to the preference as detecting, easy to catch, and charming.

EXPERIMENTS

The experiment is divided into three parts. Firstly, was collected the content of the ACA2018 conference from the committees. And then prepared the materials, texts, images, logo, graphics. Secondly, created the website by using the software WordPress. Five color at the top banner background was designed by black, white, red, green, and blue as show in Fig 2. After creating the website, text proofing was done before going to the third step. Thirdly, designed the online questionnaires with question that "what color of top banner of ACA2018 website" that you the most preference.

Figure 1. ACA2018 logo and graphic.

Figure 2. Colors at the top banner.

One hundred students from the faculty of Mass Communication were participated on this experiment. Their age is around 18-22-year-old. Participants were female (59.1%) and male (40.9%). It was quite simple question but it useful to have and confident of using color background banner which appropriates to the ACA2018 logo. In the online questionnaire, the comment box was included and participates person can be write down the comments.

RESULTS

Figure 3 showed high preference of top banner background at the white color 70 %, black 15%, blue 8%, green 5%, and red 2%, respectively. It is understandable that the white color of background can be given the clear or clean when them looked at the background with the ACA2018 logo. It showed high frequency comments that the website was created for the conference and them feeling always thinking about academic mater which is affected to the color preference of background. Some of them selected black color for appropriating background because it could be encouraged the colorful logo quite much in term of shiny, more vivid, attractive, however, it did not represent to the mood of conference website but gaming. In blue, green, and red color of background them comments were difficult to detecting the logo and uncomfortable while they looked at the website.

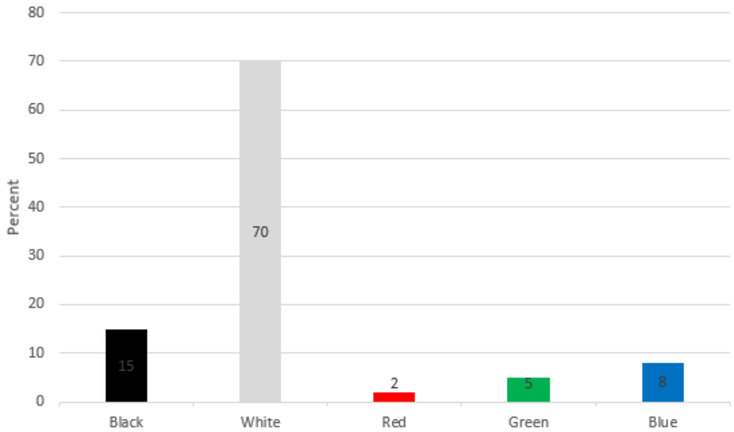

Figure 3. Percentages of color preference of the top background banner of ACA2018 website.

POSTER SESSION

ACKNOWLEDGEMENT

I would like to thank Dr. Chanprapha Phuangsuwan for suggesting many things till the experiment is successful. Also thankful to Mr. Anirut Songthanapithak for helping me to collect the data online and Compiled the data.

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POSTER SESSION

COMPARATIVE ANALYSIS ON THE EFFECTS OF CAR FRONT GRILL DESIGN TYPES ON VISUAL IMPRESSION BETWEEN JAPANESE AND THAI CONSUMERS

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Keywords: Car front grill, Visual impression, Design type, Comparison by nationalities

ABSTRACT

In our previous study, the visual impression caused by the front grill designs of Sport Utility Vehicles (SUVs) have been investigated by using many photographs of existing vehicles, and the Principal Components were compared between Japanese and Thai consumers.

In this paper, the effects of the design elements were investigated by using 3D computer graphics. Twenty-four front grills from four design types: vertical-lined type, horizontal-lined type, v-shaped type, and mesh type, were created, and four adjectives: 'special', 'luxury', 'aggressive', and 'advanced', were used to examine the consumers' visual impression. Forty people participated from Japan and Thailand, and the visual impression for each front grill was quantified by the Rating Scale method. As a result, several important relationships between the adjectives and the design elements were found. For example, as the width of metallic parts becomes thicker, the feelings of 'special' and 'aggressive' increase, while mesh type design increases the feeling of 'aggressive' for Japanese people. The results of this study will be useful for manufacturers to propose more attractive products that match the preference of overseas local consumers.

INTRODUCTION

Thailand is one of the biggest nations in the ASEAN region, and its market has been rapidly expanding. Recently, Japanese factories for such things as cars and home appliances have opened, and they are very popular in Thailand. We have researched the visual preference of Thais to develop industrial products which match the needs of the local customers [1] [2].

The front grill is one of the most important parts on the automobile front design, and it is significant for manufactures to understand consumers' visual impression of it [3]. This study aims to produce front grill panels that are more attractive for local consumers in Thailand in cooperation with a Japanese automobile parts manufacturer.

In our previous study [4], twenty-one pairs of antonyms such as 'glossy' and 'matte' were selected, and the Semantic Differential (SD) method was used to quantify the consumers' visual impression. Approximately two hundred people from Japan and Thailand participated. SD data was analyzed by the Principal Component Analysis (PCA), and it was revealed that the visual impressions for a car front grill was different between Japanese and Thais. For instance, the most important Principal Components by the PCA were expressed by the term LUXURY and CONTRAST for Japanese, whereas for Thais STYLE and LIGHTNESS were more important. Previous research did not study the effects of design elements of a front grill, such as styling, color, and texture.

In this paper, the effects of design elements were investigated by using 3D computer graphics (3DCG) of a SUV front view as shown by Figure 1.

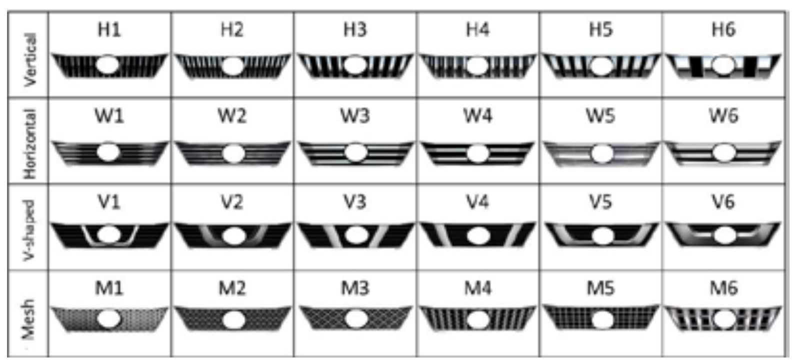
METHOD

Twenty-four front grills as shown in Table 1 were created by a front grill designer. There are four design types: vertical-lined type, horizontal-lined type, v-shaped type, and mesh type, and six design variations. Twenty-four front view images of a SUV were printed on 7.5×10 cm photo paper.

Six front views of the same design type were evaluated at the same time by the Rating Scale method ranging from 0 to 30 as shown in Figure 2. Four adjectives in Table 2: 'special', 'luxury', 'aggressive' and 'advanced' were selected from the results of our previous survey in order to quantify the visual impression, and these were presented in Japanese language for Japanese participants and in Thai for Thais. The scoring of the six front views was repeated for each adjective and each design type. Twenty Japanese and twenty Thais were questioned in this survey.

Figure 1 Front view of SUV

Table 1 Design variations of a front grill



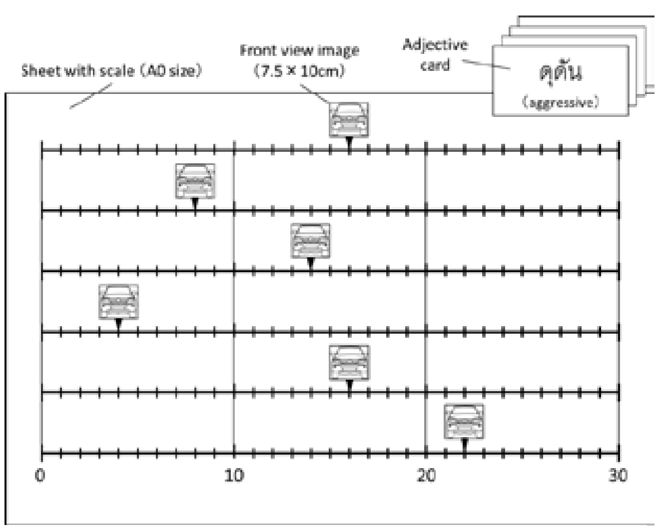


Figure 2 Arrangement of experimental materials

Table 2 Four adjectives

Thai	Japanese	English
พิเศษ	特別な	special
ดุดัน	アグレッシブな	aggressive
หรูหรา	高級な	luxury
ดูก้าวหน้า	先進的な	advanced

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RESULTS AND DISCUSSION

The width of the metallic straight line parts inside a front grill, as shown in Figure 3, were used as a quantitative index, which was expressed by a percentage (%) instead of "thin" and "thick".

Figure 4 and 5 show the correlation between the width of the metallic part (%) and the score of the adjective. In Figure 4, the score of 'aggressive' tends to increase as the width of the metallic part gets thicker for Japanese in vertical-lined, horizontal-lined, and V-shaped types.

According to Figure 5, you can see that 'aggressive' of Thais also had similarities with Japanese for the vertical-lined type. However, the thinner parts indicate more 'special' and 'luxury'. In other words, in this design type, we cannot improve the three visual impressions: 'aggressive', 'special' and 'luxury' simultaneously by using the width of the metallic part. That means that it is important to find another quantitative index, if there is a high demand to improve all of these three impressions at once.

Figure 7 and 8 show the results of 'aggressive' and 'special' in the mesh type. It became clear that M6 and M4 have a higher score against 'aggressive' for both Japanese and Thais in Figure 7. The same tendency as the other three design types, that 'aggressive' increases as the width of metallic part becomes thicker, is seen for both of the two nationalities. On the other hand, a different order was found between the two for 'special' as shown in Figure 8.

CONCLUSION

In this research, the relationship between the four adjectives and the quantitative index was investigated by using twenty-four front grill designs using 3DCG. As a result, the width of a metallic straight-line part was found to be effective in controlling the important adjectives. Based on the findings obtained, we have developed an actual front grill design for Thai consumers in collaboration with a car company. In future, it can be used to develop other Asian markets.

ACKNOWLEGEMENTS

I would like to express my sincere gratitude to everyone in charge of automobile parts manufacture who gave meaningful opinions and actual designs. Thank you very much to researchers at Color Research Center of Rajamangala University of Technology Thanyaburi (RMUTT) in Thailand: Dr. Chanprapha PHUANGSUWA and Dr. Kitirochna RATTANAKASAMSUK. And I express my appreciation to everyone who participated as subjects: the staffs and students at Meijo University.

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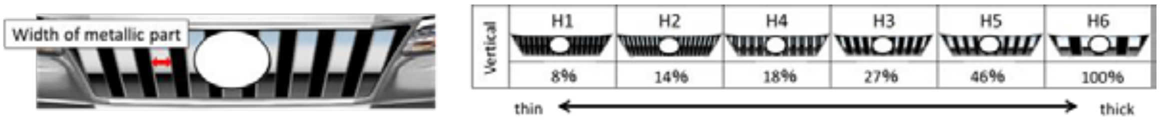
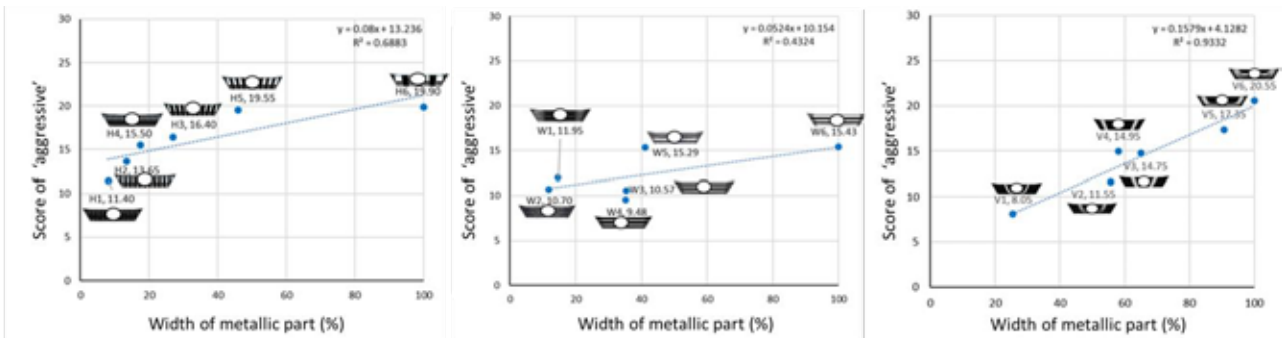
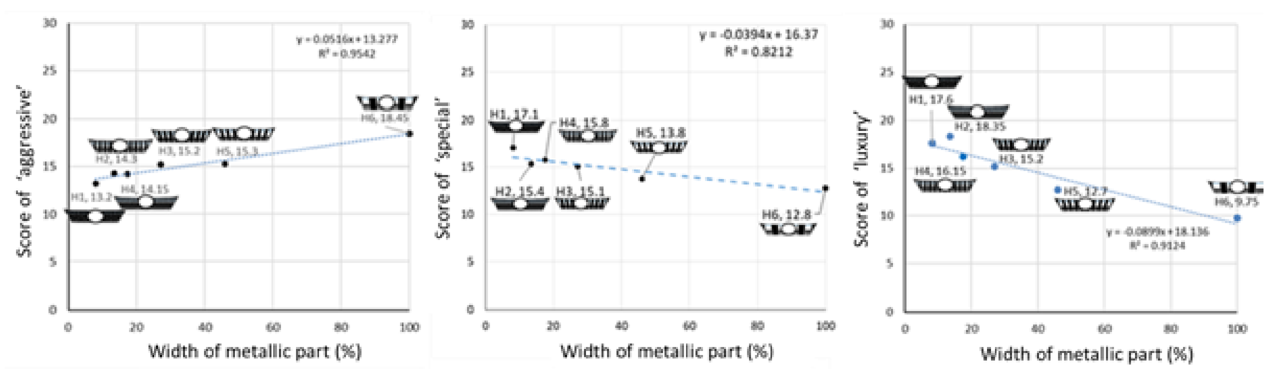


Figure 3 Width of metallic part



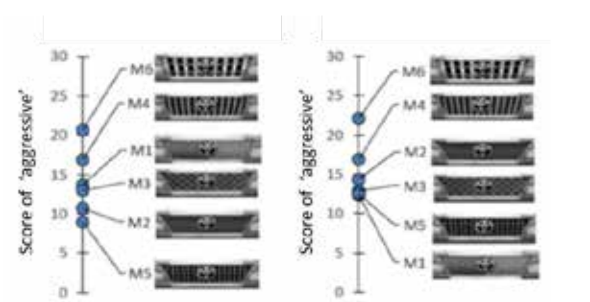
a) Vertical-lined type b) Width-lined type c) V-shaped type

Figure 4 Results of 'aggressive' for Japanese



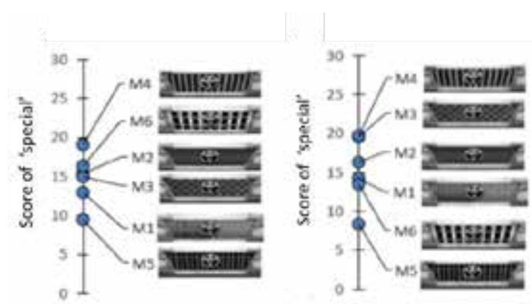
a) 'aggressive' b) 'special' c) 'luxury'

Figure 5 Results of the vertical-lined type for Thais



a) Japanese b) Thais

Figure 7 Result of 'aggressive' in the mesh type



a) Japanese b) Thais

Figure 8 Result of 'special' in the mesh type

IDENTIFICATION OF HOPPATAMB MURAL PAINTING COLOR USED FOR PACKAGING DESIGN

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Keywords: Hoppatamb mural painting, Color design, color Identification,packaging design

ABSTRACT

This research aims to analyze the effect of color vision from the painting of the fresco wall photograph by Designers on computer monitors Identify color values for use in packaging design. Use experimental research methodology. the collection of 4 temple wall painting in Khon Kaen province. The identity of the use of natural colors in the painting. There are 2 colors: blue and yellow. Bring the information from this color vision analysis. JIS Z 8721 Glossy Edition2 is used to test the color matching frequency of the designer's visual display. Munsell Color Code 2.5PB 4/10 and Munsell Color Code 10YR6 / 10 were used. The researchers used colorimeters to measure color on the JIS color plates. COLOR according to the Munsell code obtained and identified. The colors to be used in the design. Use the method to find the color difference ΔE when coloring in a computer graphics program and printing with the printer. Compare CMYK color with the value of the Lab in the computer graphics. The color values used in the blue design is CMYK MODE: C99 M57 Y13 K2 RGB MODE: R0 G95 B157 # 005F9D Yellow CMYK MODE: C19 M49 Y100 K8 RGB MODE: R197 G132 B15 # C5840F The color used in cosmetic packaging design. Set color and display values to evaluate the satisfaction with the target group. The results of the evaluation of satisfaction of the identity of the media were found to be very appropriate ($\bar{X}$ = 4.40).

INTRODUCTION

Hooppatamb is the term for the murals written on an ancient church in Khon Kaen. It is painted on wet mortar. Hippocratic writing is the ingenious wisdom of the people for 60-100 years.The first was a writing related to rituals, costume, religious beliefs and life style of people.The origin of indigo make blue and. Yellow from the Garcinia hanbury. Artists solve the problem of less using color in this work by reducing the use of colors and using as many colors as possible. Color tone is limited to 1 color. With the use of color tone. Blue and yellow of this painting. Many modern designers are interested in developing their designs. The need to communicate local cultural identity. To use in design But in the process of identifying the signature of the Hoop in the factors that designers like the color of the letters, pictures and shapes. It is also a barrier to the use of color in designs that match the identity color as much as possible. Because access to the paintings. Audience or designer can only stand in the distance with a railing. And shooting to analyze the results. Should have created a way to bring color from the database, such as photos from the study area. Researchers have taken photos in every There are 4 temples that can be photographed: Chai Si Temple, Wat Suthvari Temple, Wat Bua and Ban Lan Temple. Collected to analyze the colors that will be used in packaging design. To help increase the value of a product that is linked to the local cultural identity, it makes a difference and is a way for people to create a unique identity. It is used in the application to other factors.

GENERAL GUIDLINE

The purpose for this research is to To analyze the identity of colors in painting. Hooks from photo,to apply the design guidelines for color identification in cosmetic packaging design and to evaluate the design ideas of cosmetic packaging derived from the identity of the honeypot.

Scope of research on the analysis of color identities in HOOP paintings from designer photos.

- The experimental group is 5 packaging designers who have experience in design and color vision in graphic design at least 5 years.
- Four pictures of Huaping mural paintings: Chaiyaphum Temple, Wat Suthawaree, Wat Bua Bua, and Ban Lan Temple, each with 30 images, totaling 120 images from a specific sampling.
- Identity color analysis, which is most prominent in the two-color haptic mural: blue and yellow.
- Comparison of the color of the designer's eyes seen on the computer screen with the standard color in the color books JIS Z 8721 Glossy Edition

Scope of applied research on color identification in cosmetic packaging design.

- from color measurement with a color meter The Konica Minolta Spectrodensitomer FD-7 is based on the JIS Z 8721 Color Reference Book. It compares the color difference. ΔE creates a color profile using the Fuji Xerox Versant 80 press. When the lab color value is checked by a specialist, it is acceptable. CMYK and RGB color graphics using Adobe Illustrator
- 2 sets of cosmetic packaging design, consisting of blue and yellow

Packaging 3 face cream, 4 skin serum, 1 carton

- graphic design on packaging By design logo Hopp's skin-rejuvenating cosmetic series, inspired by the names of one of the most popular,

The scope of the research on the evaluation of the design of cosmetic packaging is derived from the identity of the honeypot.The researcher used a 30-year-old female target group of 30 persons using Accidental Sampling.

Use a closed end rating. 5 scale rating scale

The study was carried out by analyzing data from documents and Field study from 4 churches. The results of this research were as follows: 1) the color of the yellow and blue color was clearly visible; The researcher identified the position of the image in the color comparison for 5 designers to look at by experimenting one by one, 120 images from the 4 measurements in the same color vision position in the image.

Figure. 1 shows an example of the photos taken from the area. Picture A is from the Chai Sri Sattahip Temple B from Wat Sutvawaree, C from Wat Bua Kaew and D from Ban Lan Temple.

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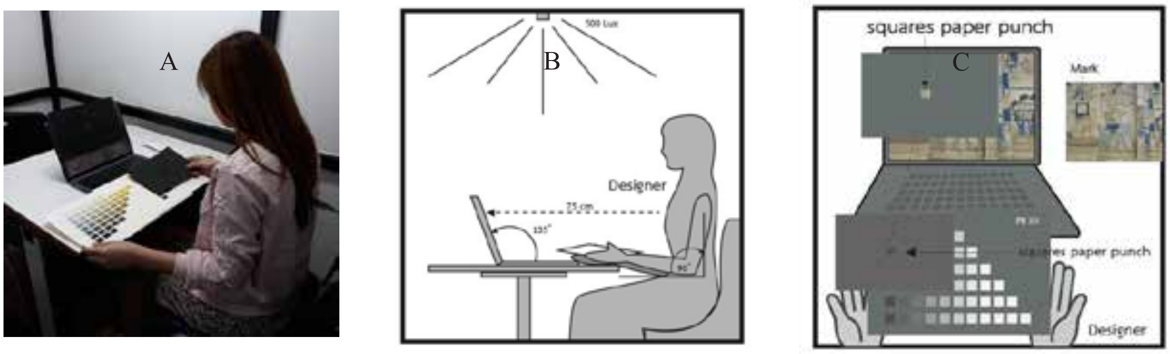
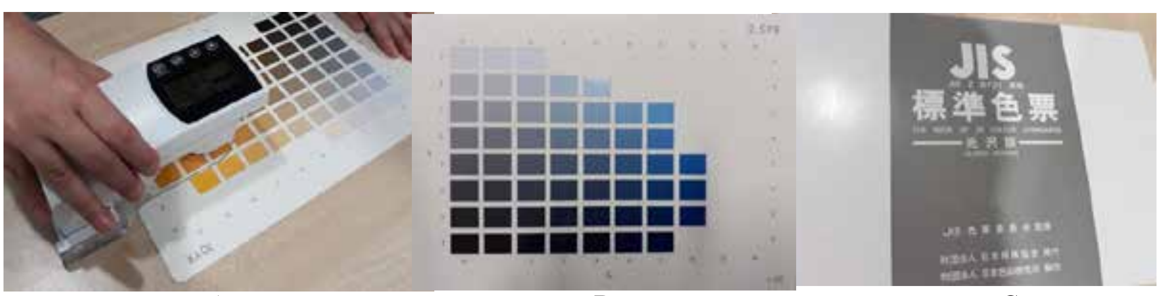


Figure.2 shows the process of looking at photos. Compare with Visible color in JIS Z 8721 Glossy Edition color book. Image B shows the definition of environment variable control and image C shows the visual environment variable.

The experiments allowed 5 designers to look at the photos on the computer screen in the control room. 500 lux brightness, slope of the computer screen 135 degrees, the distance from the designer to the computer screen 75 centimeters and the angle between the arm and the table 90 degrees. During the experiment, the designer used a rectangular plate to condition the color vision. Compare the colors in the position indicated in each color image and then save the color to the designer. The color in the position indicates the color of the image on the computer screen is the color that matches the color in the color book. JIS Z 8721 Glossy Edition



A B C

Figure.3 shows the color measurement from Color chart from JIS Z 8721 Glossy Edition. Image B: JIS Z 8721 Glossy Edition. Munsell Code 2.5 PB and C: JIS Z 8721 Glossy Edition.

Researchers record data. Frequency of color vision 5 designers compared JIS Z 8721 Glossy Edition color sheets and analyzed the statistical results for frequency. Munsell code with the highest frequency of blue and yellow. The use of RGB or CMYK standard software for color transcription from JIS Z 8721 Glossy Edition is required. The KONICA MINOLTA Spectrodensitometer FD-7 can be used to determine the compensation value of the data and then print it in the form of a paper with a Fuji Xerox versant 80 press. To compare the color scheme from the neighboring cell table and to get the lab values for CMYK and RGB conversion from swatch color in the computer program. Get value for color in packaging design. Packaging design with computer program. In a three-dimensional configuration, blue And the yellow color of the results. The material in the program is Acrylic with gloss. Show realistic Then introduced a three-dimensional packaging model. To evaluate the opinions of the design of cosmetic packaging derived from the identity of the honeypot and the results of the experiment.

The results of the four color visualization of 5 designers have summarized the frequency of color visibility compared to Munsell code color in JIS Z 8721 Glossy Edition Blue Munsell code with the highest frequency is 2.5 PB. 4 out of 132, followed by 5 PB 3/10, 80 and lowest 5 PB 2/6 blue Munsell code with the highest frequency is 10 YR 6/10, 176 times, followed by 10YR 7 / 102, and the lowest was 10 YR8 / 10 and 10YR 8/8, 5 times.

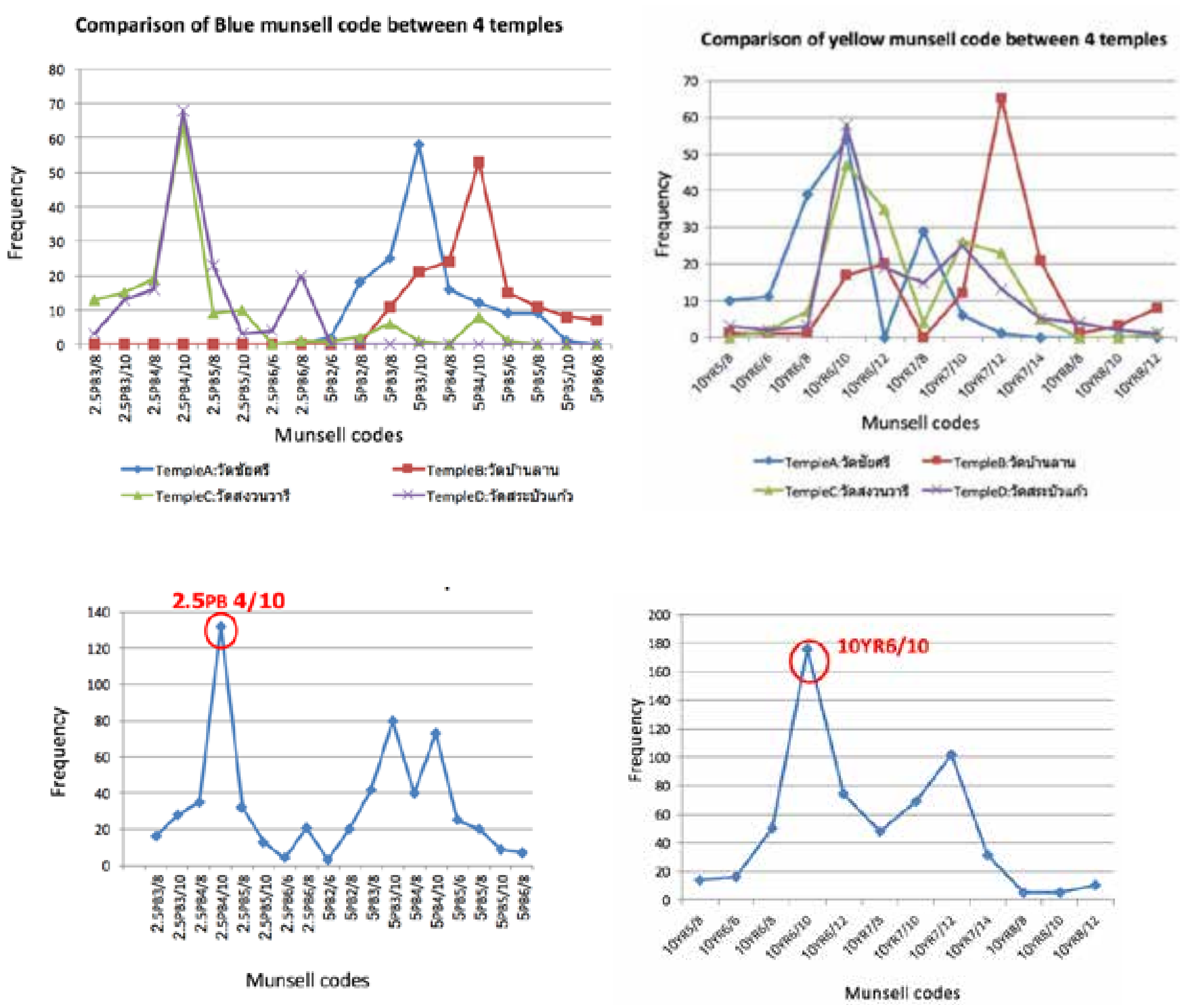


Figure.5 (left hand side) Graph showing the frequency, munsell code, color vision in the painting,

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Munsell Code	Standard			ΔE	Adobe Illustrator Cs6 / Fuji Xerox Versant 80			correction factor		
	L*	a*	b*		L*	a*	b*	L*	a*	b*
2.5PB 10/4	61.00	20.00	69.00	1.79	60.84	19.95	67.22	-0.16	-0.05	-1.78
10YR6/10	38.00	-11.00	-42.00	1.46	37.21	-10.76	-43.20	-0.79	-0.24	-1.20

Table.1 Display the results of the comparison of the difference between the colors of blue and yellow as measured by the JIS Z 8721 Glossy Edition color book with the colors obtained using Adobe Illustrator Cs6 and printing with the Fuji Xerox Versant 80.

Table 1shows the results of color measurement with a color meter. Spectral Spectrometers FD- 7Konika Minolta brings the Munsell code of the lab as measured from JIS Z .8721Labs Blue Munsell Code 2.5PB 10/4L * 61.00a * 20.00b * 69.00Yellow Munsell Code 10YR 10 / 6L * 38.0a * - 11.00b * - 42.00When comparing the difference in color using a Fuji Xerox Versant 80press with ARC cards Munsell Code 2.5PB 10/4ΔE 1.79Munsell Code 10YR 10 / 6ΔE 1.46When a lab color value is checked by a specialist, it is acceptable. The CMYK and RGB color scheme is used by Adobe Illustrator.

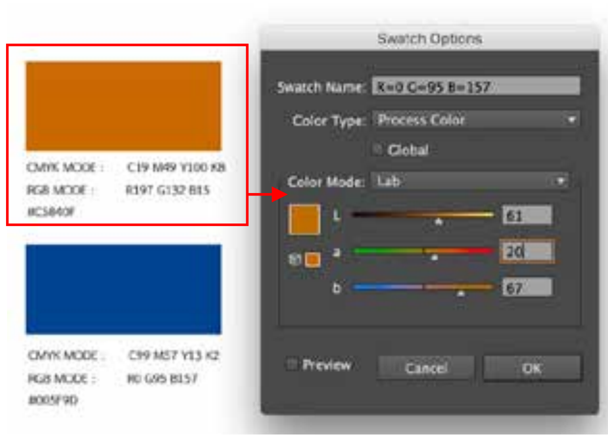

Figure.6 Using the Lab Color Conversion Tool in the CMYK and RGB color scheme.

Figure.7 shows the design of a cosmetic logo inspired by the art of painting. Under the brand name Hopp

This logo design was inspired by the writing of the murals. The use of formal characters that convey the conceptual design of the roots of the culture. The letter O denotes the shape of the brush stroke in a painting similar to the cream of a cosmetic in the center. To be unique and simple to use for printing on the packaging material cosmetics.

Figure.8 The image showing the yellowing of the Munsell Code 10 YR 6/10 for use in cosmetic packaging design. Glossy Acrylic

Figure.9 Blue Munsell Code 2.5 PB 4/10 blueprint for use in cosmetic packaging design, Glossy Acrylic

The researchers used the colors used in the design of the cosmetic packaging kit, Glossy Acrylic, by setting the color. Munsell Code 2.5 PB 4/10 and Yellow Munsell Code 10 YR 6/10, and display results to assess the satisfaction with the target. The results of the evaluation of satisfaction of the identity of the media were found to be very appropriate ($\overline{X}$ = 4.40).

ACKNOWLEDGEMENT

I would like to express my very great appreciation to Prof.Dr.Mitsuo Ikeda for his valuable and constructive suggestions during the planning and development of this research work. His willingness to give his time so generously has been very much appreciated.

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IMAGE AND IDENTITY TO PROMOTE BRAND IMAGE OF RAJAMANGALA UNIVERSITY OF TECHNOLOGY THANYABURI

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Keywords: identity, attitude, typeface, color, university

ABSTRACT

Corporate Identity (CI) represents the essence of corporate image and corporate identity for the purpose of building consumer noteworthiness, loyalty, and reliability toward the corporate [1]. Related to CI, Rajamangala University of Technology Thanyaburi (RMUTT) has been attempting to apply CI as a way of improving its institution's reputation and create an eco-friendly environment that matches the world's university standard [2]. And thus, this article aims to firstly conduct a research to assess RMUTT lecturers' attitude toward the image of the university and secondary survey the need for CI in order to promote the university's identity. For the research methodology, the assessment of 30 RMUTT lecturers' attitude toward the image of the university and survey on the need for CI of 100 students and 30 lecturers toward RMUTT were conducted. Data resulting from the assessment were then analyzed by using on average and standard deviation that could subsequently be implemented for designing identity that helps reinforce the image of the institution. If considering the university as the person, it could be found that most lecturers had the attitude and viewpoint toward the university as if it is a working adult who is regularly self-improving, reasonable, and good advisable. Overall, when designing the CI, of 56.60% of them preferred to choose sans-serif typeface for the body text, 37.50% indicated analogous for the color and 24.80% selected metal for material use.

INTRODUCTION

Rajamangala University of Technology Thanyaburi (RMUTT) has given its importance to quality management in education which has widely been accepted by both national and international education standards [3]. The institution pursuits its vision by setting out its objectives, strategic plans, and action plans to promote university's internationalization [2]. Enhancing and fostering university's learning environment and its people as a part of internationalizing processes should be added to signify its significance towards university internationalization. With different dialects and races, communication between university's personnel are considered to be one of the crucial factor that could affect Corporate Image that could eventually create the feelings of noteworthiness, loyalty, and reliability upon the institution [1].

Corporate Identity, CI has been taken in account for its influential character that may build up self-identity and corporate image for both the people and the institution itself. Besides, creating Corporate Image would also be considered as a way to help create strategic plan in terms of vision and strategy that could positively affect marketing strategy, sales profits, and in particular attract high quality personnel resulting a better financial status and creating a good workplace atmosphere for the institution [4]. And therefore, it is very much essential to design by applying graphic design elements as main tools of designing including Shape, Color, Sign & Symbol, Font, and Material [5].

From all the reasons above, the researcher has been interested in studying the attitudes of RMUTT University's lecturer and determining their identity needs toward MRUTT to promote the RMUTT image. Last but least, it could also be found that symbols or directional signs are yet to fulfilled their duties and therefore, they should be improved and used as a part of establishing internationlizedly university's identity in terms of its atmosphere and settings.

METHODOLOGY

The assessment of 30 RMUTT lecturers and personnel attitude toward their institution will be conducted through random sampling technique and the lists of topic asked will be as follows:

1. Asking questions to find out university's lecturer attitudes in terms of mood and tone toward their institution. Please select only answer for each question. The questions includes

Table 1: Questions on mood and tone

Mood and Tone	
Modern	Agile (Enthusiastic, Punctual)
	Progressive (Not conservative)
	Intelligent (Good negotiating skills)
	Unique (Being a pioneer and experimenter)
Friendly	Reasonable (Organized and secured
	Trustworthy (Very trustable)
	Dedicative (Very handy)
	Scrupulous (good choice maker)
Service	Protector (Decider and caretaker)
	Advisor (Like to advise and warn)
	Assistant (preparer and presenter)
	Server (Able to meet needs)
Personality	Teenager (cheerful and happy)
	Adolescence (A learner and an enthusiast)
	Working age (very independent)
	Adults (Patient, epicure, and dignified)

The assessment of 130 RMUTT lecturers, personnel, and students' attitudes towards their institution will be conducted through random sampling technique and the lists of topic asked will be as follows:

2) Appropriate colors in design to create Corporate Image (Royal Blue #162B75) is used as the official RMUTT University primary colour palette for design application. Participants can only give one answer for each question

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Table 2: Questions on the color used for design application

Color theory	Examples
Monochrome	
Analogous	
Dyads	
Triads	
Tetrads	

3) Appropriate materials used for designing Corporate Image of RMUTT. Participants can only give one answer for each question.

Table 3: Questions on the materials

Types of materials	
Wood / Ply Wood	Plastic
Glass	Fiberglass
Metal	Concrete
Stainless	Stone
Aluminium	Vinyl
Bronze / Brass	Sticker

RESULT

It could be found from the results that most RMUTT lecturers had expressed their attitudes towards their university as a place where most working age group is to be found. They also visualized their university as a place that equipped itself with constant improvement, rationality, and advisability. In terms of Corporate image, 56.60% of lecturers preferred the design to be applied with Sans-Serif Typeface and 37.50 % of them demanded analogous and 24.80% chose metal for material use.

ACKNOWLEDGEMENT

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THE INFLUENCE OF PACKAGING COLOUR ON THE CONSUMERS EXPECTATION OF HEALTHY FOOD

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Keywords: packaging color; consumer expectation; graphic design; packaging design

ABSTRACT

Selecting colour for graphic design with visual product colour on packaging is usually considered. The colourful packaging plays a major role in attracting consumer attention and chances to persuade consumer for creating the product expectation. The aim of this study was to investigate consumer expectation in colour on packaging for healthy food image. Product characteristics used this study were liquid, powder, and semi-solid to contain in packaging as spouted pouches and pillow pouches. Graphic design of each packaging was divided into three stimuli and three hues. Online evaluation as a tool using survey of the colour and graphic in product expectation was conducted by 61 participants. The results indicated that selecting packaging hue and product colour should be compatible. At the same time, the colour appearance on the packaging had affected to implicate in the product for healthiness and an intuitive cue for natural product. The finding also contributed by showing that graphic as colour and other design elements on packaging can be indicated in the premium product. In conclusion, assortment of colour property can be useful to promote the product expectation in healthy food through packaging design strategy for understanding by consumers. Consumer expectation of colour perception is one of the important factors for packaging designer could be involved.

INTRODUCTION

Understanding the product features by inferring with graphic design on the packaging is one of the basic packaging functions. The colour is major tool represents graphic design element for communicating the visual food product. It has influence to convey the meaning of product in packaging for consumer's expectation such as favor identity, freshness, cleanliness, nutritional value, and healthful. There are many researchers studied package colour influences the consumer decision. Ares and Deliza [1] studied influence of package shape and colour on consumer expectations of milk desserts by relating the milk favours. Holierhok et al [2] found that expectation of the product differed between packaging images but did not influence taste perception by using yogurt packaging colour in the study. Huang and Lu [3] examined the effect of package colour on intrinsic product attributes. The demonstration of red packaged product is perceived to be sweeter, whereas products packaged in green and blue are involved with perception of healthiness. Shen et al [4] surveyed the feature two different colours of product labels. They found that red labels led to longer response time in decision-making than do blue labels. For healthy food product and packaging design are associated consumer behavior in expectation of health food label by responding colour or imagery hue tone on the packaging. Laura and Britta [5] indicated increased perceived meal colour variety was associated with a healthier eating pattern, and found that future behavior change interventions by showing the colourful meals might be a promising avenue for promoting a healthy food choice strategy in

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consumers. The aim of this study was to focus on consumer's expectation in colour and graphic design element on packaging for healthy food using different products types.

METHODOLOGY

Participants and Samples

This study used design factors of colour and other graphical design elements integration. 61 participants involved in this experiment were convinced in the benefit of organic products and usually purchased the healthy food product. The selective procedure was based on the convenient samples who are been in all regions of Thailand. Job's tears categories in liquid, powder, and solid were used to design the graphic on Principal Display Panel (PDP) and information panel at different packaging types as spouted pouches and pillow pouches. The imagery of each packaging type was contained the same aspect of fresh job's tears and beverage job's tears with glass jar on PDP for each packaging type. The label colours were modified in Adobe Illustrator CC 2018 where consideration of color variation was based on relevant to job's tears feature and design principle for packaging. In addition, pictures of actual products were retouched using Adobe Photoshop CS6 before applying on the label. As shown in Figure 1, 3, and 5, the mock up of thee packaging types was created to use different hues of background and alphabet whereas images, brand name, product information and symbols were obtained similarly. The stimuli colours of each package type were displayed on the samples to support the visualization with mobile phone and digital devices. Furthermore, these packaging features were coloured with various ratios on both panels as PDP and back panel of package surface area are shown in Figure 1, 3, and 5.

According to the online questionnaire survey, the initial questionnaire included question on participant's demographic information, mock-up of package. The mock up samples were divided into three groups on answer 5-point scale as expectation toward packaging colour and graphic design meaning. The Likert scale was used to ask the participants in expectation levels represent with 1 = strongly disagree (%), 2 = disagree (%), 3 = neutral (%), 4 = agree, 5 = strongly agree (%).

RESULT AND DISCUSSION

Regarding the consumer expectation of packaging color and graphic design in this study, all data was collected through an online survey in Thailand. The survey was conducted in a total of 61 Thai participants. Male was 24.6% and the remaining of 45.4% were female. All participants were composed of age group of 18-30 year (50.8%), 31-40 year (11.5%), 41- 50 year (29.5%), 51 – 60 year (6.6 %) and over 60 year (1.6%). Mock up of Dummy L1 was higher participant's response than the other two spouted pouches is shown in Figure 2. This results indicated that the product image and package colours were effective to consumer expectation for representing natural product and making short time decision to buy the product including trust in product quality. Likewise, green, bluish green and product colour of mock up sample L1 were perceived as flavor intensity and healthiness of a product.

For the expectation of colour and graphic design on powder product pouches, the score popularity was found similarly that Dummy L1 and L3 were presented higher than L2 in rating scale level 4 and 5 as exhibited in Figure 4. Labeling design of both L1 and L3 was involved consumer expectation of conveying the healthy food product, good composition design and natural product. These reasons indicated that variation of picture and yellowish - bluish background and shade of white integration were affected to product expectation while Dummy L2 was selected red colour tone of packaging background.

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A strength of expected and perceived healthiness, colours and graphic design of sample Dummy S2 was presented higher responsible score for participants than Dummy S1 and S3. Yellow background, green and white of picture of Dummy S2 were more associated with job's tears feature (Figure 6). It was conveyed the expectation of the product in natural, premium, and healthy to participants, in agreement with study of Won & Westland [6] indicated that colour meaning can make a contribution to understanding and expecting of consumers in both positive and negative way.

Dummy L1 Dummy L2 Dummy L3

Figure 1. Three mock up liquid spouted pouches with label colours added through Adobe Illustrator

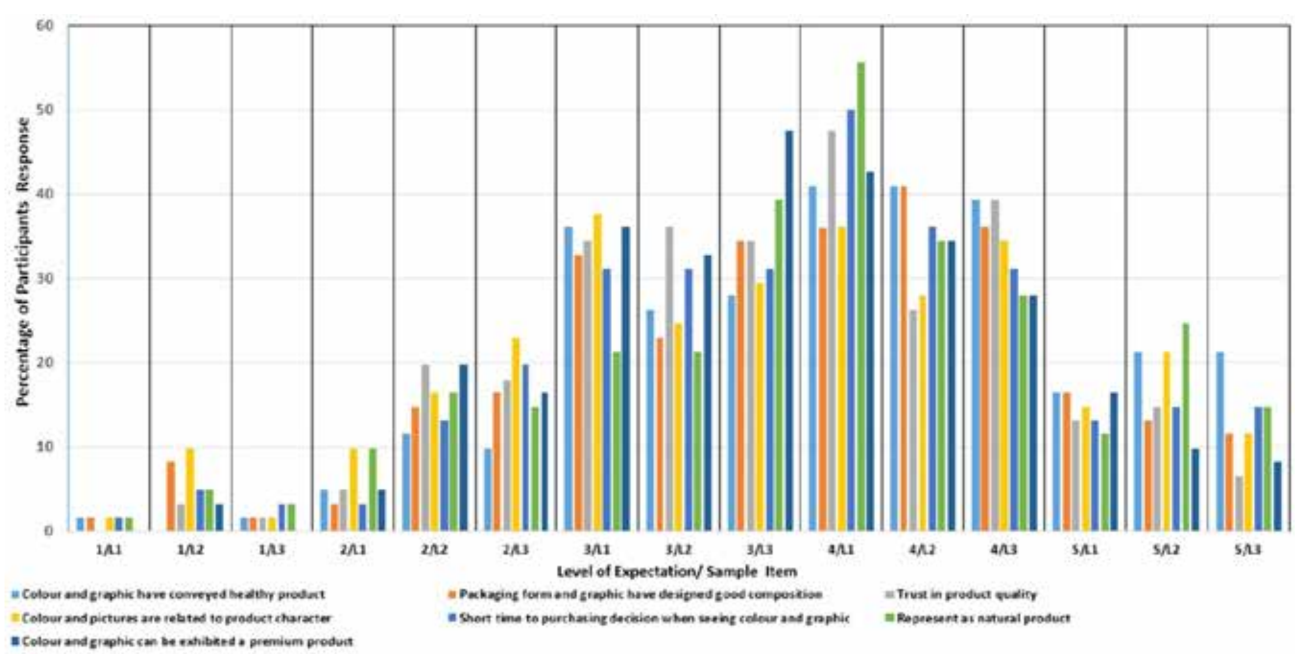

Figure 2. Percentage of participant's response in mock up colour for liquid product spouted pouches

Dummy P1 Dummy P2 Dummy P3

Figure 3. Three mock up powder pillow pouches with label colours added through Adobe Illustrator

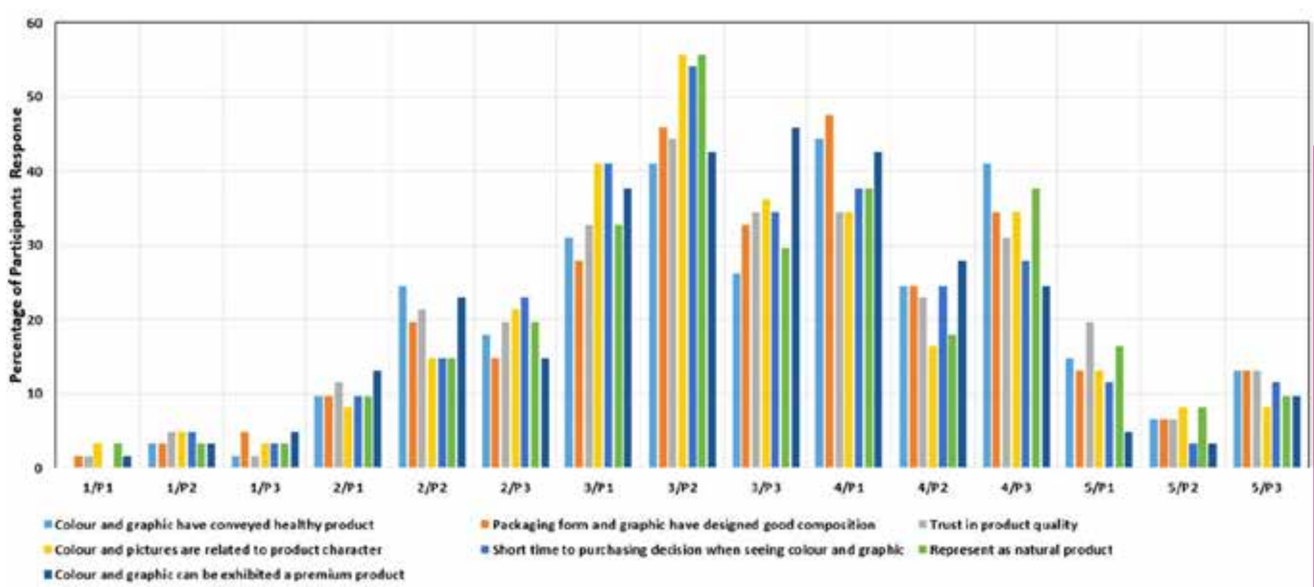

Figure 4. Percentage of participant's response in mock up colour for powder product pillow pouches.

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Dummy S1 Dummy S2 Dummy S3

Figure 5. Three mock up powder pillow pouches with label colours added through Adobe Illustrator

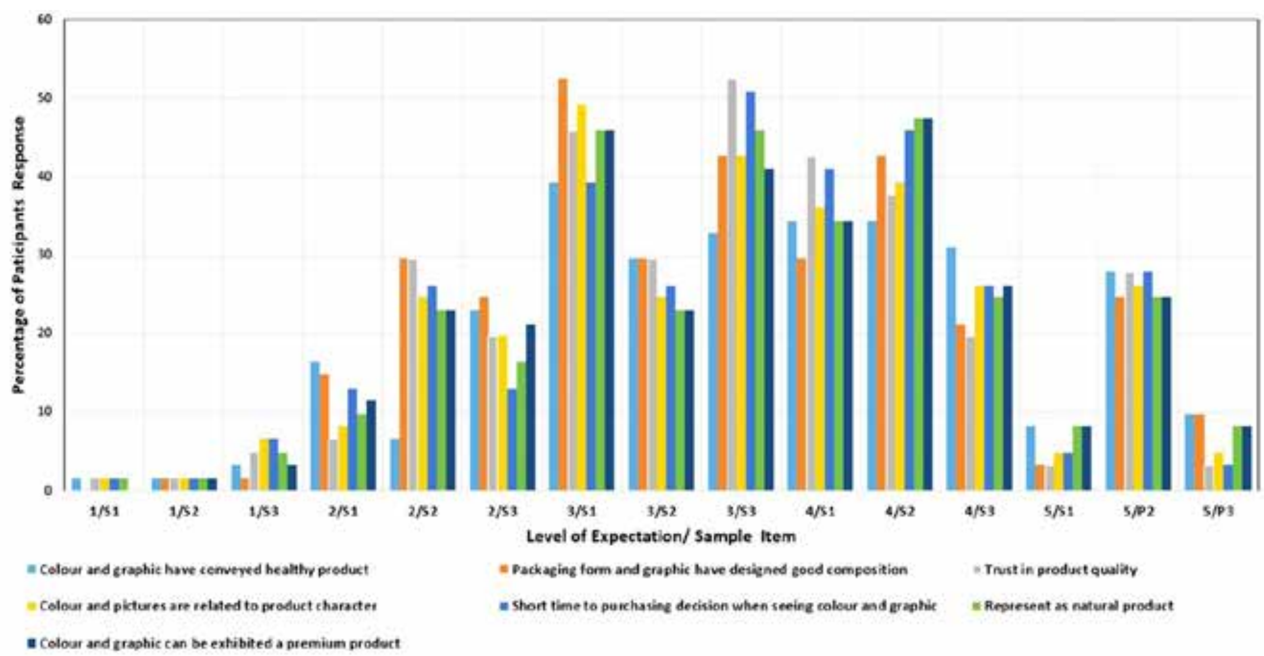

Figure 6. Percentage of participant's response in mock up colour for solid product pillow pouches

CONCLUSION

This results of this study can be useful to marketing strategy and can be a guild for packaging designer. This also found that the expectation of healthy food product should be considered with in many factors integration such as picture, composition design, branding, packaging shape, slogan, product information, letter and colour. Furthermore, selecting the colour matches with product feature is the most important element to communicate the consumer expectation.

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COLOR CORRECTION FOR MILKY WAY

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ABSTRACT

The objective of this research was to investigate the suitable method to retouch Milky Way's photograph which keeps the astronomical details. Both Michael Shainblum (MS)'s retouching technique and Kenneth Brandon (KB) retouching technique which generally used to enhance the detail in Milky Way photograph were compared. The retouched Milky Way photographs were presented on an LED monitor. Two astronomers and an astronomy photographer were asked to evaluate both retouched photographs based on two criteria. The first criterion was to evaluate whether the composition of the Milky Way photographs was complete or not. The second criterion was to evaluate whether the details of the Milky Way components were clear or not. We found that MS's retouching technique gave the better result than KB's retouching technique especially the clarity of the details in the center or the brightest part of Milky Way.

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INTRODUCTION

Galaxy is the kingdom of stars. The Earth is one of the stars in the Milky Way Galaxy which can be divided into three parts: 1. the Disk which consists of the arm of the galaxy. The main component is gas and dust. 2. the Bulge is the center of the Milky Way or Galactic Center which is the brightest part of the Milky Way. Inside the Milky Way consists of many celestial objects, such as clusters, nebulae, and black holes. The large constellations are called "Scorpion Stars" in the southern hemisphere, close to the Milky Way. The important star is Parichat or Antares which is reddish orange. While other stars are lined up like a scorpion; and 3. the Halo which is Global Cluster around the center of the Milky Way.

The observation of the beauty of the Milky Way in Thailand can be seen with the naked eyes, especially during the summer. When is the appropriate time to see the Milky Way, it can be seen from the north to the south, between the constellations of the Scorpion and the Archer. The best time to observe the Milky Way is late April to early October. During this time, the Milky Way can be seen in the middle of the sky at late night.

The Milky Way photography is part of astronomy photography. It can be divided into 2 types.

Type 1 Milky Way Photography for Astronomy. The Galactic Center consists of constellations including black holes and space gas. It cannot be seen with the naked eye. It is necessary to use astronomical imaging equipment to study and explore the constellations.

Type 2 Milky Way Photography for Art and Beauty. The photographing depends on the view and the equipment of each photographer.

Therefore, the good Galactic Center photographing should keep details of the center of the Milky Way and the colors of the stars. Some planets have visible colors, such as Mars is in red. So many people may think that the star is the same color as yellowish white. However, if you look hard enough, you will see that the star has many colors. Some are red, white, or blue.

METHODOLOGY

Apparatus and Procedure

The Milky Way photography to control the details of the center of the Milky Way in accordance with the astronomical principles has the following 4 steps.

Step 1: The preparation process.

The experimenters began researching the related information from books, articles and expert interviews. Then they set the location, the weather, the direction, time and angle for proper photographing. Later, the experimenters studied the travel plan and prepared the equipment which was Canon 7D, Canon EF-S 10-22mm Lens, EF-S 10-22mm lens, f/3.5-4.5 USM, tripod, cable release, stopwatch, and Star Chart Application.

Step 2: The Galactic Center photographing process.

The experimenters adjusted the camera with auto white balance, set the ISO sensitivity setting to 4000, aperture f/3.5, shutter speed 1/40 second and shooting angle at 20 degrees to capture the center of the Milky Way. The details of the photographs were retouched with Adobe Photoshop and Adobe Lightroom. The experimenters would retouch the two areas of the photographs which were: part 1 the details of Galactic Center and Part 2 the details of the arm of the Milky Way as shown in Figure 1.

Figure1. Images that have not been retouched.

Step 3: The retouching process

The Milky Way photographs were retouched according to the technique of Michael Shainblum (MS) with Photoshop (PS) as shown in Figure 2, and the technique of Kenneth Brandon (KB) with Lightroom (LR) as shown in Figure 3.

Figure2. Retouched by Michael Shainblum's approach (Adobe Photoshop).

Figure3. Retouched by Kenneth Brandon’s approach (Adobe Lightroom).

Step 4: The evaluation process

The retouched Milky Way photographs were presented on an LED monitor. Two astronomers and an astronomy photographer were asked to evaluate both retouched photographs based on two criteria which were the completion of the Milky Way’s component and the details and the clarity of the Milky Way.

RESULTS AND DISCUSSION

The result was that Michael Shainblum's retouching technique as shown in figure 4 has the following suggestions: 1. the tree blocked the Scorpion's Tail which is part of the Milky Way. 2. The Galactic Center was too bright and it made the nebulae unclear. 3. The constellation called the heart of the scorpion should be more bright. 4. The Antares star in the heart of the scorpion should be red. And 5. there should be no noise.

For the Kenneth Brandon (KB) retouching technique with Adobe Lightroom as shown in figure 5, there were things to consider other than the ones mentioned above which were: 6. the sky was a color aberration and 7. the photographs were not clear because of low contrast.

Figure4. The results of the assessment by Michael Shainblum's approach.

Figure5. The results of the assessment by Kenneth Brandon's approach.

The study found that Michael Shainblum's (MS) retouching technique with Adobe Photoshop provided a good contrast ratio, which results in clearer and brighter photographs detailing the center of the Milky Way than the Kenneth Brandon (KB) retouching technique with Adobe Lightroom.

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COMPARISON OF COLOR DIFFERENT BETWEEN PSD AND AI FILE FORMAT IN DIGITAL PRINTING

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Keywords: Color different, file format, digital printing, Hoop-tam mural painting

ABSTRACT

Now a day the conventional printing is decreasing but digital printing is very popular and acceptable from the clients. After getting the original file from the client then he/she always using default of the original file format from the client that sometime cause to the print-stop or color cast etc. This research is aimed to compare the color different between .PSD and .AI file format in digital printing (Fuji Digital press 700 and Fuji Digital press 80). The simulating color patches were yellow and blue from Hoop-tam mural painting with the size 3x3 cm^2 by using Adobe Photoshop CS6 (.PSD) and Adobe Illustrator CS6 (.AI) with setting color profile as default (Japan Color 2001coated CMYK). Those flies were exported through the workflow namely Portable Document Format (PDF) version 1.6/acrobat 7 with the printing mode at press quality PDF/X-4:2010. The resolution of color patches was 300 pixels per inch. The color patches were printed on the coated paper with the paper weight 210 g/m^2. The reference of yellow and blue colors is L*61, a* 20, b* 69 and L*38, a* -11, b* -42, respectively. The density and color L*a*b* were measured in each color patch. The result showed that the color different (ΔE*ab) at the printer Fuji Digital press 700 was lower than Fuji Digital press 80 for blue color only. The result suggests that the .AI file format is given the lower color different than .PSD.

INTRODUCTION

Hoop-Tam mural painting is the charming of Esan traditional which is often seen in the temple. This painting is made by delicate hand drawing and it took a long time to produce for decorating one temple. Sometime the painter was not expert for painting just normal people or monk who wants to work for the temple. That is cause to the difference in the drawing, color tone, component of the images. Hoop-Tam is Esan language but in format Thai language is called Roop-Tam (painting) which means the tinged color making the image in the mural by painter.[1)] The classical of the contrast on the pair of colors (blue and yellow) is very interested to applied in the others printed. To control the color on the printed following the reference color of unique two colors blue and yellow was investigated in the present experiment. Moreover, now a day the digital printing is popular in used. It is better to know the characteristic of those printers that we are using. In this paper we aimed to show the difference of Hoop-Tam color based on two types of file format and two types of digital printer.

EXPERIMENT

The experiment was carried out at the printing house, faculty of Mass Communication Technology, Rajamangala University of Technology Thanyaburi. Firstly, the simulating color patches were yellow and blue from Hoop-tam mural painting with the size 3 x 3 cm by using Adobe Photoshop CS6 (.PSD) and Adobe Illustrator CS6 (.AI) with setting color profile as default (Japan Color 2001coated CMYK). Those flies were exported through the workflow namely Portable Document Format (PDF) version 1.6/acrobat 7 with the printing mode at press quality PDF/X-4:2010. The resolution of color patches was 300 pixels per inch. The color patches were printed on the coated paper with the paper weight 210 g/m^2. The reference of yellow and blue colors is L*61, a* 20, b* 69 and L*38, a* -11, b* -42, respectively. The color patches were printed by two kinds of digital printer from Fuji xerox, Fuji Digital press 700 and Fuji Digital press 80. The reason why we used two kind of printer in this experiment was to check the gamut and characteristic of each printer the RMUTT printing house. Each condition of file format and each printer was printed in 5 copies. After printing the color patches of representative Hoop-tam mural yellow and blue colors as shown in Fig. 1, the process of measurement was starting by Spectrodensitometer X-Rite 504.

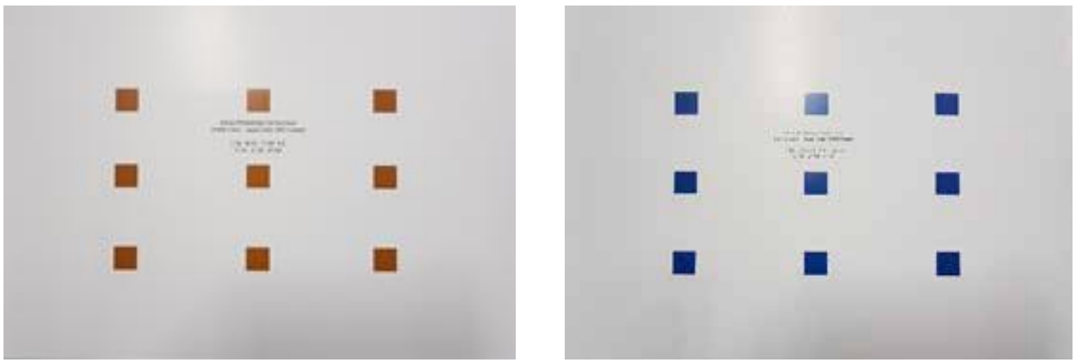

Figure 1. The simulating of yellow and blue color patches from Hoop-tam mural painting.

RESULTS

Table 1. The averages of the color measurement from the test form.

Fuji 80	Average			delta E	Reference		
PSD	L*	a*	b*		L*	a*	b*
Y-80-all	49.62	23.10	51.31	21.26	61	20	69
B-80-all	31.58	-8.40	-35.25	9.67	38	-11	-42
Fuji 80	Average			delta E	Reference		
AI	L*	a*	b*		L*	a*	b*
Y-80-all	51.16	22.80	54.03	18.13	61	20	69
B-80-all	28.84	-7.45	-38.27	10.51	38	-11	-42
Fuji 700	Average			delta E	Reference		
PSD	L*	a*	b*	PSD	L*	a*	b*
Y-700-all	55.17	18.73	46.97	22.82	61	20	69
B-700-all	35.03	-8.53	-37.72	5.76	38	-11	-42
Fuji 700	Average			delta E	Reference		
AI	L*	a*	b*	PSD	L*	a*	b*
Y-700-all	58.11	17.38	50.65	18.76	61	20	69
B-700-all	32.82	-8.00	-39.78	6.38	38	-11	-42

Table 1 showed the averages of color measurement in L*a*b* of each file format, printer compared with the reference color from the original Hoop-tam mural painting. Based on the data of measurement, seemed to show that those colors printed from Fuji 700 had the color difference value lower than the Fuji 80 in blue color only. And for yellow color the data of measurement showed very high value of color difference around 18.13 to 22.81 in both printers and file formats.

From the result showed in the table 1 we modified the yellow and blue colors to get the lower color difference till nearly to the standard of acceptable printed >5. The result of color difference was showed in table 2 and it showed the color difference at 1.79 for yellow color and 1.46 for blue color. From now we can simulate the yellow and blue colors from Hoop-tam mural painting into other printed correctly such as packaging, brochure etc. based on the L*a*b* showing in table 2.

Table 2. The color difference of yellow and blue colors after modification.

Color	Reference			delta E	.AI Fuji 700			ΔModification		
	L*	a*	b*		L*	a*	b*	L*	a*	b*
Y-80	61.00	20.00	69.00	1.79	60.84	19.95	67.22	-0.16	-0.05	-1.78
B-80	38.00	-11.00	-42.00	1.46	37.21	-10.76	-43.20	-0.79	0.24	-1.20

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PRODUCTION OF MOTION GRAPHICS MEDIA FOR PUBLIC RELATIONS RAJAMANGALA UNIVERSITY OF TECHNOLOGY THANYABURI TRANSPORTATION.

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Keywords: Motion graphics, Transportation, Vehicle, Color Principle, three-rule color

ABSTRACT

Rajamangala University of Technology Thanyaburi provides transportation services for students and various services. It's a complexity and hardly for outsider to understand how to use university bus service. Due to a broadcast problem and no idea about making a good motion graphic media for public relation. The experiment were started from testing the audience knowledge about transportation map before watching the media then started watching the media which divided to three groups of color, the three groups of color are black and white tone, full color, and only three color that is some color scheme used in design, after that tested the audience knowledge again. The results from 36 shows that 31 subject accounted for 88.9% of the data. Second, it is a full color version. The researcher 4 people accounted for 11.1% and finally concluded that the white and black. can't make the researcher recognize information.

The result of the test in the quiz is the first question. In conclusion, the number of respondents was 21 (58.3%). The number of respondents was 15 (41.7%).

The second question is, what is the last building on the tram line 1 ? The respondents were 2 8 respondents, 77.8%, 8 respondents, 22.2%. All results suggest that color-coded design results in the greatest possible perception and understanding of information.

INTRODUCTION

At present, transportation is important and necessary for daily life. Each place has different transportation. So, it will be useful if provider can design a transport map that people can easily understand.

Rajamangala University of Technology Thanyaburi have arranged provides transportation services for students and there are a variety of services. But there is very little publicity and hard to reach. The result is a lack of knowledge in the use of the content service research about production of motion graphics media for public relations.

METHODOLOGY

More specifically, when are full-color, color-highlighted, or black and white ads likely to be more persuasive, and proof that the color used in the previous study to work. In the experiment [1], they used a static image ad format, advertisements with a full color pattern were more likely to affect the audience than the media black or white and highlight - color. Research scope population and sample are the students from all faculty of Rajamangala University of Technology Thanyaburi. The steps of experiment were started from testing the audience knowledge about transportation map before watching the media then started watching the media which divided to three groups of color, the three groups of color are black and white tone, full color, and only three color that is some color scheme used in design. After that tested the audience knowledge again. For the expected results, audience can get useful information about using service in Rajamangala University of Technology Thanyaburi vehicle as well as more information from the color experiment, full color use contributes to the persuasion and understanding of the audience, and audience can use the knowledge be helpful in daily life.

RESULTS AND DISCISSION

The results from 36 researcher groups concluded that the design was based on three colors (Figure 1. Three highlight color). As a result, 31 researchers accounted for 88.9% of the data. Second, it is a full color version (Figure 3. Colorful). The researcher 4 people accounted for 11.1% and finally concluded that the white and black can't make the researcher recognize information (Figure 2. Black and White).

Figure 1. Three highlight color.Figure

Figure 2. Black and White color.

Figure 3. Colorful.

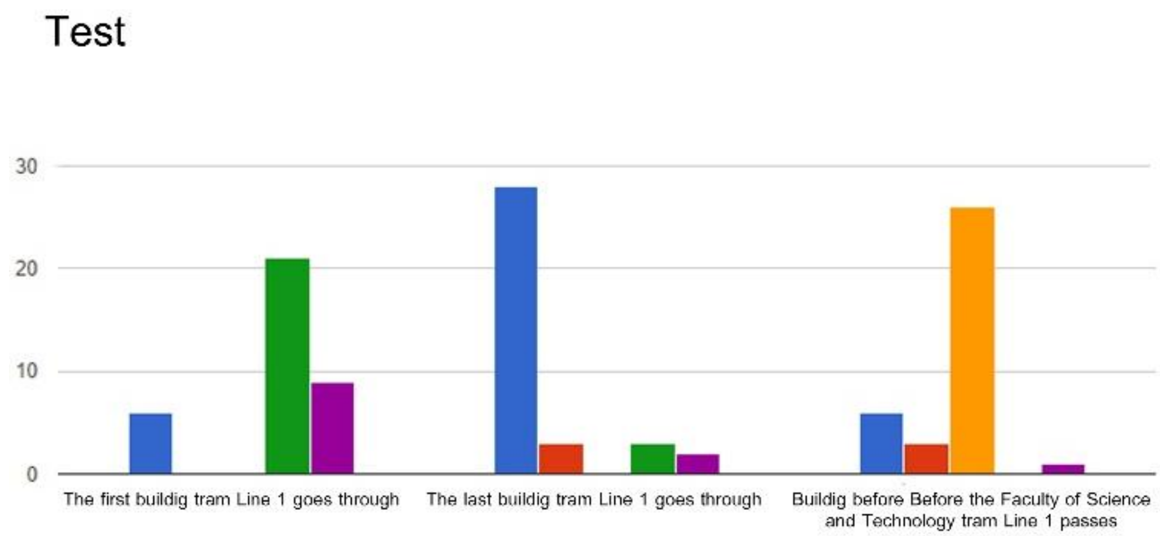

Figure 4. Researchers answered the question correctly/incorrectly.

The result of the test in the questionnaire in conclusion (Figure 4. Researchers answered the question correctly/incorrectly).

The first question is what first building tram line 1 goes through. Respondents answered the question correctly was 21 respondents (58.3%), respondents answered the question incorrectly 15 respondents (41.7%).

The second question is what the last building on the tram line 1 passes. The respondents answered the question correctly were 28 respondents (77.8%), respondents answered the question incorrectly 8 respondents (22.2%).

The last question is what building before the Faculty of Science and Technology tram line 1 passes. The respondents answered the question correctly were 26 respondents (72.2%), respondents answered the question incorrectly 10 respondents (27.8%).

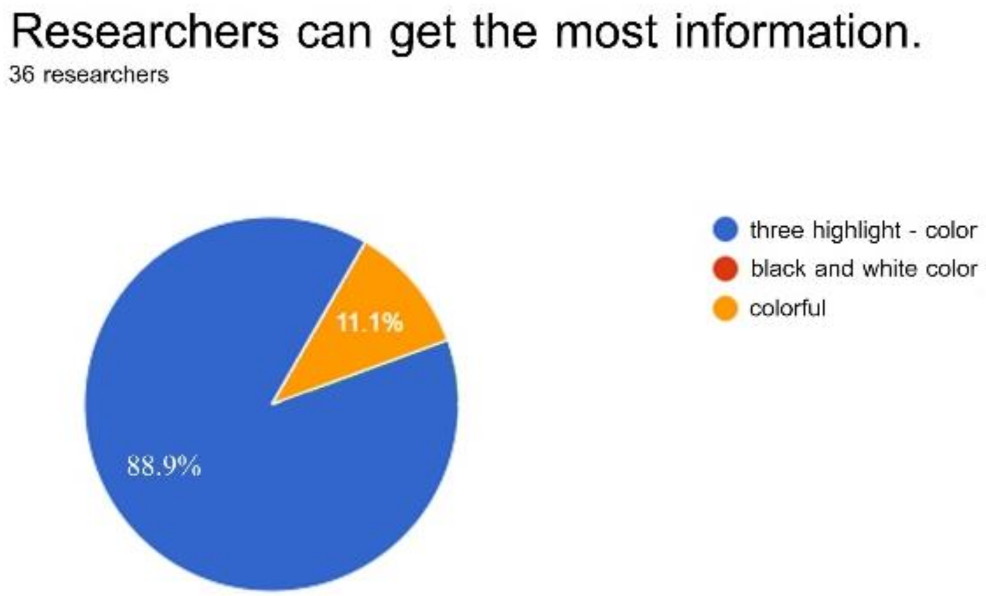

Figure 5. Researchers can get the most information.

All results suggest that three highlight color design results in the greatest possible perception and understanding of information (Figure 5. Researchers can get the most information.).

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A STUDY ON THE INFLUENCE OF SURROUND LUMINANCE ON THE COLOR PERCEPTION IN LED DISPLAY

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Keywords: surround, lightness, brightness, colorfuness

ABSTRACT

Color stimuli displayed by LED array were used to investigate the color perception changed by the different luminous level of surround. A psychophysical data set, in which observers evaluated the color attributes on the color stimuli under different luminous levels of environment, was collected. The color stimuli including Neutral color, Red, Yellow and Blue with various L* values of 20, 40, 60, 80 and various C* values of 30, 60, 90,120 are studied. The experimental results show that the visual lightness and brightness of LED array pattern viewed in dark are obviously increased and decreased in bright surround. Bright surrounds also induce a visual colorfulness of stimulus decrease. It is also found that the degree of the influence is dependent on the lightness, chroma and hue of the stimulus. The effect is larger for Neutral colors than for chromatic colors. The differences between visual lightness and lightness value of the test color viewed under dark, average and bright environment are calculated. The changed perceived values are plotted against the L*, C* of the color stimuli to investigate the size of effect by surround luminance level on the color perception. The impact of the surrounding luminance decreased with the increase of lightness value L* of color stimuli.

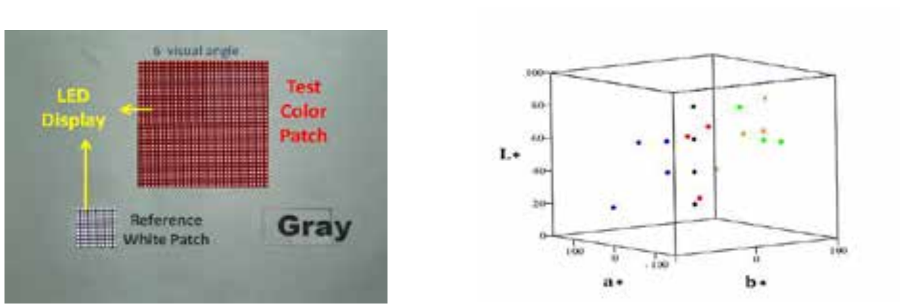
INTRODUCTION

The color appearance is obviously affected by the illuminance of environment and many investigation results related the effects have been published. Stevens effect[1] is a well-known effect of color perception change due to the luminance levels of environment. It indicated that the perceived lightness and lightness contrast of objects are increase from a dark surround to a bright surround. Bartleson and Breneman[2] found the contrast of achromatic reflective images decreased when surround changed from light to dark and was due to dark area in an image looked lighter under a dark surround than that under a bright surround. Hunt[3] shows that objects appear vivid and intense contrast with the luminance of surround increase. However, Y. J. Kim[4] *et. al* found the color displayed in small size mobile device perceive darker and less saturated by increasing the luminance of environment, from dark, average to bright. Choh[5] *et al*, using large PDP display, also found the whole picture looked lighter under dim and dark surrounds. In this study, high luminance RGB-LED panel was used to investigate the influence of color perceptions by surrounding luminance. The color appearance changes were compared with early finding with different medium.

EXPERIMENTAL

In this study, the medium used in experiment is a RGB-LED panel with high white luminance of 1646 cd/m^2 to simulate electronic billboard outdoor. The test color patch, composed of full-color

LED chips, extends a visual angle of 6° and grey paperboard was surrounded shown in Fig.1(a). Three illuminance levels: dark, average and bright with luminance of 0, 613 cd/m^2, 7298 cd/m^2 respectively were to simulate night, normal day and sunny day. The visual color attributes of lightness, brightness, colorfulness and hue of evaluated LED color patches, including achromatic color and chromatic color R, Y, G, B with various L* of 20, 40, 60, 80 and various C* values of 30, 60, 90, 120 (shown in Fig.1(b)) under dark, average, bright were collected. Veiling glare effect was included in the experiment. The detail experimental method was described before[6]. The visual data set had been used to test color appearance model CIECAME02 and A TestCAM02, modified from CIECAM02, was proposed. In this study, the changes of visual color attributes arising from the luminance levels of environment were examined and the color appearance phenomena, such as Stevens effect and Hunts effect, were further discussed.

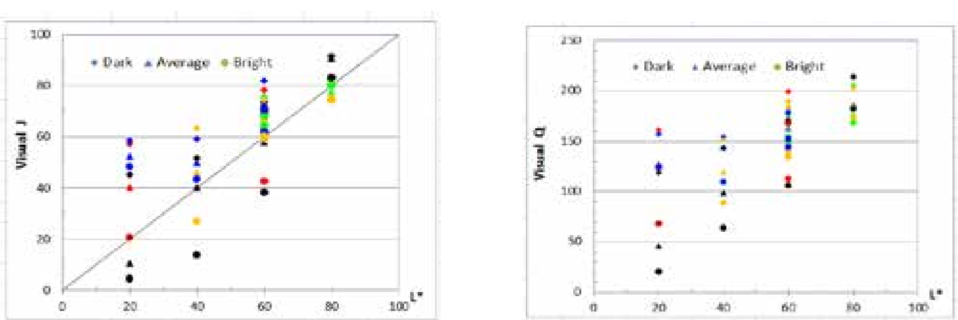


(a) (b)

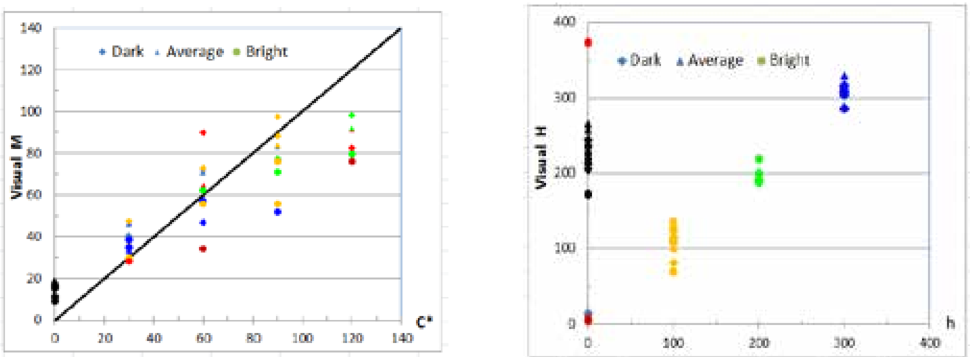
Fig. 1 (a) Layout of the psychophysical experiment diagram (b) Color coordinates distribution of LED color patches in CIELAB

RESULTS AND DISCUSSION

The visual assessment for lightness J, brightness Q, colorfulness M, and hue h of LED color patched affected by the luminance of surround were investigated. The collection data for the perceived attributes were individually plotted against the corresponding attributes of CIELAB viewing under dark surround(♦) , average surround (▲) and bright (·) (shown in Fig.2). Figure2 (a) (b) show that the visual lightness and brightness of LED color patched were largest viewing in dark surround, and they are least viewing in bright environment. This is disagreed with Stevens effect, while it consistent with the finding of JM Kim, in which mobile display (self-luminous stimulus) was used. Figure 2(c) indicates the colorfulness of stimulus also decreases with the increase of the surround luminance in this study, in a contrary trend with Hunt effect. The hue changes of color patched were not apparent with the luminous levels of surround shown in Fig.2(d). It also found that the degree of the influence on color attributes is dependent on the lightness, chroma and hue of the stimulus.



(a) (b)



(c) (d)

Fig. 2 Visual color attributes plotted against the corresponding attributes of CIELAB (a) visual lightness J against L* (b) visual brightness Q against L* (c) visual colorfulness M against C* (d) visual hue against hue

Surround luminance on Lightness and brightness

For visual lightness and brightness, all data points under dark surround are above data points under average and bright surround, which means that their perceived lightness and brightness increased as the surround luminance decrease. It is also found that the lightness (brightness) changes are larger in dark colors than in light colors, inducing the contrast reduced under a dark surround. These findings are similar as the results of Bartleson and Breneman effect in achromatic images. The degree of effect is significant larger in neutral colours than in chromatic colours, and least in blue colours. Figure 4 shows the visual lightness of stimulus against L* in achromatic colours. The simultaneous contrast effect is apparently found under average environment, indicating white against grey background perceives lighter and dark colour against grey perceives darker. The visual lightness J of colors plotted against chroma values C* of stimulus shown in Fig.5, in which data points scattered a wide range in lower chroma and a narrow range in high chroma. It indicates that the lightness perception in vivid colors is less affected by the luminance of surround than that in low saturation colours. There were the same trend findings in brightness attributes.

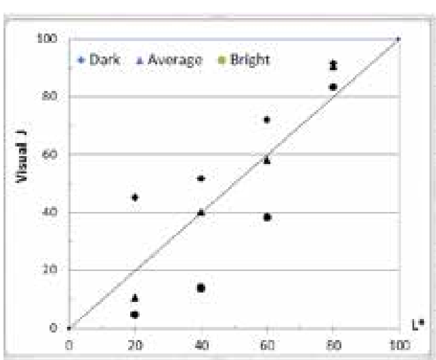


Fig.4 Visual lightness J of achromatic colors under various surrounds plotted against CIELAB L* of colors

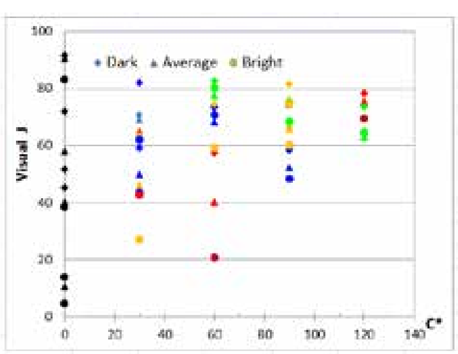


Fig.5 Visual lightness J of colors under various surrounds plotted against CIELAB C* of colors

POSTER SESSION

Surround luminance on colorfulnesss

The colourfulness of stimulus is decrease with the increase of surround luminous for all colours. The differences between visual colorfulness M and C* values of stimuli were plotted against lightness values of colors to investigate the dependency of L* on the colorfulness under various surrounds, shown in Fig.6. It indicated that the colorfulness changes were not clearly dependent on the lightness of stimulus, while Fig.2(c) shows the colours with low chroma look larger than their chroma values and high chroma looks lower than their chroma values under all luminous levels of surround. The difference between assessed chrima values and chroma value of colours viewing under dark, average and bright environment were calculated and individually plotted against and C* values of the color stimuli shown in Fig.7, indicating contrast in colorfulness was reduced in a bright surround.

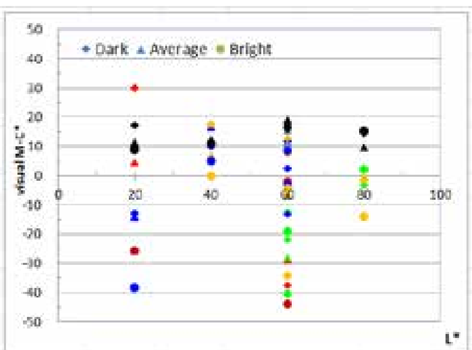


Fig.6 Visual colorfulness M difference of colors under various surrounds plotted against CIELAB-L* of colours

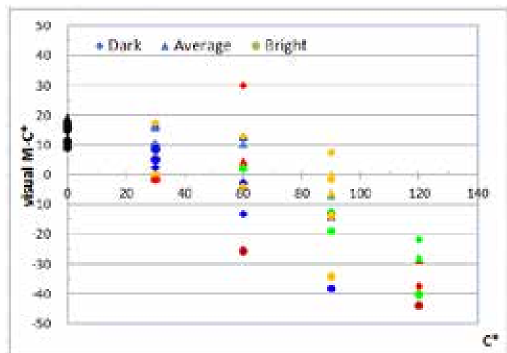


Fig.7 Visual colorfulness difference of colors under various surrounds plotted against CIELAB-C* of colors

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Determination of red floor for fake blood realistic enough viewers feel scary in make-up effect of horror film

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Keywords: Make up effect, horror film, movie, fake blood, red colors

ABSTRACT

The makeup effect that use in the horror movie is about the wound caused by various accidents, fake blood and the color of the wound. In Thailand, there are no standards of fake blood shades. This study investigates the reddish hues of stimulated blood by special make – up effect which seems to be real and influences the audience perception. There are few steps for the study. First, an image is taken from a model which has a make – up on her face. Next is to use the digital image software to adjust the red values of the original image. It controls the brightness of black and red, changes the saturation of the red level selected in Munsell Book of Color. The 6 chroma levels of Munsell red color were chosen which are considered scary. The experimenter presented the picture stimuli to subjects. One thirty people participated to the experiment. The picture stimulus was presented on display sized 2560x1600 pixel The result showed that the average chroma level at 7.5R 2/8 red color gave the most scared feeling to the subjects.

INTRODUCTION

In film industry, Make-up effect is an important part in production process to create some audience perception when he or she watches a movie. The main problem for film maker is a movie cannot be shooted and completed in one day. Due to a different day and location, It's hardly possible to make-up an actor to have the same contour effect and colored effect for a continue shooting. Even, there is a visual effect technique that is able to create make-effect in post process. Make-up effect on location is still a good option for saving cost and time. Moreover, actors could feel and make an inner emotion than without make-up effect.

In a horror movie, make-up effect normally be inspired by an accident event especially blood. Nowadays, no one in Thailand studying about which red blood color that make an audience to feel more frightened. This study, I tried to find which color would produce more real blood sensation and feel terrorize.

METHODOLOGY

Apparatus

We choose for shades of Munsell book color with examples showing the symbol of Hue, Value and Chroma, the color of each piece. Look at the color of the sample.

In first experiment, we used a normal living room in daily life. The room was illuminated by Fluorescent. the gray paper with a surface of the table and 3 color chart as 5R, 7R, 10R by Munsell book on the gray paper. And experiment two we used the same room as first experiment but we change 3 color chart to display as shown in Fig. 1.

POSTER SESSION

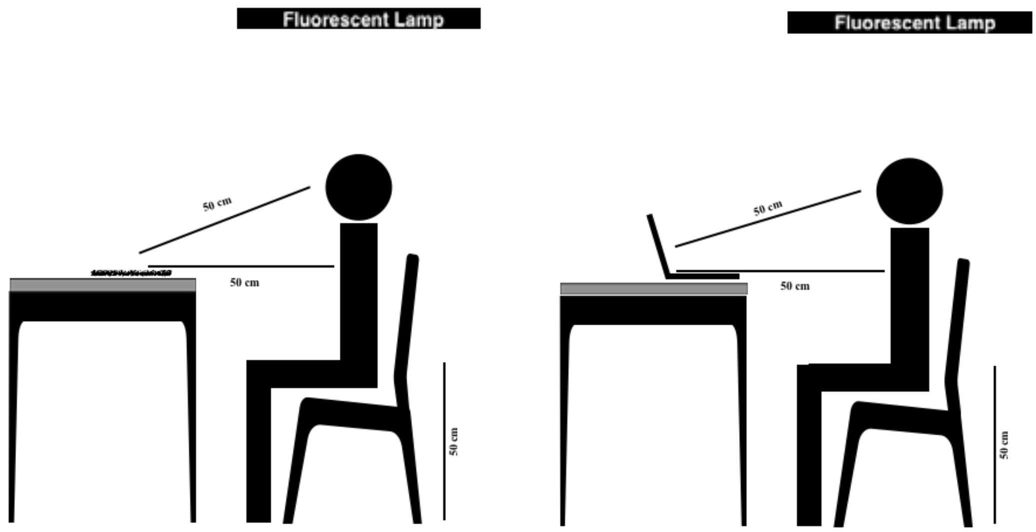

Figure 1. diagram of experiment first and second

We use the FD-5 Spectrodensitometer. To accurately measure color.

Adobe Photoshop program is used to adjust the color. It is a popular photo editor. Widely used General and professional use.

We study how to create make-up effect with the concept of zombies at the mouth. And shooting by DSLR cameras with high resolution in fig. 2.

Figure 2. Original image from shooting by DSLR camera

Procedure

There were second experiments. the first one, the 5R,7R and 10R colors in Munsell book which placed on the table were presented to a subject. An experiment room was illuminated by fluorescent lamps giving 430lx in a subject position. A subject selected 6 colors which he or she feel frightened. The result was scores by different in rank. The most frightful would get 100 scores for that color and 80. The rest scores were 60, 40,20 and 1 as the second to sixth in fig. 3. I measured colors which are the top of the rank by using spectrophotometer FD-5 to use chromaticity value as L*a*b* to stimulate the same color on a display. There were 30 subjects participated in this experiment.

POSTER SESSION

the second experiment was similar to experiment first 30 subjects were asked to select a color which stimulated on a make-up face with the same idea which one is the most frightful in fig. 4-7.

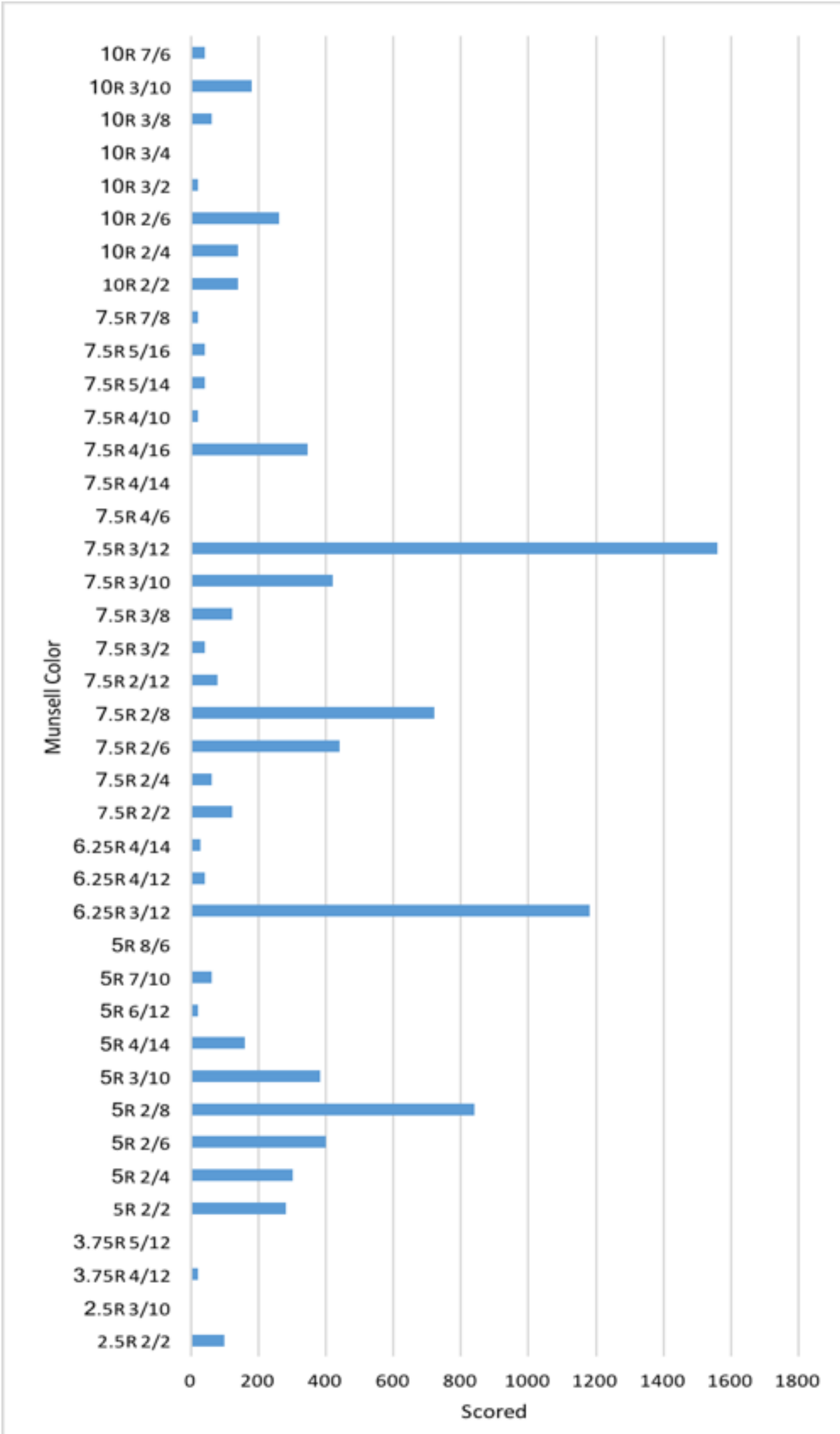

Figure 3. The sum of the scores by 30 subjects.

Figure 4. The most picture scared No. 1
7.5R 3/12

Figure 5. The most picture scared No. 2
6.25R 3/12

Figure 6. The most picture scared No. 3
7.5R 2/8

Figure 7. The most picture scared No. 4
6.25R 3/12

RESULTS AND DISCISSION

The results form first experiment showed that the color of the fake blood was the most scared. The color was 7.5R 3/12 , the No. 2 color, the No. 3 is 7.5R 2/8 , the No. 4 and No. 5 is 7.5R 3/1 and No. 6 is 6.25R 4/14

Because of that, the color shade in the No. 4 and 5 are repeated with shades of fake blood with as No. 1, we have the whole gamut only 4 of the top 6 to adjustment in Photoshop program in fig. 8 No.4 and No.5.

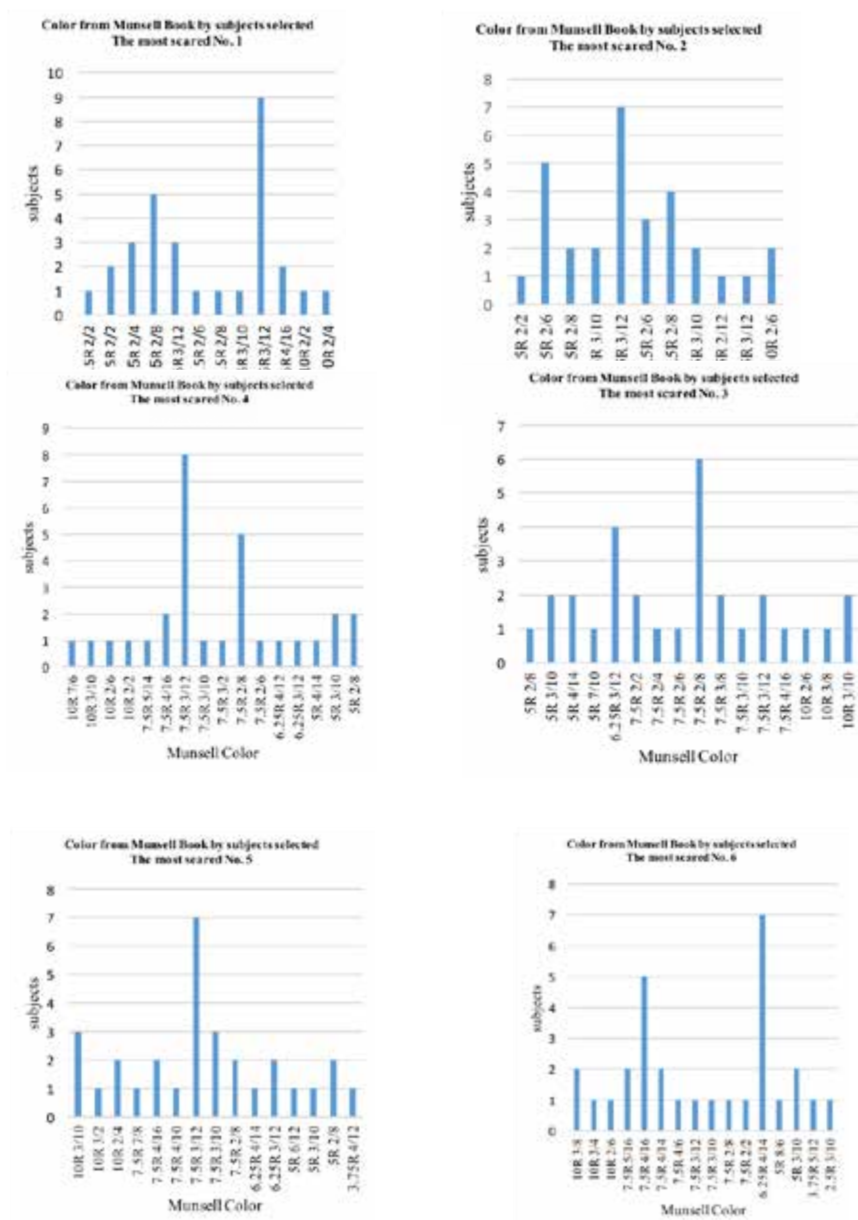

Figure 8. Color from Munsell Book
by subjects selected the most scared No. 1-6

Color measurement with FD-5 Spectrodensitometer from Munsell color system to L * A * B * for changes the saturation of the red level on pictures in Photoshop.

In the second experiment, findings from a selection of images of the most frightening. Picture of the most scared is "Picture No. 3", with a 7.5R 2/8 in the first experiment, it was a scared color No. 3 in fig. 10.

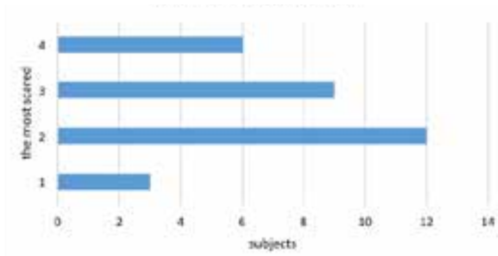

Figure 9. “Picture No.1”
(7.5R 3/12)

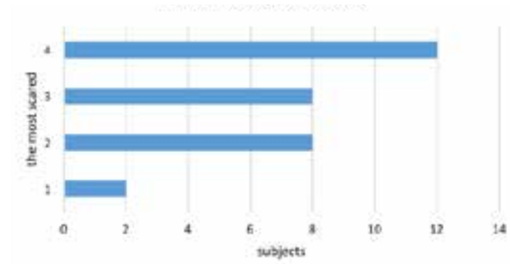

Figure 10. “Picture No.2”
(6.25R 3/12)

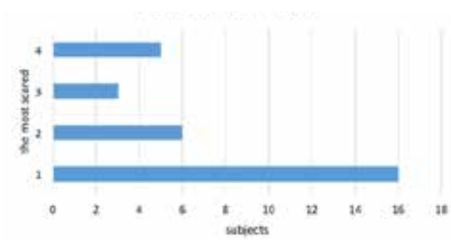

Figure 11. “Picture No.3”
(7.5R 2/8)

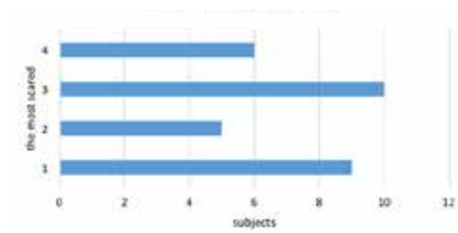

Figure 12. “Picture No.4”
(6.25R 4/14)

In conclusion, the shades of fake blood were the most frightening in the first trial. Experimentally selected from the Munsell book, not the same shade as the picture as change saturation of the red level in experiment second. In the first experiment, subjects were selected by imagination and basic horror of himself. In experiment second, the experimenter saw a gruesome wound. Shades the most scared in experiment first and second mismatch regularly in all shades of fake blood scary to be in the 4 colors are 7R level in Munsell book.

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Image scrambling on Packaging Label for Anti-Counterfeiting

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Keywords: Image scrambling, Packaging Label, Anti-Counterfeiting

ABSTRACT

The aim of this study is to apply lenticular technique for developing anti-counterfeiting packaging. This technique can be applied for designing a hidden image that can be read using a lenticular lens. In this study, the hidden image was designed and printed on a monotone pharmaceutical packaging. Afterward the image was examined in two parts; 1) readability of hidden image with/without lenticular lens. 2) the reproducibility of the anti-counterfeiting. Three different font formats (Sans Serif, Serif and Modern) were used to design sampling image with different screen resolutions of lens parameter and font sizes. The results showed that the sampling image could only be read via lenticular lens. For the reproducibility of the anti-counterfeiting, the sampling image cannot be read after reproduction process. From both investigations, it can be implied that lenticular technique can be applied for design the anti-counterfeiting packaging.

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INTRODUCTION

Packaging is a term for explain processes and materials utilized to contain, protect and transport a product. Packaging play an important role in various industries and use to present different functions such as to attract attention, assist in promotion, provide machine identification (barcodes, etc.), impart essential or additional information, and help in utilization. Recently, the big challenge in packaging industry is to create anti-counterfeit packaging. The anti-counterfeit packaging can not only use to protect the products and also provide a customer the differentiate between genuine and fake on his/her own. There are several printing techniques including material technologies that applied to develop an anti-counterfeit packaging such as, invisible ink, watermark substrate, hologram, hybrid printing method, Micro-text, spot color, and image scrambling. These techniques and materials can protect the packaging from reproducibility resulted to decrease the counterfeit packaging.

In this study, we propose a new method for fabricate the anti-counterfeit packaging using lenticular technique. The anti-counterfeit packaging was designed with image scrambling located above a barcode. This image scrambling can be seen as normal illustration with meaningless and also appear as part of the barcode. However, this image can be actually read and provided information using the specific lenticular lens. The lenticular technique can be useful for product owners in order to examine their own goods. This study presents the factors that affected to the image scrambling. The results can be applied to develop the anti-counterfeit packaging.

LENTICULAT

Lenticular technique is a method that use to hide an important information. By this method, image, symbol or text is separated into at least two set of data which cannot be able to read via normal eyes. However, these two data set can be combined using a lenticular lens as shown in Figure 1. The lenticular sheet, made from plastic, regularly has two sides. The front of the sheet consist of curve and slope similar to convex lens and the back is a flat sheet. There are three different materials that used to construct the lenticular lens which are 1) Poly Ethylene Terephthalate (PET), 2) Poly Propylene (PP) and 3) Poly Vinyl Chloride (PVC). These three types of materials provide different properties of the lenticular lens. PET offers a good property in transparent and resistant. PP is suitable for food packaging and PVC made from petroleum and present less transparent and resistant.

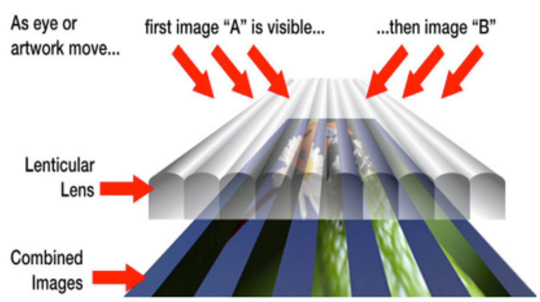

Figure 1. Schematic of lenticular Process [1]

As mention above, lenticular technique combine at least two images in one area. All images are separated in different parts and defined in two mains parameters as shown in figure 2. The first parameter is the specification of the lenticular lens, for example, resolution, slope degree, thickness. The second parameter is image processing which involved in font size, density, graphic and quantity of layer.

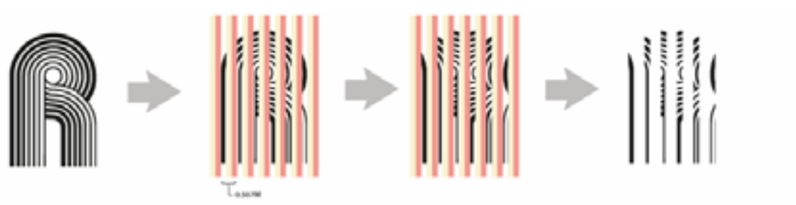

Figure 2. Image code and decoding in scrambling technique

EXPERIMENT

In this research, code and decode image scrambling data were investigated include anti-counterfeiting ability as shown in Figure 3.

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Figure 3 Experimental set up

The first stage of this study is to prepare all factors that affected to manufacturing process of the lenticular lens such as software used, printer and lenticular lens with different resolution. The resolution of the lens was set at 50 lines per inch and 75 lines per inch. The correlation of the resolution the lens and the printer was examined in order to define standard deviation of the machine using the first test chart as shown in Figure 4. The data from this stage was applied to create the sampling image in the next stage.

Figure 4 the first test chart for defining the correlation of the resolution of the lens and the printer

The second step (Image generation) is to create the second test chart which consisted of image, line, different font size and font characteristics. There are five factors that directly affected to image scrambling as follow;

1) Resolution. An experiment image was produced in 50 and 75 LPI and classified by perception of sample group.

2) Image Layer. An image was trapped in 2, 3, and 4 layers. Figure 5 shows the sample overlay image for the experiment.

(a) (b) (c)

Figure 5. The overlay images for the experiment:
(a) Layer A (b) Layer B (C) Layer C

3) Pattern of camouflage. The camouflage was designed in 3 patterns shown in Figure 6

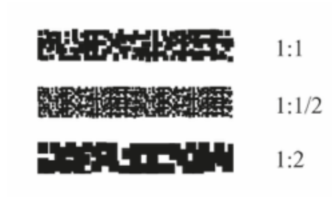


Figure 6. The pattern of camouflage

4) Font characteristics. We studied 3 fonts as serif, san serif, and line art font as shown in Figure 7.

Figure 7. Font for experiment

1) Font size. The image was created with font size at 9 – 24 point. as shown in Figure 8.

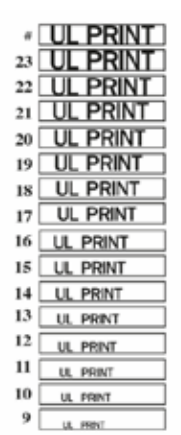


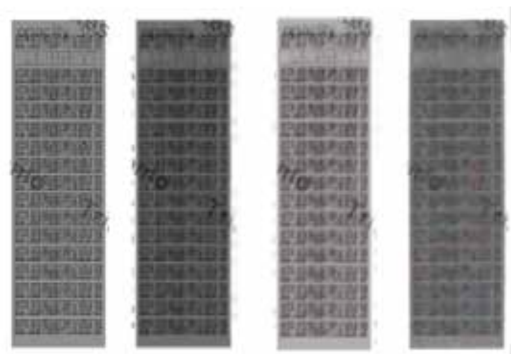
Figure 8. Different font size used in the second test chart

As described above, all five factors were considered and used to create the second test chart. This second test chart was printed by laser printer (Canon LBP7200 CDn). Before the printing, the standard deviation of the printer was used to calculate and correct the distortion of image. The deviation is directly influenced to resolution, thickness of lenticular lens including printing material and quality of printer. The third stage is to evaluate in two issues; 1) anti- counterfeit ability and 2) ability to observe the hidden image or text. The second test chart was copied using three different copies machine in order to investigate in anti- counterfeit ability. These copied image were compared to the original image and examine using lenticular lens by observers. For ability to observe the hidden image or text, different factors such as font sizes, font characteristics, density of background, pattern of camouflage were characterized and evaluated.

RESULTS AND DISCUSSION

The second test chart was printed on 280-gram paperboard. The results showed that the standard deviation was 98.5% and 99% when tested with lenticular lens at 50 and 75 lines per inch respectively.

For anti- counterfeit ability, observers tested three different copied images as shown in Figure 9. It can be seen that the contrast of these copied image were evidently decrease. In addition, these copied image cannot be seen the hidden image via the lenticular lens. There are deviation between lens and printed images such as colour and density resulted to incomplete decoding in scrambling Image.

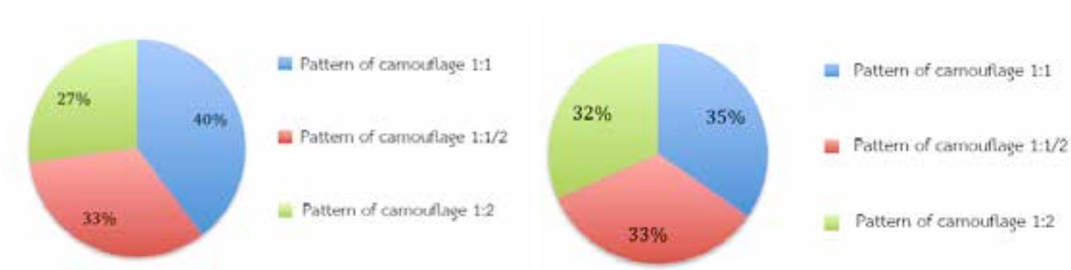


(a) (b) (c) (d)

Figure 8 The original test chart and three copied iamges

(a) Original (b) The copied image from copied machine A (c) The copied image from copied machine B (d) The copied image from copied machine C

Ability to observe the hidden image or text was examined by 30 observers and investigated into two experiments; read with lenticular lens and read without lenticular lens. The results from read with lenticular lens showed that the ratio of hidden image at 1:1 present a good result. In the other hand, read without lenticular lens, the results showed that pattern of camouflage from the image A was good in hidden image (cannot read). The ratio of hidden image at 1:1 was quite good compared to other sampling image as shown in Figure 10.



(a) (b)

Figure 10 Pattern of camouflage (a) read without lenticular lens (b) read with lenticular lens

In this experiment, the number of layer was also investigated. The hidden image were printed in different layers (2, 3 and 4 layers). The image with 3 layers cannot be read without lenticular lens and it can be clearly read with lenticular lens compared to other hidden image. It can be implied that the printed hidden image with 3 layers is suitable for this lenticular technique. Moreover, three different font characteristics were tested. Figure 11 showed that Serif was a suitable font character for hidden image because of easy to read using lenticular lens.

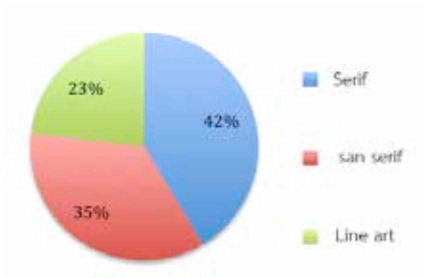


Figure 11 Readability of three different font characters

Another topic analyzed in this experiment was font size. It can be seen that the font size between 14 – 23 point can be used for hidden image read by lenticular lens. The size of font character that smaller than 14 point were difficult for reading as shown in Figure 12.

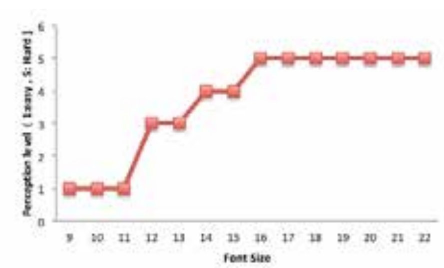


Figure 12 Readability of different font sizes

CONCLUSION

This paper presented lenticular technique for developing anti-counterfeiting packaging. Lenticular method combined at least two images and present in one image that can only read via lenticular lens. The parameters of lenticular method that directly affected to code and de-coding image were studied. The suitable parameter that we can determine were 1) resolution of lenticular lens was 50 lines per inch, 2) Pattern of camouflage is 1:1 at 3 layers, 3) Serif is a suitable font character with 14-23 point. The hidden images with these parameters were examined in reproducibility. The results showed that it cannot reproduce. To conclude, lenticular method can use to create image scrambling on packaging which can applied to develop anti-counterfeiting packaging

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DETECTION PALM COOKING OIL COLOR USING DIGITAL IMAGE PROCESSING AND ARTIFICIAL NEURAL NETWORK

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Keywords: artificial neural network, carotenoid, color, palm cooking oil

ABSTRACT

Palm cooking oil is one of nine basic needs which widely used for Indonesian households. Color is important parameter to consider for palm cooking oil after price and brands. There are many brands of vegetable oil based on crude palm oil (CPO) in retail and traditional market. This study determine palm cooking oil color using digital image processing and artificial neural network cooking for five most preferred brands in 2017 in Indonesia. Consumer perceptions are varied and influenced by illumination, size of product, environment, and observer viewing angle in retail. In order to describe standard color based on Indonesian National Standard (SNI), Lovibond Tintometer method is used to display the color of palm cooking oil. Artificial intelligence, for example artificial neural networks (ANN), widely develop to process solving complex problems by carrying out the learning process through changes in the weight of synapses. The color detection as quality parameter is prepared through digital image processing using Matlab artificial neural network. Palm cooking oil color influenced by carotenoid content. The results will be used ton enhance standard quality assessment of palm oil. Color measurement using RGB coordinates, CIE L*a *b* color space, and spectrophotometry UV-Vis are expected to achieve more objective develop the color analysis on palm oil.

INTRODUCTION

Palm cooking oil is a strategic commodity of food expenditure in Indonesian households. The level of consumption per capita (kg) / year is 9.26 in 2017 (PDSIP, 2017) which really high consumption level of vegetable oil. Currently the Indonesian vegetable oil industry is growing with increasing levels of income and consumer standard of living. Consumers choice and food consumption are increase and have been influencing many basic needs of the community for sources of fat, improving food taste, improving food texture, improving the appearance of processed products, increasing shelf life and selling value of food products (Kumar, 2016). According to consumers, the color of palm cooking oil usually bright yellowish, clean, and clear. Cooking oil which has bright yellowish color is the most of consumers choice as an indication of the absence of a frying process. Crude palm oil is very rich in natural pigments called carotenoids which give different orange-red oil colors (Riberio et al., 2018). During CPO processing into cooking oil, all carotenoids are removed and reduced in high temperature and refining process. Palm oil contains 41% saturated fat, 81% palm kernel oil, and 86% coconut oil. Palm oil is an oil that has high saturated fat levels. The instability of tocopherol in free fatty acids and the relatively low level of triacylglycerol occurring in physical distillation occurs in the process of bleaching through heat and deodorization until the resulting palm oil is golden yellow and does not contain carotene. This information is used as the basis for determining criteria for palm cooking oil that are most preferred by consumers.

The Indonesian National Standard (SNI) for the color of cooking oil refers to the use of the concept of the Lovibond Tintometer instrument and methodology. Palm cooking oil color is determined according to test method by using Lovibond 5.25 cell (SNI 7709: 2012). This measurement uses an additional 0.5 g of diatomaceous earth to 300 g of the test sample and homogenized 2.5 minutes at 250 ppm and then strained with filter paper. The oil color is read on the red scale (R) and the yellow scale (Y). SNI 3741: 2013 explain that color testing is carried out with the visual sensory by three trained panelists or one expert for sensory testing. When color changing until pale-yellow or clear light yellow in accordance with the type of oil, it is normal color, but if other colors raised it is abnormal color. The color standards stipulated in SNI 01-0018-2006 (as refined bleached deodorized palm olein) are only a maximum of 3 red and SNI 01-3741-2002 as cooking oil is white, pale yellow to yellow (BSN, 2002; BSN, 2006). Indonesian National Standard (SNI) is referenced by adding the parameters of the carotene level and raising the red color level. In addition, the fraction of vitamin E as an antioxidant which reduce cell damage caused by chemical substances and environmental pollution. Palm oil color is generally red to orange because of ten types of carotene (pro-Vitamin A). During the conventional refining process, 100% natural carotene is destroyed, while with new refining technology more than 90% of the natural carotene content can be maintained. For one hue, one image analysis feature, a negative correlation with a red reading of the Lovibond Tintometer values of image analysis and visual color are obtained.

Color is one of the most widely used product attributes in determining the quality and preferences of consumers in retail. Many consumers sometimes take pictures in retail products and supermarkets by digital cameras to communicate product attributes. By using cameras as tools for input in control system, it utilized images, then processed so as to produce a system that can control many actuators in image processing. Image processing applies a system to process objects in the form of images from the camera as a basis for purchasing decisions by consumers. Developments and changes in technology and information make computers as a tool that work as human brain to make decisions (Choong et al., 2006 and Funes et al., 2015). This condition encourages the use of artificial intelligence (AI), for example artificial neural networks (ANN), which developed to process solving complex problems by carrying out the learning process through changes in the weight of synapses. This study used the application of artificial neural networks which have been widely applied in various sciences, for example in product design and development, distribution, material handling, waste management, or material and energy balance in the production.

METHODOLOGY

For the purpose of this study, triplet samples from five preferred brands from various producers at the retail. 1 L packaged cooking oil chosen based on the same expired date were chosen to ensure for no color changes during retail period. Through this consideration, the absorbance spectrum measured in the range 200 nm to 800 nm using UV-Vis Jenway Spectrophotometer. Three mililiter of sample were put to a quartz cuvette that had dimensions of outer cells 12 mm x 12 mm x 44 mm, with a 10 mm optical path. Aquadest is used as a reference for measurement. For each oil sample, optical spectrum measurements are repeated three times to ensure consistency and repetition. During spectrum scanning, the beam of light passes through both oil samples and sequential references and optical transmission is recorded. Color Cabinet which equipped with 220V AC power, 50 Hz, and dimensions of 70 cm×41.5 cm×57 cm as a container for the image retrieval process. This color cabinet was equipped with 4 types source of light, 2 pieces of D65 18 W (International Standard Artificial Daylight), 2 TL84 18 W (Shop Light Sources), 4 F/A 40 W (Sun-Setting Yellow Light) Source), and a UV 18W lamp.

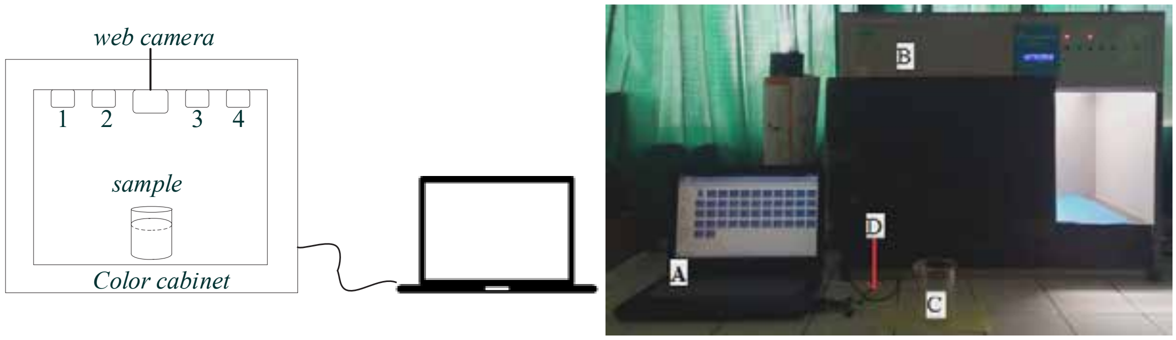

Figure 1. Product Image Retrieval Using the Color Cabinet

Lovibond Tintometer Model F is used to measure cooking oil color according to SNI 7709:2012 and SNI 3741:2013. RGB value were collected as input in digital image processing. Before processing the image, Color Cabinet, equipped with Logitech 5 Megapixel C170 Webcam for capturing image and connecting to PC and beaker glass were adjusted for sample containers. Speciments were put 20 cm under web-camera and data will be sent to PC which used OS Windows 7 Ultimate Service Pack 1 64-bit Operation System, AMD E1-6010 APU Processor with Radeon R2 Graphics 1.35 Hz, and RAM 2.00 GB which Matlab R2015a is installed as software for data processing. Captured data were compared and verified by Chromameter CR-400 Konica Minolta that uses 5V AC Adapter electrical power; 2A or with a 1.5V x 4 battery; 0.2A. Small sized cartridges as sample containers for testing Minolta Co., Ltd., Osaka, Japan for measuring the color of transmittance in liquid media used in L*, a*, b*, respectively, according to lightness, the green-red component, and blue-yellow components. Hue value (a*/b*) are measured when cooking oil were filled into the cup until there is no air cavity when the petri dish is closed.

All instruments were calibrated with deionized water. Measurements are conducted on melting samples (45°C) which were placed in a 20-mm tube. The result is the average of three consecutive measurements. Type of light source and selecting the background color play important roleduring image taking (background). A blue background color and D65 light source were set for Color Assessment Cabinet, there are 2 D65 lamps with 18 W power and a temperature of 6500K (International Standard, Artificial Daylight). Sample preparation before image taking is done by taking each sample as much as 250 mL and put in a 250 mL beaker glass. Spectrophotometer Jenway Model 6305 used to analyse 230 / 115V, 50VA, 50 / 60Hz power sample in cuvette. The wavelength used in this measurement is from 374 nm, 416 nm, 427 nm, 455 nm, 460 nm, 483 nm, and 670 nm. Calibration is conducted using distilled water as a blank to adjust the spectrophotometer until the measurement wavelength has zero absorption into the cuvette.

RESULTS AND DISCUSSION

Measuring palm cooking oil using Lovibond Tintometer type F shown similar result according to SNI 7709:2012 and SNI 3741:2013. Capturing image samples using a webcam camera in the Color Cabinet will be stored in of 2592 pixels x 1944 pixels.

(A) (B) (C) (D) (E)

Figure 2. Five Prepared Samples for Color Cabinet

Digital image processing is used to obtain RGB component values for each sample cooking oul. were conducted using graphical user interface (GUI builder/GUIDE) Matlab programming to be able to select the image to be processed and then separate objects from the background color. After the object is separated (Figure 3), then the mean red, green, blue, L, a, and b value (Figure 4).

(A) (B) (C) (D) (E)

Figure 3. Results of Separation of Objects

Figure 4. Selected data for image object

Color of palm cooking oil that is most preferred by consumers but most of them do not understand the standard of color. This study used artificial neural network with three layers, namely input layer with six neurons, hidden layer (hidden layer) with five neurons and output layer with two neurons. In the process of training artificial neural networks, the activation function in the input layer is used *tansig*, in the hidden layer used *tansig*, and *logsig* at the output layer and the training method used is *trainrp*. The final result shown average cooking oil color which capture by cabinet color and chromameter are 61.23±0.24 for L, 9.27±0.21 for a, 13.22±0.19 for b with 84.7% accuracy. The parameters that influence the color of packaged cooking oil are carotenoid content and vitamin A fortification. Palm oil producer be able to modify the parameter at refining process, for example reducing the concentration of earth bleaching (<0.5%) and deodorization temperature (<240ºC). Palm cooking oil enriched with pro-vitamin A must have a special standard as cooking oil (as a material for revision of SNI-01-3741-2013).

Carotenoids are natural pigments in CPO (500-700 ppm) yellow to reddish. UV-Vis spectroscopy was used to analyze the content of beta carotene in cooking oil with a value of (3.78%). The color of the RBD palm oil sample was observed for hue value (a*/b*) at 900 nm wavelength (infrared light), 700 nm (visible light) and 400 nm (ultraviolet light). The clearest wavelengths in this measurement are 375 nm, 415 nm, 425 nm, 455 nm, 460 nm, 485 nm, and 670 nm (Figure 5). The level of carotenoids in oil cannot be calculated because the characteristics of peak carotenoids around 450 nm are not present in palm oil. Carotenoid loss occurs during the bleaching process. The absorption percentage increases when using 900 to 700 nm (Near Infrared), 700-400 nm (visible), and 400-200 nm (Ultraviolet).

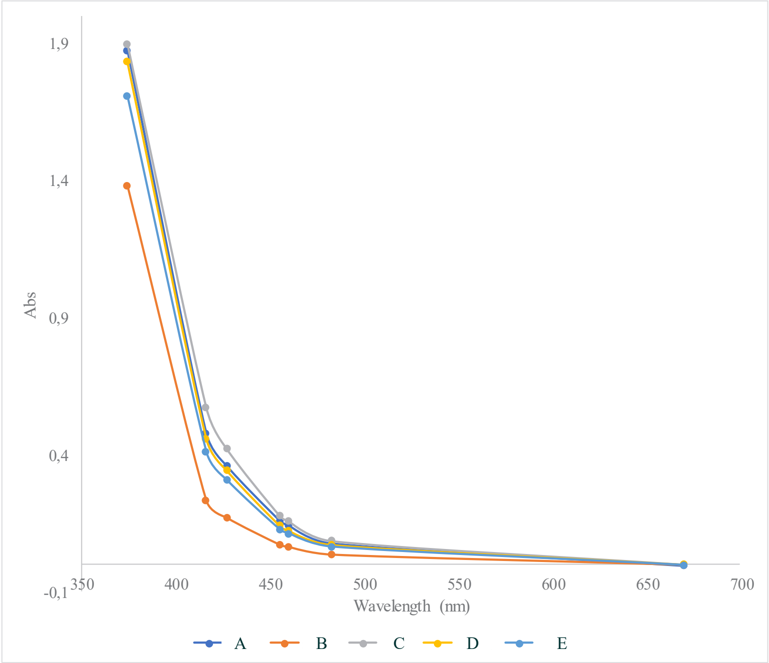

Figure 5. Spectrophotometer UV-Vis for for five brands palm cooking oils

Meanwhile, the percentage of transmission decreases because light absorption passing through palm oil because the level of oxidized fatty acids, polymers, acid values, peroxide values, viscosity, and reflective index heating and cooling treatment process.

Table 1. Color Cabinet Measurement for Five Brands Palm Cooking Oils

No	R	G	B	L	a	b	Brand
1	181.39±0.17	142.04±0.26	48.30±0.29	60,78±0.33	9,26±0.29	13,57±0.22	A
2	176.01±0.19	158.29±0.24	83,55±0.22	64,69±0.31	5,12±0.23	10,78±0.18	B
3	177.38±0.25	136.66±0.09	45.07±0.16	60,44±0.17	9,83±0.14	19,56±0.28	C
4	185.48±0.23	146.63±0.48	51.63±0.14	62,40±0.28	9,20±0.18	13,38±0.16	D
5	177.32±0.89	147.83±0.12	58.25±0.27	61,87±0.22	4,36±0.33	12,12±0.23	E

Table.2 Chromameter Measurements for Five Brands Palm Cooking Oils

No.	L	a	b	Brand
1	62,97±0.21	-2,44±0.16	18,98±0.09	A
2	64,42±0.25	-0,62±0.07	9,15±0.15	B
3	63,18±0.08	-2,97±0.08	20,71±0.16	C
4	63,25±0.17	-2,29±0.13	17,32±0.12	D
5	63,48±0.24	-2,25±0.22	15,55±0.11	E

Color measurements also evaluated from industrially bleached palm oil. For each replicating oil sample in the measuring tube is changed. L*, a*, b* values were (L 61.23±0.24, a 9.27±0.21, b

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13.22±0.19). Table 1 shows the result of chromameter measurement of five preferred brands palm cooking oil in color cabinet and Table 2 shows the result of chromameter measurement of five preferred brands palm cooking oil after getting result from Lovibond Tintometer scale. When using L*, a*, b* methods, the methods R*, G*, B* illustrate the color complexity of palm oil which has become very dependent on the bleaching process which is affected by the temperature when processing crude palm oil (CPO).

CONCLUSION

This study used artificial neural network with three layers, namely input layer with six neurons, hidden layer (hidden layer) with five neurons and output layer with two neurons for color cabinet and chromameter to Lovibond Tintometer method for palm cooking oil color measurement. Most of customer preferred 61.23±0.24 for L, 9.27±0.21 for a, 13.22±0.19 for b for palm cooking oil color 1L retail package. Quantitative color standards can be used to support information on the decision to purchase palm cooking oil based on pale yellow to be set in Indonesian National Standard (SNI).

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EXPERIMENTAL CONSIDERATION OF FACTORS AFFECTING THE SHITSUKAN CONTRAST EFFECT

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ABSTRACT

The richness of the real world can be realized through the “Shitsukan” perception, which refers to the total appearance of objects and their subjective visual values. Glossiness, transparency, and roughness are some examples of subjective qualities of Shitsukan. In the field of vision science, various contrast effects have been studied; the simultaneous color contrast effect, for instance, states that the color appearance of a central stimulus varies according to the background color. However, instances of the Shitsukan contrast effect have rarely been reported. In the proposed study, the authors attempt to experimentally confirm the generation of a Shitsukan contrast effect. Two Shitsukan perceptual attributes, namely roughness and glossiness, were analyzed in the proposed study. Further, it was assumed that these two high-level contrast effects can be generated by the combination of low-level contrast effects, such as brightness, texture interaction, and spatial frequency. Through multiple regression analysis of psychophysical experiments, it was found that the contrast effect of spatial frequency can influence roughness by 50% to 70%. Furthermore, the obtained results show that the glossiness contrast effect can be influenced by approximately 80%, owing to the contrast effects of the brightness and texture interaction.

INTRODUCTION

Two antagonistic mechanisms in the human visual system that are used for estimating the brightness of reflecting objects have been investigated. One is a local, presumably retinal, neural mechanism that responds to the physical contrast between an object and its background [1]. The other mechanism, which is responsible for the classical psychological phenomenon of assimilation [2], makes an observer’s perception of the brightness of an object co-vary with the apparent brightness of the object’s surroundings.

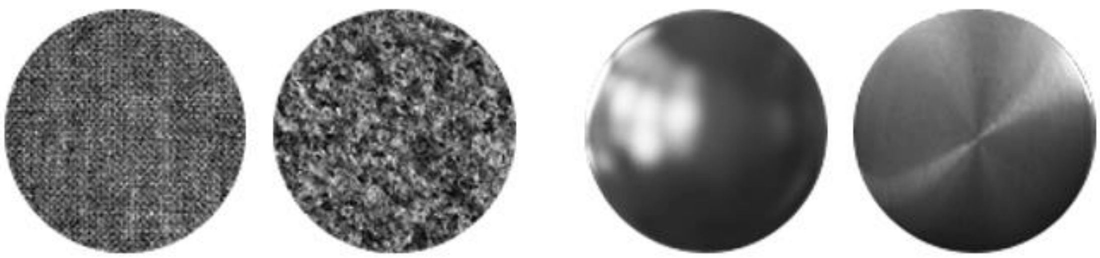
In recent years, “Shitsukan” characteristics of objects have been drawing attention [3]. Shitsukan is a Japanese word for the subjective and effective qualities of surfaces and materials. In Japan, national projects have advanced, where experts from different fields, such as engineering, psychology, and neuroscience, were brought together to advance our knowledge of the mechanisms of the human Shitsukan perception and facilitate the progress of Shitsukan technology [4], [5].

In this manner, Shitsukan has actively been studied, but there have been few reports on the contrast and assimilation effects on Shitsukan. In this study, we focus on two Shitsukan perception attributes, namely roughness and glossiness, to investigate high-level contrast effects. We assume that the two high-level contrast effects can be generated by the combination of low-level contrast effects such as brightness [6], texture interaction [7], and spatial frequency [8]. Therefore, the proposed study investigates how these three low-level contrast effects can influence the high-level contrast effects, glossiness and roughness.

EXPERIMENT

Experimental Stimuli

In our experiment, we used test images with roughness and glossiness to investigate the Shitsukan contrast effect. We selected two types of images from the Kylberg Texture Dataset [9] as roughness stimuli; one is a cloth-like image with fine roughness and the other is a stone-like image with a coarser texture. We created two types of images as glossiness stimuli by using a Mitsuba renderer. One of the glossiness images included a strong highlight and the other a dull luster. The four stimuli are shown in Figure 1.



(a) Roughness **(b) Glossiness**

Figure 1. Experimental stimuli

An image with a different roughness from the two types used for the central stimuli was selected for the background from the Kylberg Texture Dataset. We prepared 27 background images in which the brightness, contrast, and spatial frequency were varied in three steps. From the standard brightness set at level 121, the brightened background was set at 146 and the darkened background at 96 with the same change amount. We identified these three backgrounds, with the three stages of brightness changes, as "bright," "standard," and "dark." Background images with high and low contrast, with an equal change amount from the standard background, were prepared for the texture interaction based on the Michelson Contrast. We referred to these three backgrounds with three stages of texture interaction change as "high-texture-interaction," "standard," and "low-texture-interaction." Further, a two-stage smoothing processing with $\sigma = 1.5$ and $\sigma = 2.25$, was performed using a Gaussian filter for the standard background; we labeled these three backgrounds with three stages of spatial frequency change "high-frequency," "standard," and "low-frequency."

Elimination of disturbance effects

It was necessary to exclude factors other than contrast effects by brightness, texture interaction, and spatial frequency. All images were converted from grayscale to eliminate the influence of simultaneous color contrast effects. As previously explained, nine kinds of backgrounds with different background contrasts and spatial frequencies were prepared for each specific brightness. However, when the perceptual brightness of these backgrounds was different, a brightness contrast effect could have occurred. In order to eliminate this possibility, we asked subjects to adjust the brightness so that the brightness of the nine backgrounds became perceptually equal.

Experimental procedure

The experiment was conducted in a darkroom and used a display device (EIZO ColorEdge CG 221). The viewing distance was 80 cm. The viewing angle of the background stimuli was set to 8 degrees with reference to the experiments of Singer and D'Zmura [12], and observed with both eyes. Subjects were six students (one woman) in their twenties who were studying imaging science.

Experimental stimulus was a combination of background equalized perceptually the brightness beforehand and a central stimulus with roughness or glossiness. Each experimental stimulus was presented to test subjects on the left and right in a random manner. Subjects evaluated difference in roughness and glossiness attributes of the images displayed on the left and right. There were 729 combinations of experiment stimulus presented, 27 each on the left and right. These 729 combinations of stimuli were randomly presented to the left and right as shown in Figure 2. The evaluation method was a two-option forced choice, and test subjects then selected the central stimulus that they felt had a strong attribute of roughness or glossiness from the two stimuli. There was no time limit for image selection.

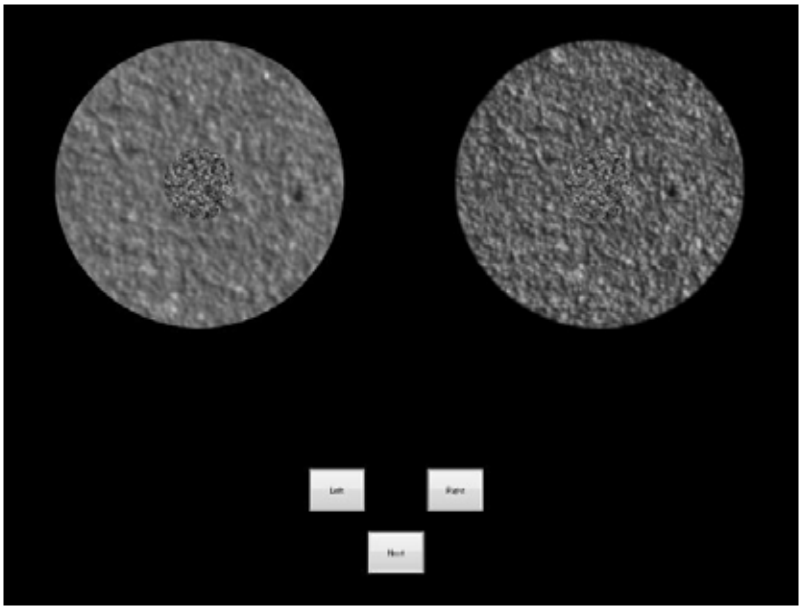


Figure 2. Snapshot of displayed stimuli

RESULTS

We took the correlation of each response and excluded responses as outliers that showed a significant negative correlation with others. Results of test central stimuli with roughness and glossiness are shown in Table 1 and Table 2, respectively. Each column shows the degree of spatial frequency, texture interaction, and brightness of the background stimuli from the upper to the lower layer. Each row and column contains the background stimuli represented on the left and right side of the test stimuli display. Each number at the intersections represents the number of subjects who responded that the center stimuli on the left side was more roughness or glossiness. The red color of intersections indicates that the Shitsukan of the stimuli on the left was felt strongly and the green color indicates the opposite.

Table 1 shows that many answers with high response values for roughness are distributed in the lower left. On the other hand, many answers with low response values for roughness are distributed in the upper right. These results suggest that the central stimuli on the background with lower spatial frequency were perceived as having greater roughness. Table 2 shows that many answers with high response values for glossiness are distributed in the upper right section surrounded by the thick frame. Many answers with low response values of glossiness, however, are distributed in the lower left section surrounded by the thick frame. These findings would appear to indicate that the central stimuli of the background with higher texture interaction was perceived as having greater glossiness.

Table 1: Results of test stimuli with roughness

Roughness second image			low-frequency									standard									high-frequency								
			l-tex			standard			h-tex			l-tex			standard			h-tex			l-tex			standard			h-tex		
			dark	standard	bright	dark	standard	bright	dark	standard	bright	dark	standard	bright	dark	standard	bright	dark	standard	bright	dark	standard	bright	dark	standard	bright	dark	standard	bright
low-frequency	l-tex	dark	3	3	1	3	0	2	2	1	3	3	0	1	1	1	0	0	0	0	0	1	0	1	0	0	0	0	1
		standard	5	4	3	4	3	3	2	1	1	3	3	3	5	0	2	1	1	0	1	1	0	0	1	0	1	0	0
		bright	6	4	4	3	4	4	4	4	4	4	3	2	6	1	1	3	1	0	1	1	0	0	1	0	0	1	0
	standard	dark	3	1	3	2	4	3	1	3	2	4	3	2	4	1	1	0	0	2	0	0	1	1	1	0	1	1	0
		standard	4	3	3	2	3	3	4	3	4	4	1	3	3	1	0	1	2	0	1	1	0	1	1	1	0	0	0
		bright	6	5	3	4	4	3	4	5	5	4	3	3	2	2	2	2	1	3	1	0	1	0	1	0	1	0	1
	h-tex	dark	5	3	3	3	2	3	4	3	1	4	3	3	3	0	2	0	0	1	0	1	1	1	1	1	1	0	0
		standard	5	5	4	3	1	2	3	4	3	3	2	3	5	2	2	2	1	2	1	0	2	1	1	0	0	1	1
		bright	6	5	1	5	4	5	3	3	5	5	5	3	5	2	0	2	2	3	1	2	2	1	1	0	1	0	0
standard	l-tex	dark	5	3	3	5	1	2	4	2	3	3	5	3	3	1	0	0	0	2	0	0	1	0	0	0	1	0	1
		standard	5	4	3	3	4	4	3	5	3	4	3	3	6	0	1	1	2	2	1	0	0	1	1	0	1	0	0
		bright	6	3	5	6	5	5	5	3	5	3	4	4	5	2	1	2	3	0	1	1	1	2	1	1	0	1	0
	standard	dark	4	2	0	4	2	0	2	1	1	2	2	1	3	1	1	2	1	1	0	1	0	1	1	0	1	0	0
		standard	5	5	3	4	5	4	5	5	3	6	5	4	5	4	3	5	3	3	1	1	3	0	0	1	1	0	0
		bright	6	4	4	4	5	5	5	5	5	5	4	4	5	4	4	5	2	2	1	1	3	1	2	1	1	0	1
	h-tex	dark	6	5	5	4	4	4	4	4	3	5	5	4	4	4	4	2	2	3	0	0	3	0	0	2	1	0	0
		standard	6	6	4	5	4	5	6	5	6	5	3	4	5	2	2	2	2	4	2	0	5	1	2	2	0	1	0
		bright	6	5	5	5	6	5	4	6	4	5	5	4	5	2	2	3	3	3	0	2	1	1	1	1	0	0	0
high-frequency	l-tex	dark	6	5	5	5	4	5	6	6	4	6	6	4	5	6	5	5	5	5	4	3	3	5	5	4	3	3	2
		standard	5	5	6	6	5	6	6	5	5	6	6	6	5	4	6	5	6	5	2	5	4	1	1	4	1	2	2
		bright	6	6	6	6	6	6	6	6	6	5	6	5	6	5	5	3	4	5	2	2	3	2	2	4	1	1	2
	standard	dark	6	5	5	4	5	5	5	5	5	5	6	5	5	5	5	6	5	5	5	3	4	2	3	4	3	2	3
		standard	6	6	6	6	5	5	5	5	5	5	5	5	5	6	6	5	5	5	4	4	5	4	2	5	2	2	3
		bright	6	5	5	6	5	6	6	5	6	6	5	6	5	5	5	5	4	6	2	2	3	2	4	4	2	1	0
	h-tex	dark	6	6	6	6	5	5	5	6	6	6	6	5	5	6	5	5	6	6	4	5	4	3	2	4	2	2	2
		standard	6	5	5	6	6	6	6	5	6	5	6	5	5	5	6	6	6	5	5	5	5	4	4	5	3	3	5
		bright	6	6	5	6	6	6	5	6	6	6	5	6	6	5	5	4	6	5	4	5	5	3	5	3	2	1	3

Table 2: Results of test stimuli with glossiness

Glossiness first image			low-frequency									standard									high-frequency								
			l-tex			standard			h-tex			l-tex			standard			h-tex			l-tex			standard			h-tex		
			dark	standard	bright	dark	standard	bright	dark	standard	bright	dark	standard	bright	dark	standard	bright	dark	standard	bright	dark	standard	bright	dark	standard	bright	dark	standard	bright
low-frequency	l-tex	dark	3	3	5	3	5	4	2	4	5	5	4	4	3	3	4	5	5	4	5	4	3	4	5	4	5	4	4
		standard	1	3	4	1	2	2	2	3	4	1	2	5	1	2	4	3	4	5	3	5	4	3	4	5	2	5	4
		bright	1	1	0	2	1	3	2	2	4	0	3	1	1	2	0	1	2	3	4	2	3	2	4	4	1	2	4
	standard	dark	1	3	4	1	3	4	3	5	4	1	4	4	3	3	5	4	4	5	3	3	4	2	4	3	4	4	4
		standard	0	0	4	2	4	4	2	3	5	2	1	4	0	1	4	4	4	5	3	2	3	3	3	4	3	5	4
		bright	1	1	2	1	0	3	2	2	2	0	0	3	0	0	0	2	3	2	0	2	3	2	2	1	2	2	4
	h-tex	dark	0	3	5	3	4	3	2	2	3	1	4	4	0	2	3	1	3	4	4	3	4	2	3	5	4	4	4
		standard	2	1	1	0	2	2	1	1	4	0	1	2	1	2	3	2	2	4	1	3	4	2	2	3	4	3	2
		bright	0	0	2	1	0	2	1	1	1	0	1	1	2	1	2	1	1	2	1	1	3	1	2	3	3	2	5
standard	l-tex	dark	2	3	3	3	3	4	3	4	4	2	3	3	2	4	4	3	4	4	4	5	5	3	5	4	2	4	4
		standard	3	2	3	2	2	3	3	4	3	1	0	3	1	1	3	3	4	4	3	5	5	3	4	4	2	5	4
		bright	1	0	2	2	2	1	2	2	3	2	2	2	0	1	3	3	2	4	1	3	3	3	2	4	4	1	4
	standard	dark	2	5	4	4	5	5	4	3	5	4	3	5	2	3	4	3	4	3	4	5	4	3	5	4	4	4	4
		standard	1	4	4	2	3	4	3	3	4	3	4	3	3	3	3	2	4	4	3	4	4	3	4	3	4	5	3
		bright	1	3	2	1	1	2	1	3	4	1	2	2	2	1	2	2	2	3	2	0	2	4	2	1	4	4	2
	h-tex	dark	0	3	3	1	1	2	2	3	3	1	3	3	1	3	3	2	3	3	1	2	3	3	3	4	3	3	4
		standard	0	1	2	0	0	3	0	5	4	0	1	4	1	1	2	2	1	5	0	3	3	2	1	2	1	1	4
		bright	0	0	2	0	2	2	1	2	3	1	0	2	1	1	0	3	1	4	2	2	2	1	2	3	1	2	4
high-frequency	l-tex	dark	1	3	2	2	3	3	3	4	4	2	4	2	2	3	3	2	5	5	2	3	4	2	4	4	4	5	4
		standard	2	2	0	2	2	3	2	3	3	1	1	2	0	2	1	1	2	5	1	3	3	3	3	3	4	5	4
		bright	2	0	0	1	1	1	2	1	1	1	1	2	1	0	2	1	2	2	2	1	2	2	2	2	2	2	4
	standard	dark	0	0	2	1	2	3	2	4	4	2	4	4	0	2	4	2	4	5	1	3	4	4	3	3	3	4	3
		standard	0	0	2	1	3	2	1	3	4	0	1	4	1	0	1	0	0	3	0	3	2	2	2	3	4	3	5
		bright	1	2	2	2	0	2	1	2	1	2	1	2	1	1	1	0	1	4	0	1	4	0	3	2	2	2	2
	h-tex	dark	1	0	2	1	1	2	1	1	4	2	1	4	0	1	4	1	2	4	2	3	4	1	3	4	4	3	4
		standard	0	0	2	1	2	3	0	2	2	0	0	3	3	1	1	2	3	3	1	0	5	1	2	4	1	5	3
		bright	0	0	3	1	1	2	1	1	3	1	1	1	2	1	1	4	3	1	1	1	1	2	1	1	4	1	1

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CONSIDERATIONS

The correlation (r) between the response values obtained in the experiment and estimated values from our model were 0.617 and 0.804 for the two test stimuli with the roughness attribute. The correlation for the two stimuli with the glossiness attribute was 0.494 and 0.504.

We derived how much the brightness, texture interaction, and spatial frequency of the background contributed to perceptions of roughness and glossiness based on t-values obtained by multiple regression analysis. Figures 3 and 4 represent the ratio of t-values in experiments for roughness and glossiness, respectively. The two pie charts in each figure show the results for the two test images. In each figure, F is spatial frequency, T is the texture interaction, and B represents the brightness contrast effects. Subscript L means left stimulus, and R refers to the right stimulus. The spatial frequencies of the background largely contributed to the roughness perception of the central stimuli in both test images. The contrast effect of spatial frequency influenced the roughness contrast effect by 50% and 70% on the first and second test images. Further, the brightness and texture interaction of the background largely contributed to the glossiness perception of the central stimuli in both test images. The contrast effects of the brightness and texture interaction influenced the glossiness contrast effect by 80% on both images.

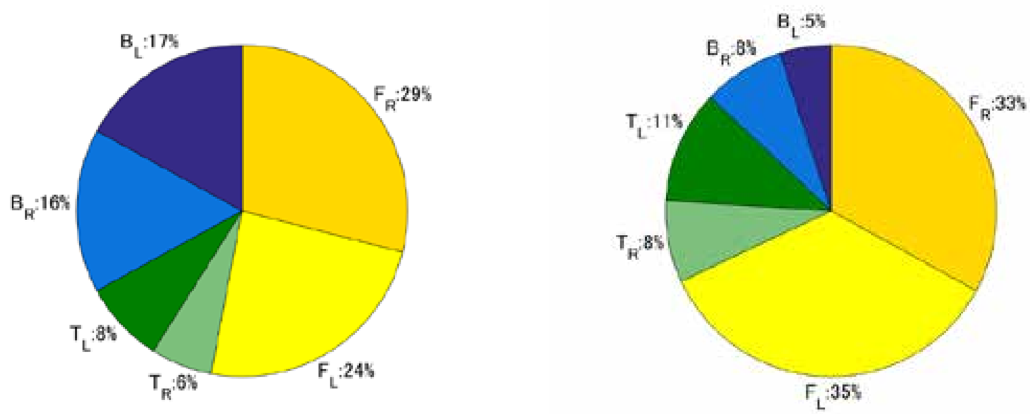

Figure 3. Ratio of the low-level contrast effect contributing to the contrast effect of roughness

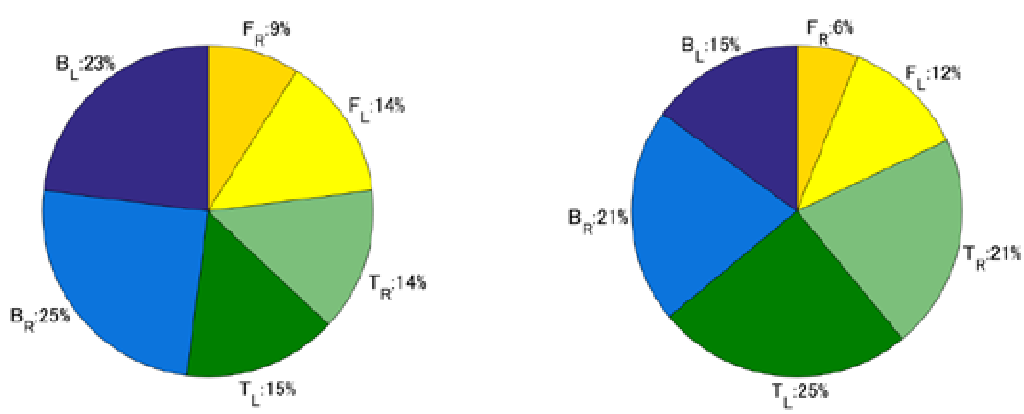

Figure 4. Ratio of the low-level contrast effect contributing to the contrast effect of glossiness

CONCLUSION

This study explored the Shitsukan contrast effect by hypothesizing that the high-level contrast effects, namely roughness and glossiness, could be generated by the combination of low-level contrast effects, such as brightness, texture interaction, and spatial frequency. The background stimuli were constituted of brightness, texture interaction, and spatial frequency, which were varied in three steps for each image. The central stimuli were images that depicted roughness and glossiness. This study investigated whether perception of the central stimuli would change by processing the background stimuli. We found that the contrast effect of spatial frequency can influence the roughness contrast effect by 50% to 70%. In addition, the obtained results showed that the glossiness contrast effect can be influenced by approximately 80%, owing to the contrast effects of the brightness and texture interaction.

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THE CUSTOMERS PERCEPTION EVALUATION FOR PACKAGING DESIGN SELECTION BY USING MULTI-ATTRIBUTE UTILITY THEORY (MAUT) METHOD

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ABSTRACT

The packaging design evaluation is an essential process to decide for development in the next step. However, There are many customer perceptions and varies factors that led to the design selection. This research aims to develop the evaluation method of customer perceptions in packaging design by using the Multi-Attribute Utility Theory (MAUT) methodology. This method combines qualitative criteria and quantitative data for calculating evaluation. In the case study of lemon juice products in the first step is to define the group of visual perception criteria; color, shape texture, image, and text. The second step is to weight score of each criterion and calculate base on the normalized score. The third step compares packaging alternatives and ranks in the group. The final step is to calculate MAUT score and compare between the upper and lower score of each alternative. The Interpretation of the result by selecting the maximum upper score is appropriate packaging selection. The Interpretation of the result by selecting the maximum upper score is appropriate packaging selection. The MAUT method can apply in the evaluation in the design phase and combine qualitative data to quantitative data.

INTRODUCTION

According to the early design stage, packaging designers develop concepts and make several packaging alternatives. Then, they need to brainstorm, discuss and analyze the pros and cons each of proposed packaging prototype options based upon optimizing functional structure and embodiment. The Multi-Attribute Utility Theory (MAUT) which is well known in consumer organizations for engineering parameter evaluations can be applied [1]. In the multi-attribute utility analysis, decision support systems play essential roles, and they have been utilized as an integral part of the effective and efficient analysis because, even in identifying a single-attribute utility function and trade-off analysis between a pair of attributes, it is necessary for a decision maker to use trial and error. Engineers are always making design decisions. Poor decisions could result in loss of money, resources, and time. Therefore, it is crucial that engineers make logical and reasonable decisions. The decision process can, however, prove to be quite complicated, especially when a tradeoff needs to be made, such as between the strength and weight of packaging. The purpose of using the Multi-Attribute Utility Theory in design selection is to create a mathematical model to aid the process. It gives the decision maker the ability to quantify the desirability of specific alternatives [2]. The objective of this research is to develop the evaluation method of customer perceptions in packaging design by using MAUT method.

METHODOLOGY

Utility theory can be used to design scenarios where uncertainty and risk are considered [2]. The result of using this method is a function which represents the designer's preferences, given a specific set of design attributes.

1. Design Criteria

The design criteria or design attributes come from a wide variety of sources, such as surveys, focus groups, interviews, trade shows, complaints, and even expert opinions. Obama and Buddeejeen [3] describe the design criteria of visual perception. The essential factors of customer needs are to include as Numbers, Letters, Illustration and Picture, Symbol, Ornament, Material, Shape, and Color. They are clues when customers understand the contents or features of products or judge their values regardless of language and culture differences.

2. Design Evaluation

MAUT method combines qualitative criteria and quantitative data for calculating evaluation. In the first step is to define the group of criteria and attribute. The second step is to weight score of each criterion and calculate base on the normalized score. The third step compares packaging alternatives and ranks in the group. The final step is to calculate MAUT score and compare between the upper and lower score of each alternative. The Interpretation of the result by selecting the maximum upper score is appropriate packaging selection. Where u_i is unify dimensional utility function of the i attribute, λ_i is the weights of importance, k is the scaling alternative, $\underline{B}^k$ is a lower bound attribute, $\bar{B}^k$ is an upper bound attribute as the Eq. (1) - (6).

$$u(x) = \lambda_1 u_1(x_1) + \ldots + \lambda_n u_n(x_n) = \sum_{i=1}^{n} \lambda_i u_i(x_i) \quad (1)$$

$$u(x^*) = 1, \quad u(x^0) = 0 \quad (2)$$

$$u_i(x_i^*) = 1, \quad u_i(x_i^0) = 0 \quad (3)$$

$$\sum_{i=1}^{n} \lambda_i = 1, \quad \lambda_i \geq 0 \quad (4)$$

$$\underline{u}_i(x_i^k) = 1 \text{ if } x_i^k = x_i^* \; ; \; \underline{u}_i(x_i^k) = 0 \text{ ; other cases}$$

$$\bar{u}_1(x_i^k) = 0 \text{ if } x_i^k = x_i^0 \; ; \; \bar{u}_1(x_i^k) = 1 \text{ ; other cases}$$

$$\underline{B}^k = \sum_{i=1}^{n} \lambda_i \underline{u}_i(x_i^k) \quad (5)$$

$$\bar{B}^k = \sum_{i=1}^{n} \lambda_i \bar{u}_1(x_i^k) \quad (6)$$

RESULT

The proposed methodology is to evaluate packaging alternatives in design selection for customer perception to buy. Especially, in a case study of lemon juice product that also requires good protective packaging to keep its quality during the manufacturing process and transportation. There has a significant role in the market which one is easy to understand for customer perception to buy. Figure 1 is shown the sample of lemon juice packaging in the market. The research has observed in-depth behavior and interviews with elderly nine persons (70-85-year-olds). The case study of the lemon juice product showed that the central functional usability design was not complicated. The shape of packaging affects to understand the opening method rather than text characters. The experience of using older people will be the first choice of packaging model when first activated [4].

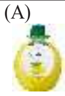
Figure 1. A sample of lemon juice products [4]

From Figure 1, The customer more than 60 percent (six persons of nine-person) selected Alternative (A), (B), and (C). The important factors of customer needs are to include Color, Portion size, Structure and texture, Image, and text. Then, The weighting value (W_i) is calculated as Color (0.367), Portion size (0.250), Structure and texture (0.137), Image (0.190), and Text (0.056). The single-attribute utility function and trade-off analysis between a pair of attributes are illustrated in Table 1.

Table 1: The main criteria and attribute of lemon juice products

Criteria	Attribute	Alternatives of Packaging (A) 	(B) 	(C) 
Color	Likert scale (score)	3.4	4.32	3.85
Portion Size	Diameter x Height (mm.)	Ø60x75	Ø55x220	Ø47x175
Image	Coginitve Time (s.)	6	4	7
Structure &Texture	Touching Area (%)	95	0	0
Text	Reading Time (s.)	2	6	3

Table 2: Multi-Attribute Utility Theory (MAUT) calculation

Criteria	Attribute	Wi	Alternatives of Packaging (A) 		(B) 		(C) 	
			$\underline{U}_i$	$\overline{U}_i$	$\underline{U}_i$	$\overline{U}_i$	$\underline{U}_i$	$\overline{U}_i$
Color	Likert scale (score)	0.367	0	0	1	1	0	1
Portion Size	Diameter x Height (mm.)	0.250	0	0	0	1	1	1
Image	Coginitve Time (s.)	0.190	0	1	1	1	0	0
Structure &Texture	Touching Area (%)	0.137	1	1	0	0	0	0
Text	Reading Time (s.)	0.056	1	1	0	0	0	1
	Total	1.000	$\underline{B}_a$	$\overline{B}_a$	$\underline{B}_b$	$\overline{B}_b$	$\underline{B}_c$	$\overline{B}_c$
	Functional utility		**0.193**	**0.383**	**0.557**	**0.807**	**0.367**	**0.673**

From Table 2, the Lower bound value of Alternative (B) is higher than the upper bound value of Alternative (A) [$\underline{B_b}$= 0.557 > $\overline{B_a}$= 0.383], then Alternative (A) is rejected of boundary comparison.

Thus, the most importance weighting value (W_i) is calculated in the adjusted boundary. From Table 2 is shown that W_1 = 0.367 as the Image criteria calculation;

$\underline{U}_i(x_i^k) = \underline{U}_i(x_i^b) = U_i$ (0.367) Then, adjusted boundary $\underline{U_3}(x_3^k) = U_i(x_i^k) = (\overline{U_3})(x_3^k)$ = 0.367. The adjusted function value is illustrated in Table 3.

Table 3: Recalculating Multi-Attribute Utility Theory by adjusted boundary

Criteria	Attribute	Wi	Alternatives of Packaging (B) 		Alternatives of Packaging (C) 	
			$\underline{U}_i$	$\overline{U}_i$	$\underline{U}_i$	$\overline{U}_i$
Color	Likert scale (score)	0.367	1	1	0	1
Portion Size	Diameter x Height (mm.)	0.250	0	1	1	1
Image	Coginitve Time (s.)	0.190	1	1	0.367	0.367
Structure &Texture	Touching Area (%)	0.137	0	0	0.367	0.367
Text	Reading Time (s.)	0.056	0	0	0	1
	Total	1.000	$\underline{B}_b$	$\overline{B}_b$	$\underline{B}_c$	$\overline{B}_c$
	Functional utility		**0.557**	**0.807**	**0.370**	**0.793**

From Table 3 is shown that the lower value of Alternative (*B*) is higher than the upper value of Alternative (*C*) [$\underline{B_b}$= 0.557 >$\underline{B_c}$= 0.305] and the upper value of Alternative (*B*) is higher than upper value of Alternative (*B*) [$\overline{B_b}$ = 0.807 > $\overline{B_c}$= 0.728]. The conclusion is to select Alternative (*B*) is appropriated packaging the for lemon juice product.

DISCUSSION

This research aims to develop the evaluation method of customer perceptions in packaging design by using the Multi-Attribute Utility Theory (MAUT) method. The packaging design evaluation is an essential process to decide for development in the next step. The MAUT method can apply in the evaluation in the design phase and combine qualitative data to quantitative data. This research does not cover all the factors that use in designing the product, such as the perception of usability of packaging. Future research will extend the scope of customer perception evaluation in term of usage recognition.

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INVESTIGATE PERCEPTUAL QUALITIES OF SURFACE APPEARANCE UNDER CEILING LIGHT USING REAL MATERIALS AND DISPLAYED IMAGES

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Keywords: material appearance, material perception, D65, real object, reproduced image

ABSTRACT

The perceptual qualities of appearances on object surfaces are important characteristics with which to judge information such as the material category and function of objects in our daily lives. In this study, we conduct psychophysical experiments to investigate the influence of the perceptual qualities of surface appearance under ceiling light (6500 K) to simulate a general lighting environment. The real materials and the displayed images were used as experimental stimuli to investigate the difference in the perceptual qualities of surface appearance. Compared to the results in our previous study obtained under local lighting, it is found that when observed under ceiling lighting, the perceptual qualities of the real materials and its displayed images vary more.

INTRODUCTION

Material classes such as metal, plastic, and fabric can be identified through mere visual information, and their perceptual qualities of surface appearance such as glossiness, roughness, and color can be judged directly without touching the object [1], [2]. For example, Fleming et al. [2] investigated the relevance of ten material categories and their perceptual properties. Based on the results, it was suggested that humans have similar perceptual qualities of surface appearance for the same category of material. However, if these objects are reproduced colorimetrically on display, identical perceptual qualities to the real object cannot always be achieved. Owing to the recent popularization of mobile devices such as smartphones, reproduced images are often viewed on digital displays. For example, in the case of online shopping, it is important that the perceptual qualities of the displayed images accurately represent the actual perceptual qualities of the product.

Tanaka & Horiuchi investigated the differences in the perceptual qualities of real objects and their reproduced images in accordance with the local standard illuminant D65, in a viewing booth set in a dark room for conducting psychophysical experiments [3]. Consequently, it was confirmed that the glossiness of metals and the transparency of glasses can decrease in reproduced images on display devices. Since objects are seldom observed under the local illuminant in a darkroom, it is necessary to investigate the perceptual qualities in a general lighting environment. Studies have been conducted on the perceptual qualities of surface appearance in general lighting environments [1], [4], [5]. These studies addressed computer graphics (CG) stimuli which were generated by considering the lighting environment in the real world. However, the appearance of CG stimuli is not completely the same as the appearance of a real-world object owing to depending on the modeling method which is simply mimicking light behavior. Therefore, it is important to use the real material rather than CG images in the investigation of perceptual appearance of the object surface.

In this study, we investigate the influence of the ceiling light as a general lighting condition on the perceptual qualities of surface appearance using real materials and displayed images by further developing our previous study [3].

POSTER SESSION

EXPERIMENTS

Illumination Condition

We conducted psychophysical experiments in a different lighting environment to our previous study [3] which used only a local light source in a viewing booth. We prepared a new global lighting condition of illumination by four primary-color RGBW LEDs attached to the ceiling [6]. The color temperature was adjusted to 6500 K, and the illuminance was approximately 550 lx. We confirmed by an illuminometer (CL-500, Konica Minolta) that this lighting condition was spatially uniform in the experimental room. The viewing booth (Macbeth Judge II) with illuminant D65 was also prepared for the local light source. The experiments for real stimuli were conducted in an environment where both the global and local light sources were illuminated simultaneously. The experiments for the displayed images were conducted in a dark room.

Experimental Stimuli

We used the same experimental stimuli composed of 34 exemplars of real materials as our previous study. [3]. Figure 1 shows the experimental stimuli of the real materials. The size of the experimental stimuli was 50 × 50 mm, and there were ten material categories (stone, paper, glass, wood, metal, rubber, ceramic, fabric, leather, and plastic). In addition, we generated the displayed images as the experiment stimuli by taking pictures of the real materials in the viewing booth using a digital camera (EOS-5D Mark II, Canon). The displayed images were displayed on an Apple MacBook Pro with Retina display. The color difference between the real materials and the displayed images was ΔE^{*}=1.87.

(a) List of real materials

(b) Example of the experimental stimulus of the displayed image (Rustenburg, Stone)

Figure 1. Experimental stimuli

Evaluation Method

The experimental environments are shown in Fig. 2. The observers start the evaluations after adapting to the lighting environment. The viewing distance from the surface of the experimental stimuli to the observer's eye was 400 mm. The head of the observer was set on the chin rest to maintain the position of the head and eyes. For all experimental stimuli, the observers assess the perceptual appearance of the individual stimuli with the same experimental method. The evaluations

POSTER SESSION

were conducted for eight perceptual qualities (glossiness, transparency, colorfulness, roughness, hardness, coldness, naturalness, and prettiness) based on Fleming et al. [2]. We used a six-point scale in which the lowest and highest evaluation scores were one and six points, respectively. Using the glossiness evaluation as an example, the meanings of each point are as follows in terms of difficulty of perceiving the glossiness of the surface appearance: one (difficult); two (difficult to slightly difficult); three (slightly difficult); four (moderately difficult); five (very difficult); and six (extremely difficult). The observers conducted assessments using one eye to prevent the influence of the binocular parallax.

(a) Real material **(b) Displayed image (the ceiling lights were off during the experiments)**

Figure 2. Experimental environments

RESULTS

Five observers with normal color vision participated in this psychophysical experiment. We confirmed that these observers had the repeatability between plural evaluations for perceptual qualities of surface appearance in the preliminary experiment. The experimental results were tested to exclude the outliers of the observers' perceptual qualities of surface appearance evaluation values using t-tests and Smirnov-Grubbs tests.

In this paper, we describe the experimental result by focusing on the significant difference at the $p < 0.05$ level. Figure 3 shows the average rating values of perceptual qualities to compare with the results for real materials and one for the displayed images. The surrounding squares indicate that the pair of results of the real materials and the displayed images has a significant difference ($p < .05$). In the case of the lighting conditions with only local illumination in the previous study, only three material categories exhibited significant differences [3]. However, in the case of lighting condition under local and global illumination, significant differences were confirmed in the results in six material categories.

The six categories (stone, paper, metal, fabric, leather, and plastic) have some significant differences. Stimuli in these five categories indicate that the evaluation scores of the real materials were higher than those of the displayed images. Despite the equivalent luminance signal physically entering the eyes during observation of the real materials or displayed images, the ceiling light affected the perceptual qualities of the surface appearance. This result suggests that the evaluation of the perceptual qualities of the real materials is more affected by the ceiling light than the displayed images.

In addition, we consider the difference between our results in simultaneous lighting conditions and local lighting conditions [3] to indicate the influence of the ceiling light. We focus on the evaluation results for “naturalness” which has more significant differences than the other perceptual quality evaluations. Figure 4 shows the average rating values of “naturalness” for each lighting condition.

Regardless of the experimental stimuli such as the real materials and the displayed images, “naturalness” has some significant differences in illuminant conditions. According to the number of the significant difference, the ceiling light entirely affects the “naturalness” evaluation of the surface appearance.

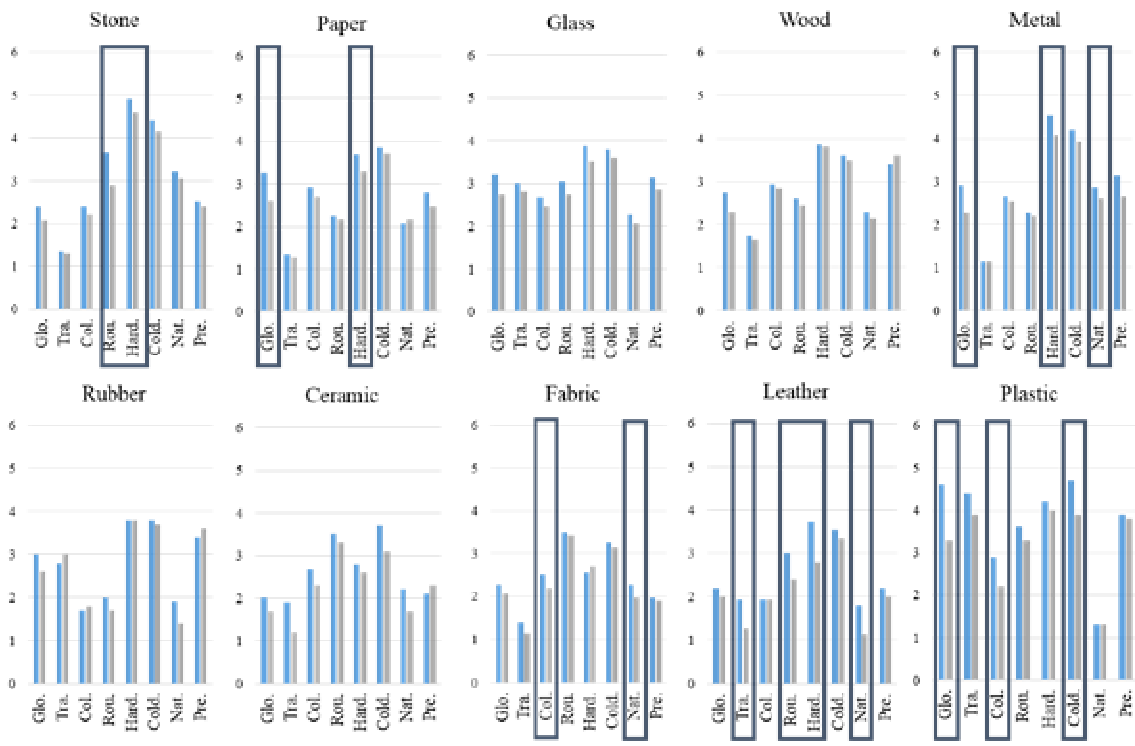
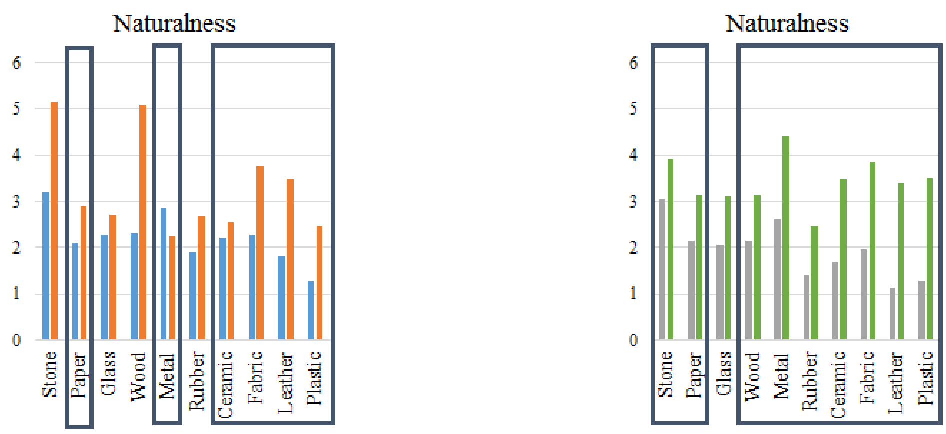


Figure 3. Evaluation scores for the real materials (blue) and displayed images (gray)



(a) For real materials. Simultaneous lighting (blue); local lighting [3] (gray)

(b) For displayed images. Simultaneous lighting (blue); local lighting [3] (gray)

Figure 4. Evaluation scores for “naturalness”

CONCLUSIONS

In this study, we investigated the influence of a ceiling light on the evaluations of perceptual qualities of surface appearance by conducting psychophysical experiments. The experimental stimuli were 34 exemplars of real materials consisting of ten material categories and their displayed images. The observers evaluated eight perceptual qualities on a six-point scale. The results show that, by adding ceiling light to a local light source, the evaluation scores of the real materials were higher than those of the displayed images. This result suggests that the ceiling light affected the material perception of real materials. Comparison of the evaluation results under different lighting conditions of simultaneous and local lighting shows that the "naturalness" evaluation was significantly affected.

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Brightness Property Adjustment of Handicraft Paper of Natural Latex

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Keywords: Natural Latex, Handicraft Paper, Optical Properties, Brightness

ABSTRACT

This research aims to adjust the brightness quality of the handcrafted paper of latex. The research methodology was to prepare the pulp of the cultivated banana with the 12 percent intensity of Sodium Hydroxide with the 4 percent intensity of Sodium Sulphite. Then, the recycled paper pulp was prepared by sinking in the water for 24 hours. The pulp of both kinds of paper were stirred with the stirrer for 15 minutes. The ratio of both papers was in 3 levels: 80:20, 50:50 and 20:80 which were mixed with 3 levels of the latex 50, 60 and 70 percent respectively. When tested the optic of paper, it was found that the handcrafted paper with high banana leaf ratio led to low brightness. In the contrast, when the ratio quantity of banana leaf was high, the paper brightness was high. It was because after handcrafted pulp was in the boiling process, the sheet molding turned to be yellow-brown. Also, it dealt with low whiteness and the latex slightly increased the brightness of already-bright paper.

INTRODUCTION

Paper tends to be increasingly used because of the economy and industrial growth of food export. Moreover, the paper usage for packaging and environmental campaign of recycling and reusing since the paper is an only kind of package that can be reproduced by reforesting. Also, it can be easily printed and beautifully decorated or coated or attached with other materials as well as easily designed and printed the graphics. Besides that, it can save the cost and it is very convenient to transport from producers to consumers by folding. The paper can be stated that it plays a significant role for the economic and social development of the country.

The raw materials of the paper are cellulose which is fiber mostly from plants, particularly trees in a kind of soft wood such as Eucalyptus and others; Bamboo, Bagasse, Cotton, Sensitive Plant, Rice Straw. Every types of plants with fiber can be made as paper. However, in the industry, only some kinds of suitable fiber can be used. Currently, the tree usage in the paper industry is one of the reasons of deforestation. The fiber usage needed to be carefully used because of a lack of raw materials. The raw materials from other industries or agricultures including reused paper were brought to recycle for eco-friendly and worthy as possible.

Banana is a kind of annual crops which can be planted in any weather condition in Thailand and all its parts can be used; for example, its leaves for wrapping Thai ancient snack and foods, its fruit for freshly eat and processed to be snacks, its trunk for cooking Thai soup or chopping into small pieces as supplementary vitamin for pig and cows. The handcrafted paper was then originated by using parts of Cavendish Banana to produce paper.

Latex is white-to-off-white color and concentrated liquid staying in a tube in the part of rubber tree bark. Bringing latex out of rubber trees needs to use a knife to scratch the tree to cut off the latex tube in the latex. It is composed of two parts which are dried rubber and non-rubber. Dried rubber is the quantity of rubber which is in the latex. Normally, in the latex there is dried rubber for approximately 25-45 percent. The dried rubber is useful for human and turns to be important for everyday lives. The latex carries the 0.98 intensity which has 6.8 ph. In the laboratory, different sizes of particles hang in the liquid which those particles have minus electric charge and push each other. That makes those particles float and stay as the latex until other factors disturb to make the latex unstable and clotted.

This research would develop the brightness of handcrafted paper together with the recycled pulp by using the latex to fulfill the brightness of paper.

EQUIPMENT AND EXPERIMENT METHOD

1. Research Materials

Sodium hydroxide (NaOH) (Sigma–Aldrich, USA) was used to be the boiled substance to melt Lignin in the pulp. Sodium Sulphite Na_2SO_3 (Sigma–Aldrich, USA) was used to be the boiled substance to melt Lignin in the dried pulp of the leaf sheaf of banana tree with the size of 4-5 centimeters to prepare to be handcrafted paper. Also, proofreading waste paper weighted 50g/m2 without printing process was prepared to be recycled pulp and natural latex with high ammonia.

2. Pulp Preparation

2.1 Handcrafted pulp preparation

The leaf sheaf of banana tree with 4-5 centimeters was weighted and boiled to melt Lignin with 12-percent intensity of Sodium Hydroxide (NaOH). Sodium sulfate (Na_2SO_3) concentration of 4 percent of dried pulp. Boil the pulp for 90 minutes. After that, it was washed and the stirrer with the speed is around 700 rpm for 2 minutes. Make smash the pulp for 1 hr.

2.2 Recycled pulp preparation

The proofreading paper was cut into small pieces of approximately 2-3 centimeters and sunk in the water for 24 hours to soften the pulp. After that, it was stirred with the electric stirrer at the speed of 700 rpm for 1 minute. Then, it was dehydrated and kept under low temperature to mold as paper sheet.

3. Latex Preparation

The latex was prepared in a clean container and stirred with a spoon for 30 minutes to make ammonia evaporate from the latex.

4. Sample Paper Preparation

4.1 Mixing the handcrafted pulp with recycled pulp

The handcrafted pulp and recycled pulp were brought to prepare weighting in the specified ratio. Then, they were put in the 500-milliliter water-filled beaker and stirred in the stirrer with the speed of 300 rpm to let the pulp dispersed and mixed for 15 minutes. The latex was blended in the pulp and slowly stirred. Then, it was poured on the strainer with the holes of 80 mesh. Later, the pulp was equally spread out for approximately 48 hours and the sheet was pressed with the heat at the temperature of 50 degrees.

The sample ratios of handcrafted paper to 3 proofreading pulp were 80:20, 50:50 and 20:80, and the intensity changes of latex were 50, 60, and 70 percent respectively.

THE QUALITY TEST OF SAMPLE PAPER

1. Testing color values of sample paper

The sample paper was cut in the size of 10*10 centimeters for 5 pieces and tested color values in the format of CIE L*a*b* with the Spectrodensitometer. There were 5 tested points backed up with white paper averaged and recorded.

2. Testing color different values

The paper was tested to find the color difference from the equation of

$$\Delta E = ((L^*_1 - L^*_2)^2 + (a^*_1 - a^*_2)^2 + (b^*_1 - b^*_2)^2)^{1/2} \quad (1)$$

RESULTS

L* value represented the whiteness of sample paper with the high L* value displaying the high brightness. Conversely, if the paper had low L* value, the paper would have the low brightness. a* and b* values illustrated redness and yellowness which a value is plus and it showed redness. But, if a value was minus, it would show the greenness while b value was plus, it would show yellowness and minus b value showed blueness.

The experimental result came from mixing the handcrafted pulp with recycle pulp in the ratio of 80:20 by weight. The colors of sample paper were dark brown in the reddish yellow tone since the 50:50 mixing ratio by weighting of handcrafted pulp in high quantity which the pulp was boiled in the soda process without bleaching. The sample paper was dark brown in the reddish-yellow tone which was lighter than the previous one and its ratio of 20:80 by weight. The sample paper was light brown in the yellow tone because the sample paper contained the recycled paper in the high amount which the recycled paper used in the experiment was white.

For the brightness, it was found that the sample paper with the ratio of pulp of 80:20 by weight, when mixing with latex of 50, 60 and 70 percent, would have the brightness value changed slightly because the handcrafted pulp was in the high quantity resulted in the concealed whiteness of the rubber in the pulp. The sample paper with the ratio of 50:50 by weight was mixed with 50, 60 and 70 percent of latex respectively. The paper would have brightness in average higher than the first type of the paper as the paper has the high ratio of recycled paper. Also, the increasing latex quantity blended in the paper has not resulted in high brightness of the paper. The sample paper of the pulp ratio of 20:80 by weight was processed by mixing 50, 60 and 70 percent of latex respectively. The paper would have the highest brightness since the mixing ratio of the recycled pulp was grown and increasing the latex led to high brightness.

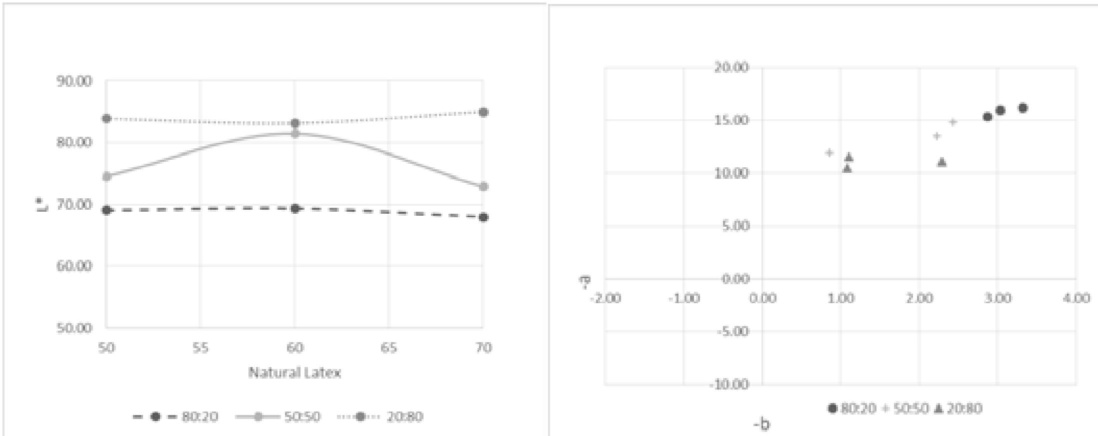

Figure 1. whiteness and Color of sample paper

SUMMARY

The sample paper would have the increasing brightness resulted from the ratio of increasing recycled paper and the amount of latex with different intensity level leading to the brightness of the already - bright paper.

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OPTICAL ANALYSIS OF RAINBOW COLOR MIXING CUBE

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Keywords: color science, subtractive color mixing, color cube, rainbow color, learning support

ABSTRACT

The principle of subtractive color mixing is more difficult to understand than that of additive color mixing. Therefore, we developed teaching material for the purpose of learning subtractive color mixing visually [1]. Our teaching devices consist of two types of transparent cubes with three colored surfaces. The core-type "rainbow mixed color cube" was evaluated as beautiful. However, the mechanism by which such resulting color mixtures became aesthetically pleasing has hitherto not been elucidated. In this report, we measured the "rainbow mixed color cube" with a two-dimensional color luminance meter. Furthermore, we used optical simulations of transmission and reflection to analyze the mechanism of light processes within the rainbow color-mixing cube. We found that the indicated color is different in various parts of the cube color regions, and strongly depends on the direction of incident light.

INTRODUCTION

Because it has both a beautiful appearance and puzzle features reminiscent of contemporary art, the building blocks of Cubicus (Figure 1) are attractive as teaching materials for visual learning. Therefore, while incorporating artistic puzzle elements, we want to teach color mixing visually by developing new teaching material. The purpose of the color-mixing cube is to provide teaching material that will make subjects experience the fun and beauty of color while learning about subtractive color mixing used for printing or photo reproduction. We prepared two types of transparent cubes with three colored surfaces as shown in Figure 2. The core-type "rainbow mixed color cube", shown in Figure 2(b), was evaluated as beautiful due to its colorful tone gradation. However the mechanism by which the aesthetically pleasing color mixture was produced was hereto not elucidated. Therefore, we set out to analyze the mechanism of the rainbow color-mixing cube by experiment and simulation.

Figure 1. Cubicus of Naef [2]

Figure 2. Two types of color mixing cube. (a) Box type and (b) Core type (rainbow mixed color cube)

EXPERIMENTS

Differences in the optical processes of color-mixing cubes

Two types of color-mixing cubes with three colored surfaces (cyan (C), magenta (M), and yellow (Y)) were prepared as shown in Figure 2. One is a box-type empty cube and the other one is a core-type acrylic-filled cube. The optical difference between these two cubes is illustrated in Figure 3. The box-type cube did not produce any reflections within the cube, while the core-type cube had one total reflection and two refractions.

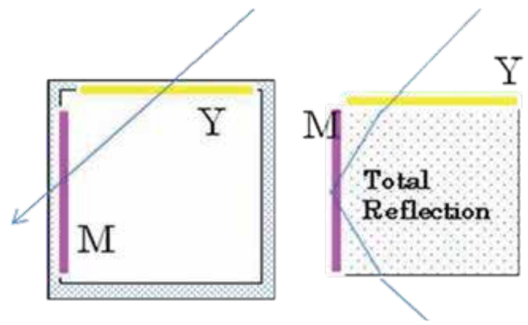


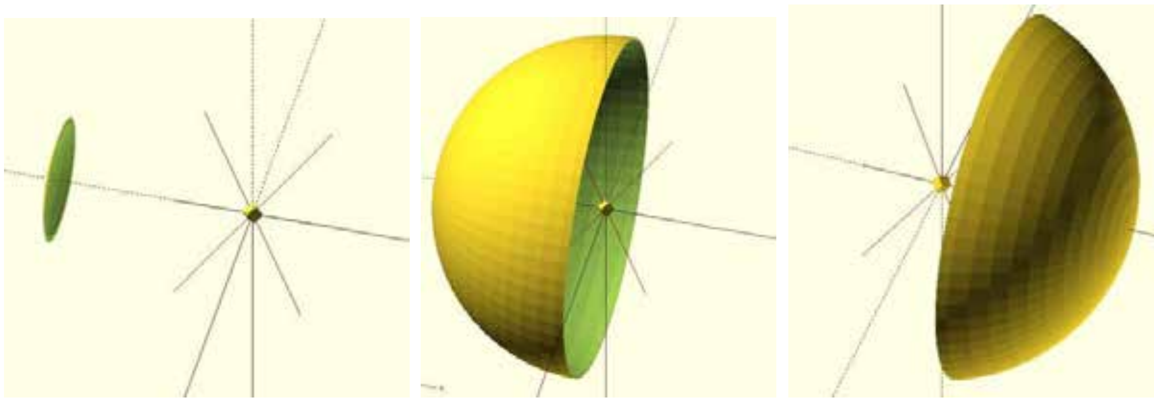
Figure 3. Optical structure and lighting-path of (a)Box-type and (b) Core-type color -mixing cube.

Colorimetric measurement

In the first analysis, xy CIE (Commission Internationale de L'Eclairage) chromaticity coordinates of the rainbow color cube were measured. A Macbeth standard light source (i.e., a fluorescent lamp used for color evaluation) was used for illumination, and an image was captured from the non-colored side with white felt as the background. A colorimetric image of a rainbow colored mixed color cube was captured and measured with a two-dimensional color luminance meter (CA-2000, Konica Minolta).

Optical simulation

Subsequently, we analyzed the mechanism of light processes in the rainbow color-mixing cube using optical simulation with transmission and reflection. The optical simulation was performed by physics-based simulation software for light and human vision (SPEOS, OPTS Co. LTD). In order to obtain the data necessary for this simulation, the colorimetric spectral characteristics of each surface C, M, and Y, were measured with a spectroscopic gonio-photometer (GCMS-4, Murakami Color Labs.). The rainbow color gradation of digital still camera images and optical simulation results were compared using three different angular distributions for lighting of the cube as shown in Figure 4.



(a) Back lighting (0–10°) (b) Middle lighting (0–90°) (c) Front lighting (120–180°)

Figure 4. Angular distribution for lighting of the cube

RESULTS AND CONCLUSION

Colorimetric analysis

Figure 5 shows a photograph of the rainbow color-mixing cube. The cube illustrates nine parts of different colors within the cube color regions, depicted by alphabetic color codes. These colors in Figure 5 were evaluated based on their xy CIE chromaticity coordinates and plotted to corresponding regions as shown in Figure 6. We found that R1 and R2, G1 and G2, B1 and B2 are not the same hue, and that those colors, as well as C, M and Y color coordinates form a color-circle suggestive of the rainbow sequence.

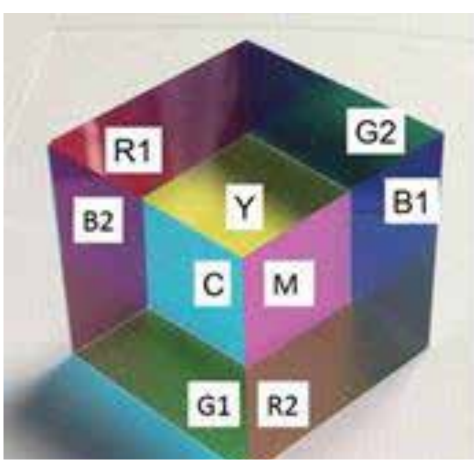


Figure 5. Photograph of the rainbow color-mixing cube. The alphabetic color codes represent different color regions.

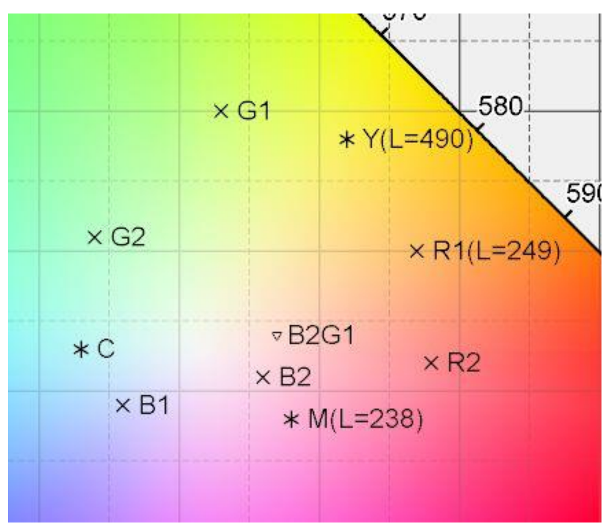


Figure 6. xy CIE chromaticity coordinates corresponding to each color region in Figure 5.

In order to investigate the gradation of color in color-mixing of the RGB area in the rainbow color cube, the RGB color profile was plotted in Figure 7. In this area, only the green color profile changed gradually. Accordingly, in the red and blue color-mixing areas, only red or blue profiles changed, respectively.

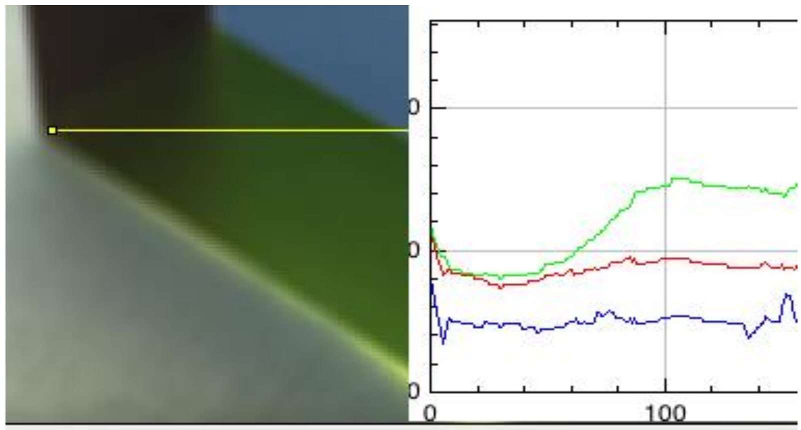


Figure 7. The RGB color profile (right figure) of the yellow line (left figure) in Figure 5 (dotted square area).

Optical simulation and lighting-path analysis

We analyzed the mechanism of light processes within the rainbow color-mixing cube, from the standpoint of transmission and reflection as shown in Figure 2 (b) and Figure 3 (b). By using calculations for geometrical light conduct and the color-mixing principle, we obtained predictive simulation results for the rainbow color-mixing cube. Primarily, in order to investigate the basic light source angular distribution dependency, we proceeded with the basic simulation of a from-back-to-front directional light as shown in Figure 8. It appears that the center cyan, magenta and yellow colors are produced by backward lighting(**0–60°**) while the color-mixing areas of red, green and blue were produced by lighting from both directions(**70–180°**).

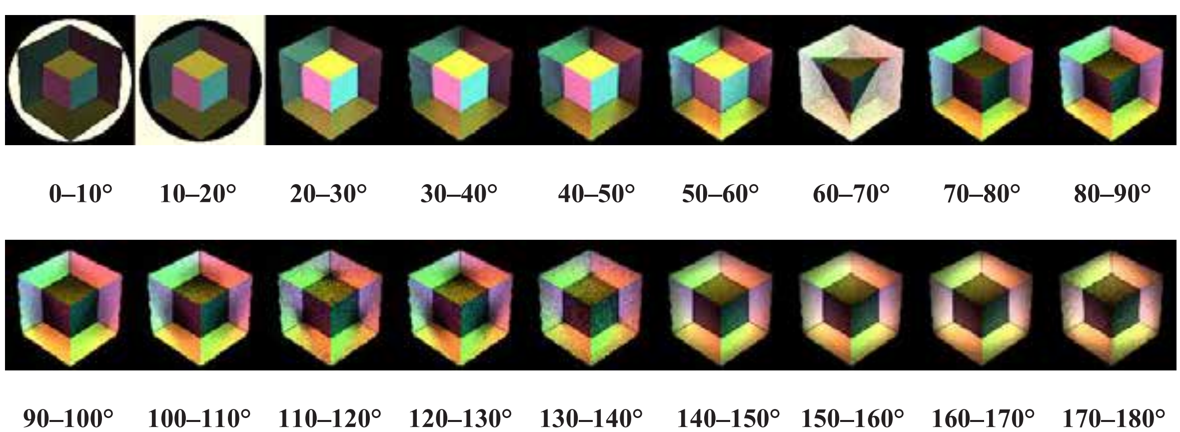
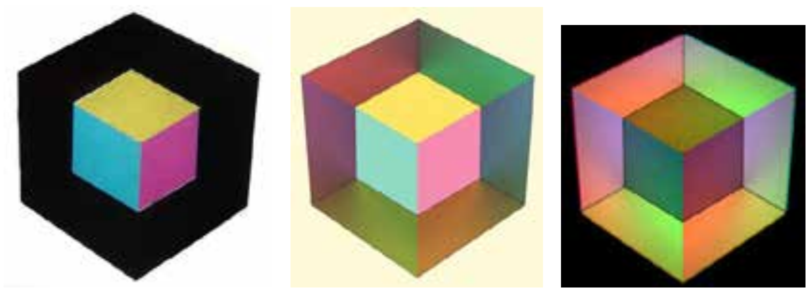


Figure 8. Basic optical simulation results for light source angular distribution

For the three kinds of different light source angular distributions depicted in Figure 4(a), 4(b) and 4(c), color-mixing images of the rainbow color cube were simulated and are shown in Figure 9(a), 9(b) and 9(c), respectively. The actual digital camera images with practically identical lighting angular distribution angles, are shown in Figure 10 (a–c). Although the hue and chroma of the captured color images are not entirely similar, the simulated images are nearly equal to the capture images for the different lighting distributions with respect to color and light balance. Thus, by using colorimetric analysis and optical simulation, the iridescent mixed simulation cube is almost matched with the actual color cube.



(a) Back lighting (b) Middle lighting (c) Front lighting

Figure 9. Optical simulation cube images by different lighting angle

(a) Back lighting (b) Middle lighting (c) Front lighting

Figure 10. Actual cube images by different lighting angle

ACKNOWLEDGEMENT

I wish to acknowledge valuable discussions and thank Dr. Noboru Ohta.

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OPTIMAL COLOR TEMPERATURE OF BAKERY PHOTOGRAPHY FOR ADVERTISING

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Keywords: Bakery Photography, Food Photography, Color Temperature, Advertising

ABSTRACT

This research aimed to study the optimal color temperature in the production of cake photography for advertising by using 8 light-bulb KINO fluorescent. The color temperature used in the experiment was in the range of 3000-11100 Kelvin. In the photographing process, the lighting was controlled to not directly touch the bakery. The light was from the back or slightly back of the bakery and the Reflex was used to make the light soft. The aperture was set at F8. The 30 subjects who have normal vision evaluated the beauty and the attractiveness of bakery photos using the Semantic Differential Scale 7 Step. The results showed that the color temperature that creates the beauty and attractiveness of the bakery photos ranges from 3700 to 4200 Kelvin which is slightly yellowish white.

INTRODUCTION

Nowadays it is very popular to go to a bakery or coffee shop to relax, chat with friends or use it as a workplace. The opening of the full bakery service is the answer to today's lifestyle. Therefore the bakery shop has been continuously opening.

Since 2016, the bakery industry is likely to continue to grow. The main positive factors affecting the bakery industry are the behavior of consumers who need more ready-to-eat food, look for a healthy alternative as well as the modern trend of Social Network that will stimulate the need to taste the new bakeries as seen from the social media.

The advertising image is one of the important components used to inform the target audience about the details of the product. Its advantage is that the target audience can understand the message in a short period of time. The advertisement are designed to be outstanding. The product was set to be beautiful and colorful in order to create a positive image and to be eye-catching. Finally, the target audience will be interested in the product. In photography, the beauty of the photo is a very important factor because it results in attracting the attention of the target audience to be interested in the product.

One important factor for light setting is the color temperature. If the color temperature is not suitable, it can reduce the beauty of the product. Then this experiment was aimed at studying the optimal color temperature for the production of cake photos for advertising by photographing the bakery at a color temperature of 3000-11100 Kelvin. Then 30 subjects who have normal vision assessed the beauty and attractiveness of cake photos.

METHOD

During the photographing process, the light was set to not directly touch the bakery by using the light from the back or slight back of the bakery. The Reflex was used to make the light soft as shown in Figure 1. The light source was from 8 light-bulb KINO fluorescent. The color temperature was the combination of Cool White and Warm White with the color gel. The color temperature was set for 14 values in the range from 3000-11100 Kelvin checked by the Konica Minolta CL-200A.The aperture used for photography was set at F8 for all photos. The sample photos using all 14 color temperature values were shown in Figure 2.

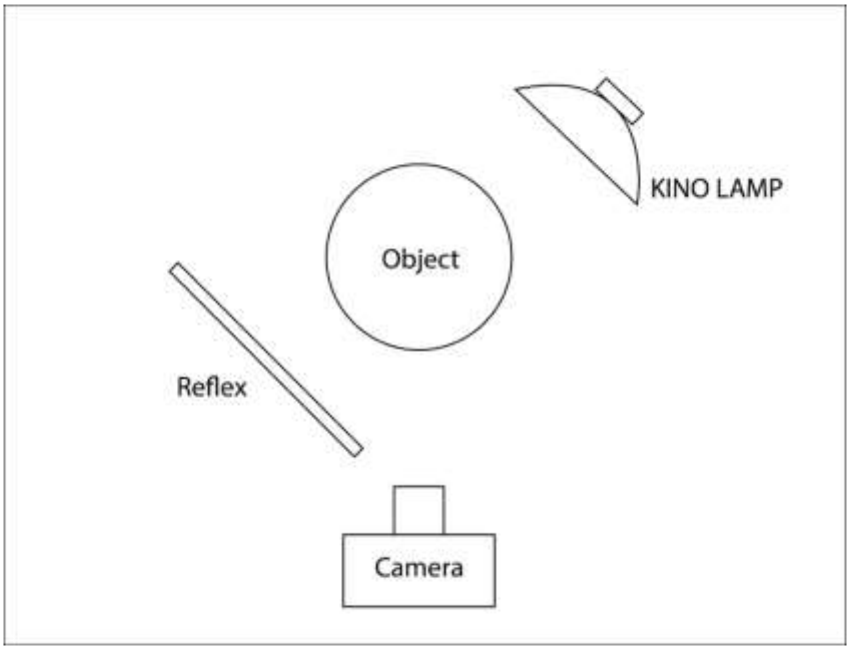

Figure 1. Plan Lighting

The photo assessment was in a laboratory. Measured at the seat of the subject, the brightness was controlled to be 300 lux. The distance between the photo and the subject was 30 centimeters. The photos were randomly displayed on a 21.5-inch iMac. The subject evaluated the beauty and attractiveness of the bakery photos by using a Semantic Differential Scale 7 one photo at a time.

Figure 2. Bakery Photo Using Different Color Temperatures

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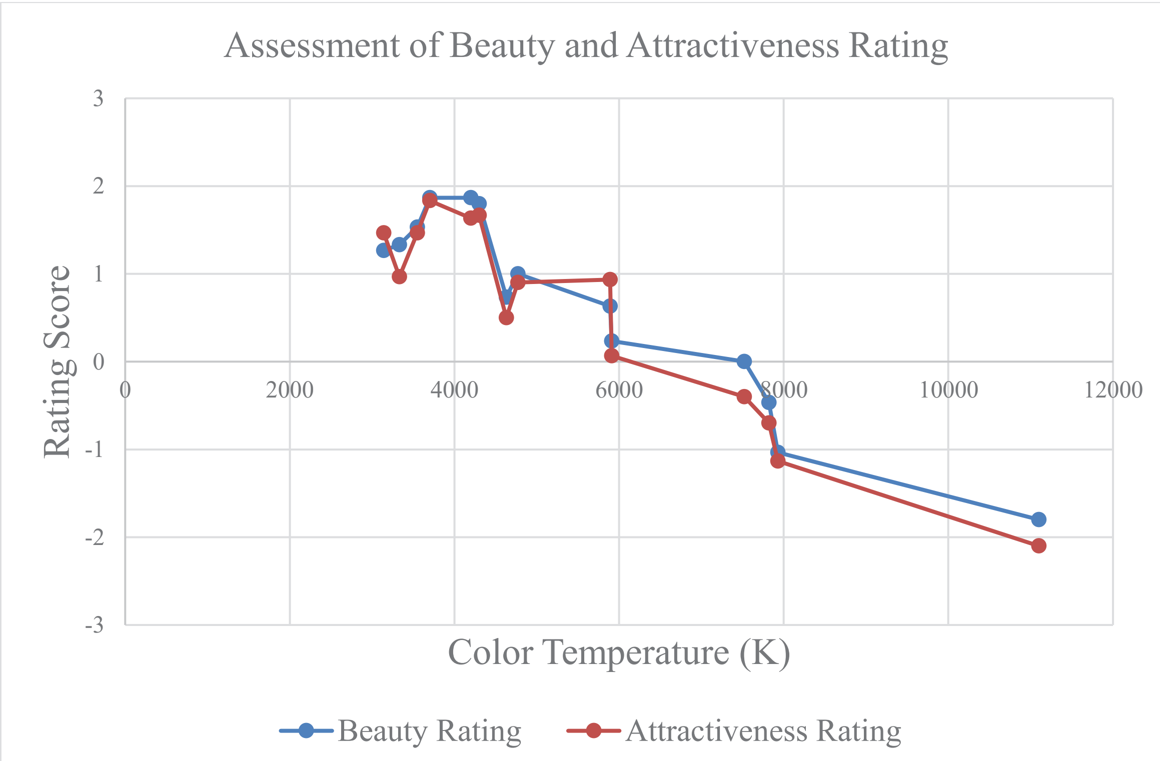
RESULT

A study on the influence of the color temperature of bakery photography for advertising was shown as the following chart.



In assessing the beauty of the cake photos, the color temperature that made the photos beautiful at a good level was in the range of 3140K-4300K. The color temperature that made the highest score was 3700K-4200K.

In assessing the attractiveness of the cake photo, the color temperature that made the photos attractive at a good level was in the range of 3140K-4300K. The color temperature that made the highest score was 3700K. The color temperature of slightly yellowish white was assessed to be at a good level.

CONCLUSION

The study found that the color temperature that made the cake photos beautiful, attractive and suitable for use in the production of bakery photography for advertising is in the range of 3700K-4300K, which is slightly yellowish white. On the other hand, the color temperature that is not appropriate for use in the production of bakery photography for advertising, because it makes the photo not beautiful and unattractive, is in the range of 7930K-11100K, which is blue, that make the wrong color of the cake.

ACKNOWLEDGEMENTS

We would like to thank the Faculty of Mass Communication Technology and the Department of Advertising and Public Relations Technology for the opportunity to conduct this research. As well as 30 subjects and other parties who are not mentioned here who helped with this research.

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ANALYSIS OF METALLIC AND TRANSPARENCY PERCEPTION OF GLASS OBJECT

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Keywords: material appearance, material perception, projection mapping, luminance distribution statistics

ABSTRACT

In this study, we investigated the metallic and transparency perception change of a glass object with different illuminance levels of projecting light by conducting psychophysical experiments. In our experiments, observers were asked to evaluate the degree of metallic or transparency appearance. The relationship between the subjective values and the luminance distribution statistics of captured images were also analyzed. The experimental results reveal that the transparency appearance was almost constantly perceived for the illuminance level of the projected light source, whereas the metallic appearance was confirmed for the condition with high illuminance. The correlation between the illuminance distribution and the subjective value showed a weak and strong negative correlation for the transparency appearance and metallic appearance, respectively. From these findings, we have confirmed that it was possible to present the metallic appearance under certain condition using glass objects without real metallic characteristics.

INTRODUCTION

In recent years, many techniques have been developed to edit the appearance of an object by adjusting the projection light in projection mapping. Using these techniques, the surface appearance of various familiar objects can be controlled, and it becomes possible to change the apparent color and material of the projection target. For example, Amano proposed a projection technique to edit the transparency and glossiness of various materials such as pottery, plastic, and silk [1]. However, even with these techniques, it is still difficult to reproduce the clear transparency of materials like glass. It is also difficult to transform the appearance of a glossy object into that of a non-glossy object. As such, there is a limit to the performance of appearance-editing techniques that rely solely on the adjustment of the projection light.

In our study, we aim to edit the material appearance of a glass object by controlling the illuminance of the projection light source. Through our psychophysical experiments, we investigate whether or not the perception of metallic and transparency appearance of a textured glass object used as a projection target can be altered by varying the illuminance of the projected light.

EXPERIMENTS

We investigate whether or not the metallic and transparency appearance of a glass object changes under different illuminance light of a simple projection source on the basis of the results of an evaluation experiment.

Experimental environment

Our experiment was conducted in a dark room. Figure 1 shows the experimental setup. The EPSON EMP-TW 1000 was used as the projection source. The viewing distance was 100 cm. Each subject observed a glass object through a peephole and the observation position was behind the

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projector. To investigate the relationship between the projected light and the appearance of the object, black wallpaper was used as the background to minimize its influence. The distance between the background and the irradiation source was 9 cm and the fixed part of the projector and the peephole was covered with a black cloth so that the influence of reflection at the fixed part was eliminated.

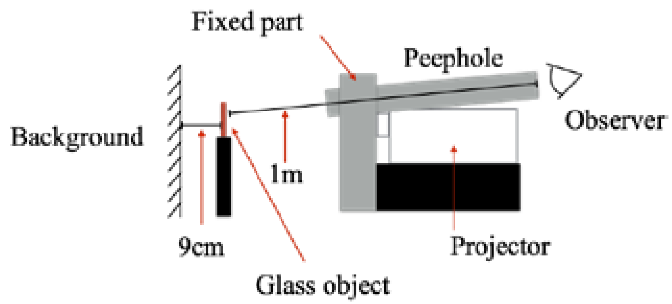

Figure 1. Experimental setup

Experimental method

Sixteen observers consisting of 13 males and 3 females with normal vision participated in the experiment. The experimental stimuli were prepared using a glass object as shown in Figure 2 which was projected using 23 different light source with different illuminance. The glass object had an uneven texture on the surface (size 50 × 50 mm). To investigate the relationship between illuminance and transparency or metallic perception, the projection light was generated so that the illuminance was performed with increments at a constant step size. Subjective evaluations were conducted in increments of 100 lx from 0 lx to 1400 lx beforehand. Then, since it was predicted that there is a change in transparency and metallic perception at approximately 200 lx, fine increments were performed near this value. Specifically, 23 different incremental steps were performed at 50 lx from 0 lx to 100 lx, 25 lx increments from 100 lx to 300 lx, 50 lx increments from 300 lx to 400 lx, and then 100 lx increments up to 1400 lx. Here, an adjustment was made so that the chromaticity was within the range of $(0.32, 0.32) < (x, y) < (0.34, 0.34)$. The projection stimulus was simultaneously and uniformly projected onto the background region and the stimulation area.

The evaluation was performed in order of metallic and transparency perception. The observer's task was to assess each stimulus in regard to metallic or transparency perception and to respond to a series of evaluation questions using a four-point scale. Specifically, in the case of metallic perception, "0" represents metallic-like appearance, "1" represent little metallic-like appearance, "2" represents metallic-like appearance and "3" represents considerable metallic-like appearance. The subjects observed each stimulus with one eye so that they were not influenced by the effects of the afterimage.

Figure 3 shows an outline of the stimulus presentation that was viewed by the subjects and the evaluation procedure. The 23 stimuli were randomly presented and the metallic-like appearance was evaluated first. Subsequently, the 23 stimuli were again randomly presented and the transparent-like appearance was evaluated. These sessions were each repeated to confirm their reproducibility. The experiments were then conducted under the following two conditions: (condition 1) observation of only stimulus, and (condition 2) observation of stimulus and background together.

Figure 2.
Glass stimulus with texture

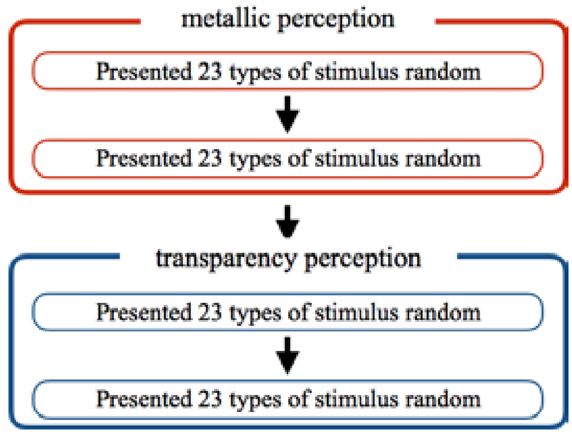

Figure 3.
Experimental procedure

RESULTS

The evaluation value was the average of the two trials. Evaluations in which the distribution of the two trials was greater than 1 were excluded as outliers due to their low reproducibility. Figures 4 and 5 show the relationship between the illuminance and evaluation value under conditions 1 and 2, respectively. The curves in each figure exhibit a logarithmic approximation for each metallic and transparency perceptions.
For the experimental results, as shown in Figure 4, the score of the transparent-like appearance of the glass object remained almost constant, regardless of the illuminance. However, the score of the metallic-like appearance increased logarithmically with an increase in the illuminance. In addition, despite the observation of a transparent object, a stronger metallic-like appearance was perceived compared to transparency, even at a considerably lower illuminance of approximately 50 lx. As shown in Figure 5, a tendency is observed which is similar to that observed in Figure 4 for metallic perception. Even for observation under condition 2, at 175 lx or more, the metallic perception of the glass object was higher than that of the transparency perception.

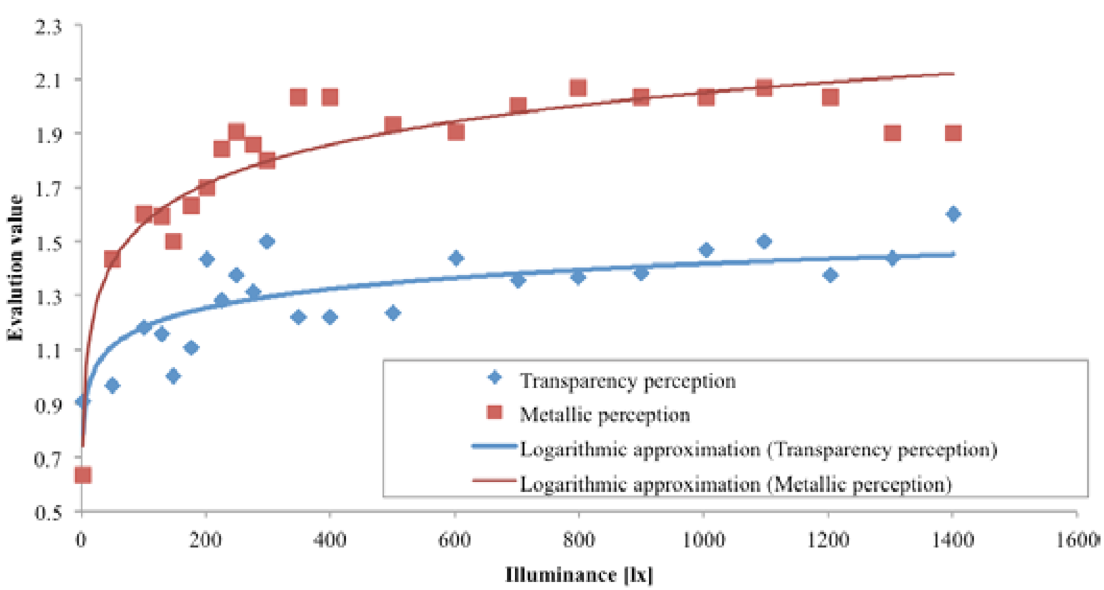

Figure 4. Experimental result under condition 1

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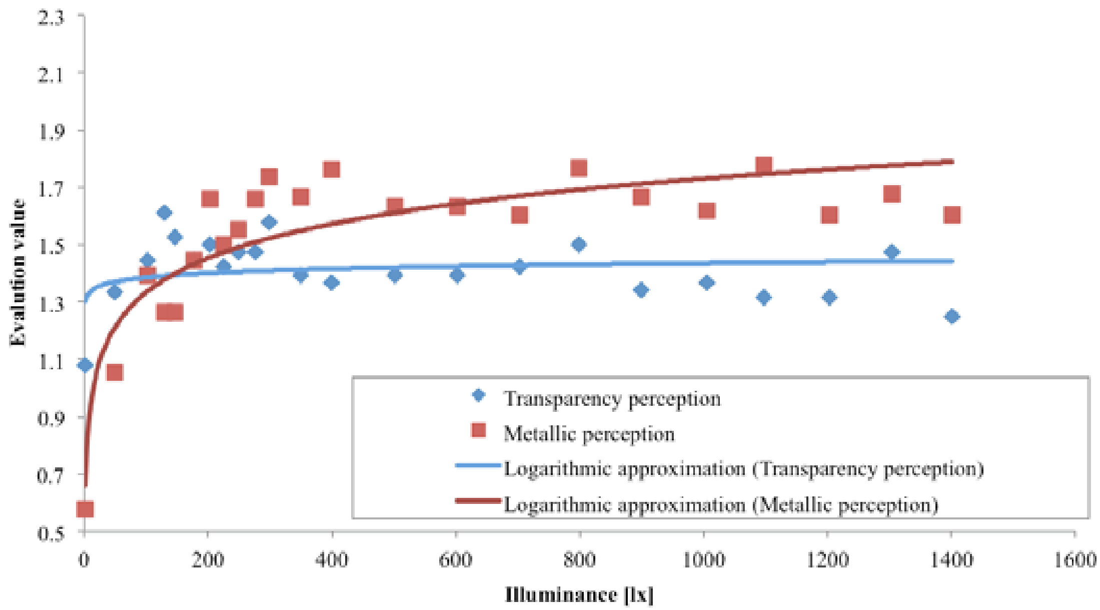

Figure 5. Experimental result under condition 2

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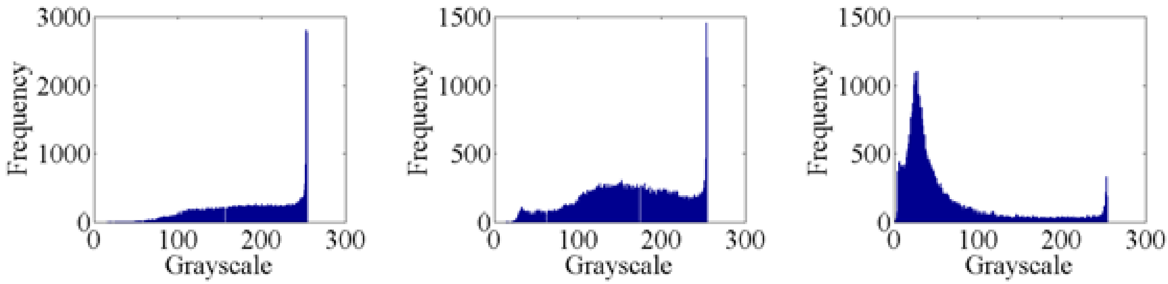
CONSIDERATION

In Ref. [2], Motoyoshi et al. discussed the relationship between metal perception and luminance distribution statistics. In order to investigate the visual mechanism of the metallic perception of the glass object, we acquired images of two stimuli using a calibrated camera, and the luminance distribution statistics were calculated. One was an image of the glass object at the increment level of the illuminance of the projection light where the evaluation of metallic perception was higher than transparency perception (Figure 6(b)). The other was an image of the glass object at the increment level of the illuminance of the projection light where the evaluation of transparency perception was higher than metallic perception (Figure 6(c)). We excluded the stimulus part from the captured image, and a luminance histogram was calculated. In order to compare a real metal, a luminance histogram of aluminum was also prepared under similar conditions (Figure 6(a)). The illuminance of the projection light on the aluminum was used when judged subjectively, to be close to the metallic perception perceived from the glass object. Figure 7 show corresponding luminance histograms for images in Figure 6.

(a) Aluminum (b) Metallic glass (c) Transparency glass

Figure 6. Captured stimuli



(a) Aluminum (b) Metallic glass (c) Transparency glass

Figure 7. Luminance histogram corresponding to Figure 6

Comparing Figures 7 (a) and (b), we can confirm that the shape of the histograms is similar. This result supports that both are metal perception. On the other hand, the luminance distribution between Figures 7 (a) and (c) is different. In this way, the difference in material perception is expressed as a difference in the luminance histogram.

Table 1 shows the relationship between the evaluation values and the luminance distribution statistics (skewness and standard deviation of the luminance histogram). As shown in Table 1, the relationship between each luminance distribution statistic and the evaluation value showed a strong negative correlation for metallic perception, whereas there was a weak negative correlation for transparency perception. Regarding the relationship between metallic perception and image statistics, a previous study has been performed based on CG images by Matsumoto et al. [3]. According to the study, the metallic perception obtained from the CG image had a negative correlation with the skewness of the luminance histogram and a strong positive correlation with the standard deviation. Compared with the presented results, the same result was obtained with regard to the skewness. However, the correlation of the standard deviation was opposite to the reported result. Unlike CG, the gloss of the actual glass object was very high so many pixels of the captured image were saturated. Therefore, this may account for the decrease in the standard deviation.

Table 1: Relationship between evaluation value and the luminance distribution statistics

	Correlation coefficient		t-test p-value	
	Metallic	Transparency	Metallic	Transparency
Skewness	-9.41×10^{-1}	-6.63×10^{-1}	1.59×10^{-4}	5.15×10^{-2}
Standard deviation	-9.81×10^{-1}	-7.95×10^{-1}	3.12×10^{-6}	1.04×10^{-2}

CONCLUSION

This study aimed to edit the apparent material of a glass object by adjusting the projection target, not the projection light. Our psychophysical experiments demonstrated that the perception of metallic and transparent appearance of a textured glass object used as a projection target can be altered by varying the brightness of the projected light, and this mechanism is discussed in this paper.

In the experimental results, the score for the transparent-like appearance of the glass object remained almost constant, regardless of the illuminance. However, the score of the metallic-like appearance increased with illuminance. In addition, despite the observation of a transparent object, a stronger metallic-like appearance was perceived than that of transparency, even at a considerably low illuminance. Next, we acquired an image of each stimulus using a calibrated camera, and the luminance distribution statistics (skewness and standard deviation of the luminance histogram) were calculated. The relationship between each luminance distribution statistic and evaluation value showed a weak negative correlation for transparency, whereas there was a strong negative correlation for metallic perception. We confirmed that the luminance distribution statistics well-explains the perception of the metallic and transparent appearance of the textured glass object.

ACKNOWLEDGEMENT

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THE BACKGROUND COLOR FOR SILVER ACCESSORIES ADVERTISING PHOTOGRAPHY

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Keywords: Silver Accessories, Background Color, Advertising Photography

ABSTRACT

This research aimed to study the background color suitable for silver accessories advertising photography. The methodology of this study was to photograph the silver accessories in 8 different background colors which were green, blue, cyan, magenta, yellow, white and black. The researcher controlled the lighting, the lens, the aperture of the lens, the photo size, the camera angle and the composition of all photos. The 15 subjects of working women assessed the feeling toward the photos. The study found that red background made the silver accessories stand out from the background and helped to create a brightness of silver accessories. The yellow background helped to create a gentle feeling for the silver accessories. For the liking and the purchasing demand, the background color did not affect the liking and the purchasing demand of the silver accessories.

INTRODUCTION

The photograph is the message for communication. Better than words, the good photograph can create perception and understanding of what the photographer wants to present. It can also create reliability. Now the advertising business has been involved in the trading industry even more. It is the beginning of the photography for advertising because the photograph can help create the curiosity about the product. If a photograph can communicate the story, emotion, feeling and present the concept clearly, this will help consumers create a quicker purchasing demand.

The objectives of silver accessories advertising photography are to create the beauty and the image of the product as well as to encourage the consumer's purchasing demand. The photographer is responsible for the presentation of the beauty and the story of the photograph by setting the light, finding the camera angle and setting the composition of the image which is the selection of the props and the background color. These will not only create the beauty of the photo but also create the uniqueness and promote the product appearance.

The study of the background color of silver accessories from the Internet found that the background colors commonly used in silver accessories photography are black and white. Some use other colors such as red, yellow, or blue.

The background color affects the feelings of the viewers. For example, if we choose a colorful background color, it helps to create a bright and playful mood. On the other hand, if we choose black or dark background color, it can create either an interesting or fascinating and charming feeling. To communicate the story with a photograph, it is important for photographers to focus on the selection of things in the photograph and use them appropriately.

METHOD

This research aimed to study the background color suitable for silver accessories advertising photography. Eight background colors which were 3 additive colors: red, green, blue,3 subtractive colors: cyan, magenta, yellow, and popular colors which were white and black. The researcher used the following methods:

1. The researcher used 1 piece of silver necklace.
2. The researcher set eight background colors which were 3 additive colors: red, green, blue,3 subtractive colors: cyan, magenta, yellow, and popular colors which were white and black.
3. The researcher photographed the silver accessories by changing the background color. The lighting, the lens, the aperture of the lens, the image size, the camera angle and the composition for all images were controlled to be the same.

Figure 1. Example of the Silver Accessories Photo Used in the Study

4. The photographs were shown to fifteen subjects who were working females to assess the feelings toward the silver accessories photographs. By answering the questionnaires, the subjects saw the photos on 21.5-inch Apple computer. The color values of silver accessories through the computer screen were shown in Table 1.

Table 1. Color Values of Silver Accessories Through Computer Screen

Color name	Y	X	y
Red	24.67	.598	.328
Green	19.23	.240	.372
Blue	3.08	.199	.166
Cyan	74.13	.234	.302
Magenta	15.97	.335	.215
Yellow	187	.380	.420
White	186	.310	.333
Black	.38	.198	.420

Using the Semantic Differential Scale, the scale was divided into 7 levels and used the following adjectives:

Stand out of background…………………Blend in with background

Brightness...Dull

Gentle..Hardness

Like...Dislike

Purchase..Do not purchase

RESULT

The result of the study of background color for silver accessories advertising photography was as the following.

1. The result of the study of the background color affects the standout of the silver accessories was shown as Chart 1.

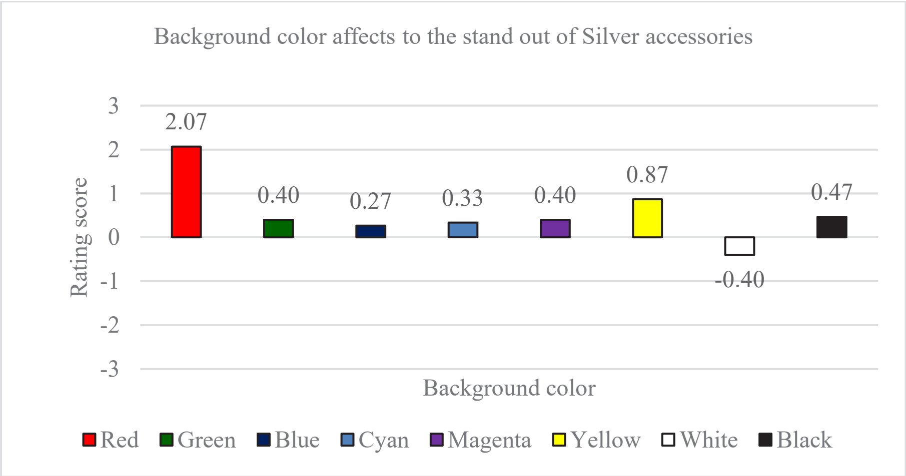

Chart 1. Shows result Background color affects to the stand out of Silver accessories

According to the chart, the background color that mostly affects the standout of the silver accessories was red, followed by yellow. The white background was the color that similar to the silver accessories. Therefore, it blended in with the accessories and did not help make the accessories stand out from the background.

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2. The result of the study of the background color that affects the brightness of the silver accessories photograph was shown in Chart 2.

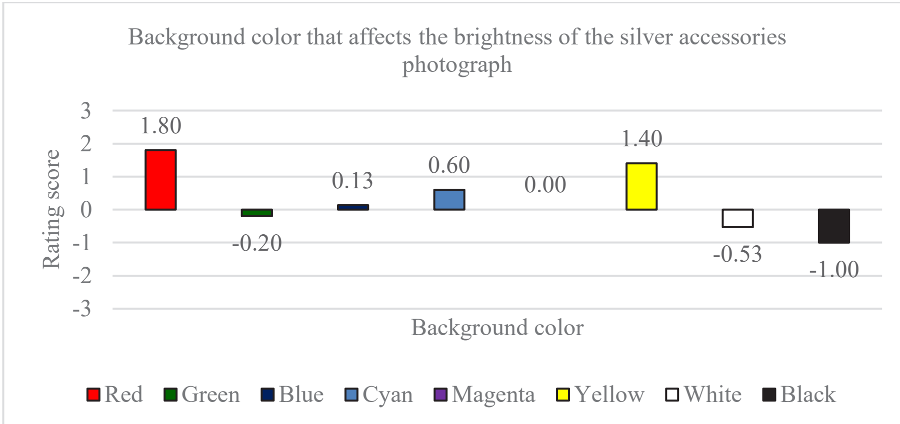

Chart 2. Background Color Affects Brightness of Silver Accessories Photography

According to the chart, the background color mostly affects the brightness of silver accessories photography is red, followed by yellow. This may be because red is a bright and eye-catching color while yellow is brighter than other colors. Therefore, the viewers feel bright. Black did not affect the brightness, however, it created the dull feeling toward the silver accessories photographs. It may be because black is a dark color without detail. In psychology, it creates the negative sense. Then, the viewers felt that the black background made the silver accessories look dull.

3. The result of the study of background color that affects the gentle of silver accessories photograph was shown in Chart 3.

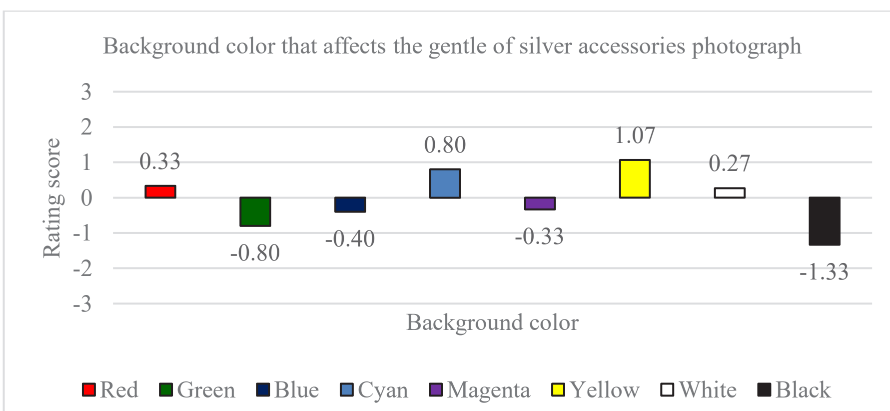

Chart 3. Background Color Affects Gentle of Silver Accessories Photography

According to the chart, the background color mostly affects the gentle of the silver accessories is yellow, followed by cyan. This may be because these colors are in bright tone. In psychology, the colors in bright tone create light, gentle, and sweet feeling. Black background did not affect the gentle of silver accessories photograph, however, it mostly affected the hardness. Maybe it is because black is in a dark tone and in psychology, dark color represents hardness or toughness more than the colors in the bright tone.

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4. The result of the study of the background color that affects the liking of silver accessories photograph was shown in Chart 4.

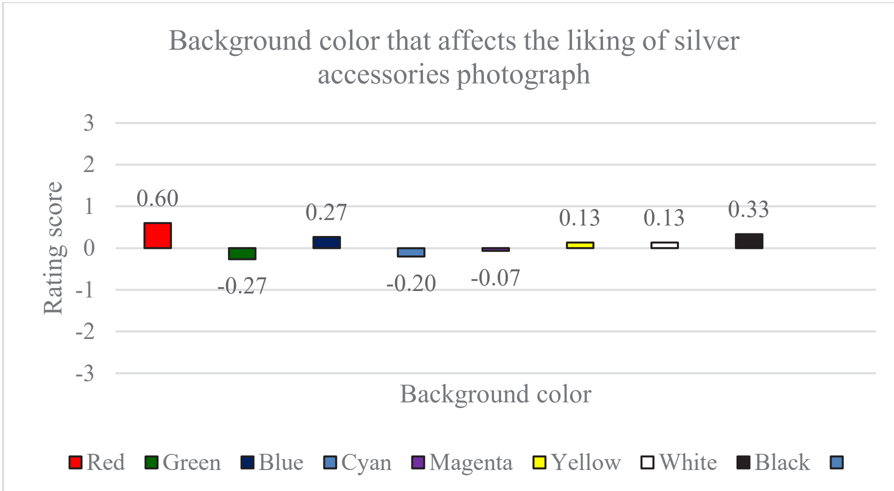

Chart 4. Background Color Affects Liking of Silver Accessories Photograph

According to the chart, the overall background color did not affect the liking of the silver accessories photograph.

5. The result of the study of the background color that affects the purchasing demand for silver accessories was shown in Chart 5.

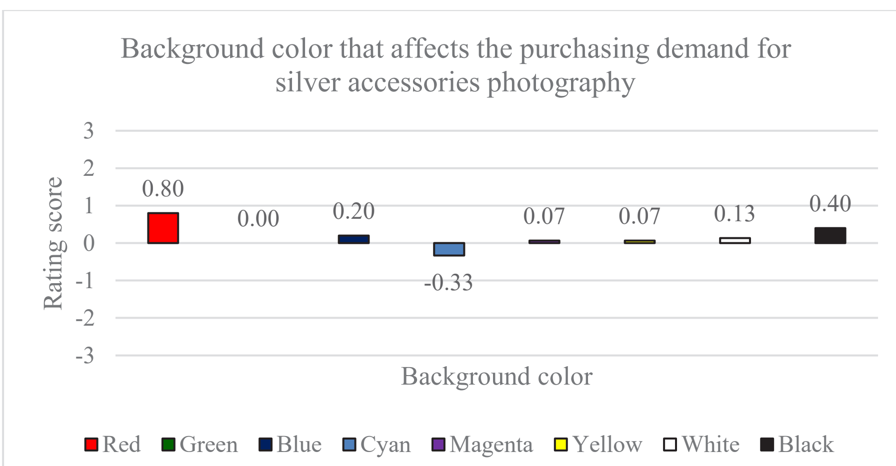

Chart 5. Background Color Affects Purchase Demand of Silver Accessories

According to the chart, the overall background color did not affect the purchase demand of the silver accessories.

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CONCLUSION

For the background color that affects the standout, the brightness, and the gentle of the silver accessories photograph, the study found that red background made the silver accessories most stand out of the background and created the brightness for the silver accessories. Yellow background created the gentle feeling for the silver accessories the most. However, the changing of background color did not affect the liking and the purchasing demand of the silver accessories. This probably is because the subjects were women working for the same organization, no diversity in occupation. Also, they are a group of people who can afford the silver accessories but do not like to wear silver accessories. Therefore, the results showed that the background color did not affect the liking and purchasing demand for silver accessories.

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YELLOWNESS AND RELATED STRUCTURAL CHANGES OF UV CURABLE OVERPRINT VARNISH

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Keywords: yellowness, UV radiation Curing, E-beam Curing and Overprint varnish

ABSTRACT

The main objective of this research was to study the yellowness of UV curable overprint varnish (OPV) after it was cured by two methods; UV radiation exposure and E-beam radiation. The OPV was coated on the white substrate by using the K-coater. After that it was taken to cure by UV radiation at different intensity, and E-beam radiation. The yellowness of the OPV cured by these two methods was measured by using the spectrophotometer. Fourier transformed infrared spectroscopy (FTIR) was used to characterize the structural changing of the cured OPV. The result revealed that UV radiation intensity and the photo initiators impacted on properties of the UV curable coating especially for yellowness. On the other hand, the curing by E-beam did not cause the yellowness.

INTRODUCTION

The overprint varnish (OPV) is a thin layer covering on the surface of an object substrate generally applied in finishing processes for decorative appearance, information, protective barrier and functionalization. OPV is applied to an entire printed surface after printing that is a combination of oils, resins, waxes, solvents, monomer, oligomer and other materials used as to increase surface properties, for example increase of gloss for better appearance and increase of the protective barrier from abrasion and tear due to handling or contact with moisture, chemical or other potential sources of damage. Moreover, it is also referred to an over-coating applied to a printed product following printing as finished process. Overprint is applied for entire printing surface nevertheless for only partial parts of a printed surface, it is called spot varnish. The importance property of OPV formulation is compatible with ink or other coating materials. It is important to ensure that the OPV coating process is not a cause of ink bleeding and other printing defects

UV-curing provides many advantages such as instant drying, broad formulating range, low energy consumption and low space and capital requirement for curing equipment (Wang et al., 2008) Increased emphasis on environmental protection is a driving force advancing the utilization of Radiation-curable technology in the printing and graphic arts industry. Radiation-curing include ultraviolet light (UV) curing and electron beam radiation (EB) curing.

The OPV is mostly cured by ultraviolet (UV) light and it is called UV-OPV. The curing process is a process that transform monomer in liquid form to 3-dimension network of polymer in solid form by polymerization and cross-linking reaction. UV is the one of the famous technologies for curing processes. The formulation of UV-OPV curing basically compose of resin or prepolymer, one or several reactive diluents or cross-linking agents, photo-initiators (PIs) as well as some additives.

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PIs is a free radical initiator generator to induce radical cross-linking polymerization reaction based on photochemistry reaction.

Basically, UV-OPV coating systems usually contain similar component, i.e., oligomer and monomer that is the binder system or reactive diluents (~60-80%), pigment (absent in clear coatings) (10 - 20%), PIs (5 - 15 %) and minor additives (5 -10%). However, EB-OPV is not necessary to have PIs in this system because of radiation-induced free radical and chemical reaction mechanism. For avoiding the toxicity problems of PIs in printing and packing industries (Van Bossuyt, et al., 2016), the EB-OPV is a technical challenge of green printing for the future. Since, cost of EB equipment has come down significantly over the last decade. Recently, the new and competitive manufacturing using EB machine and overall reliability of the curing units has significantly increased in the world. For the near future, "Green Economy" (Enviroment Management Group, 2011) that is an economy that results in improved human wellbeing and social equity, while significantly reducing environmental risks and ecological scarcities, is a trend to apply in many countries. Therefore, in printing and packing industry, EB curing is the touchable technology for coating and curing in printing/finishing processes for printing and packing industries.

UV curing ink is known for yellowing, which is due to initial photo yellowing and subsequent aging. Also, a layer with an ink film thickness in the range of sub-microns to microns will show considerably less color change when compared to a layer with an ink film thickness of 500 µm. This may be attributable to the Beer-Lambert law (Studer et al., 2001)

Certain photoinitiators are known to cause yellowing, particularly during long term aging of cured compositions under photolytic aging conditions (e.g., UV or fluorescent light). Heat may also induce yellowing. Discoloration in general and yellowing in particular is undesirable and has become anathema in the industry. Hence, a photoinitiator which would lack harmful crystalline effects and still effect fast cure, but would result in yellowing, would not sufficiently meet the most stringent industry demands. (Timothy Edward Bishop, 2010)

The target of this work was to study the yellowness of UV overprint varnish due to curing with UV radiation dose. UV dose is measured in millijoules seconds per cm^2 (mJ/cm^2) and is calculated using the following parameters: UV Intensity measured in milliwatts per cm^2 (mW/cm^2). Finally, an explanation for the optical and chemical process behind yellowing was investigated.

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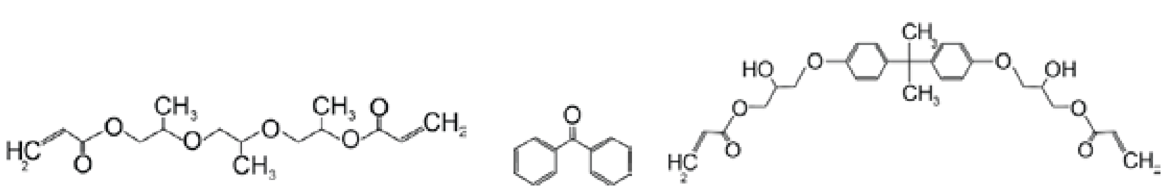
EXPERIMENTAL METHODS

1. MATERIALS

UV OPV were prepared four conditions (Table 1) and supported by Anwill (Thailand) Co. Ltd. The main components consist of Epoxy acrylate (EA), tri-propylene glycol diacrylate (TPGDA) and Benzophenone (BP). The chemical structures are shown in Fig. 1(A) 1(B) and 1(C), respectively.



(A) (B) (C)

Figure 1. Chemical structures of (A) TPGDA, (B) Benzophenone (BP and (C) EA

Table 1: OPV formulations

	Tri-propylene glycol diacrylate (TPGDA)	Epoxy acrylate (EA)	Benzophenone (BP).
UV OPV-A	59% w/w	39% w/w	2 %
UV OPV-B	58% w/w	38% w/w	4 %
UV OPV-C	57% w/w	37% w/w	6%
EB OPV	60% w/w	40% w/w	none

2. PREPARATION OPV COATED SUBSTRATES

The UV OPV solutions were coated onto white paper sheets using k bar coater (No.1 or 4-6 µm wet film thickness). The coated samples were cured using UV irradiation by a medium pressure mercury vapor lamp of UV Dryer with the doses of 0.561, 0.672, 0.797, 1.000 and 1.612 J/cm^2 respectively for OPV-A, OPV-B and OPV-C. The UV energy are measured by UV dose meter. The EB OPV were cured using EB with the doses of 5, 10, 15, 20 kGy (J/g). The Electron beam curing system (250 keV) in a nitrogen atmosphere is supported by National Metal and Materials Technology (MTEC), Thailand.

3. FTIR SPECTROSCOPY

FTIR Spectroscopy Analysis Infra-red (IR) spectrum was obtained using FTIR spectroscopy (Perkin Elmer, Japan). The sample was placed on the readymade disc from a potassium bromide (KBr) for sampling. The IR spectrums were recorded at spectra in the range of 4000 to 400 cm^{-1}

4. COLOR MEASUREMENT

Each sample were measured in CIELAB system (D65/10º, specular component included) by using X-Rite Color i5 spectrophotometer at three locations. Yellowness index (YI) ASTM E313 were also measured with the same device. It is based on the following Eq.1:

$$YI = (1.301 \cdot X_{10} - 1.149 \cdot Z_{10})/Y_{10} \quad (1)$$

where X_{10}, Y_{10}, and Z_{10} are the tristimulus values at 10º standard observer. Each reported measurement represents the average value of three measurements.

RESULTS AND DISCUSSION

1. COLOR APPEARANCE

The images of three UV-OPVs which were cured by different UV intensity are shown in Figure 2. Faster speed of curing means less exposure time or low intensity to UV and slower speed means more exposure or high intensity to UV. As the amount of UV (radiant energy density-Joules/cm^2) increased, the yellowness of UV-OPVs increased. At the same time, the increasing amount of photoinitiator also increased the yellowness of OPV.

2. MORPHOLOGIES

The morphologies in cross section of un-coated substrate, UV-cured and EB-cured OPV coated substrates, i.e, photograph paper and aluminum foil coated paper are revealed in Figure 3. It is important to report that UV-OPV could not strongly adhere on the surface of aluminum foil coated paper. Although it could be cured into solidified coating layer, it was removed easily from the surface (data not shown). By using EB curing, EB-OPV exhibit good surface adhesion not only on paper but also on aluminum foil coated paper.

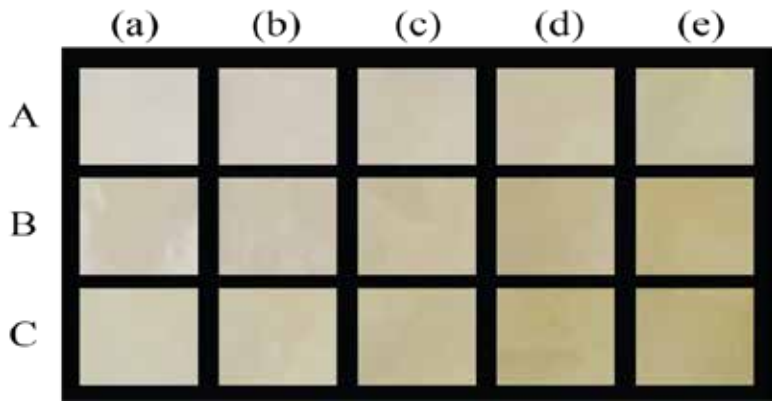


Figure 2. Colour appearance of OPV treated with various UV doses of 0.561(a), 0.672(b), 0.797(c), 1.000(d), and 1.612 (e) J/cm^2 and concentration of photoinitiator 2%(A), 4%(B), and 6%(C)

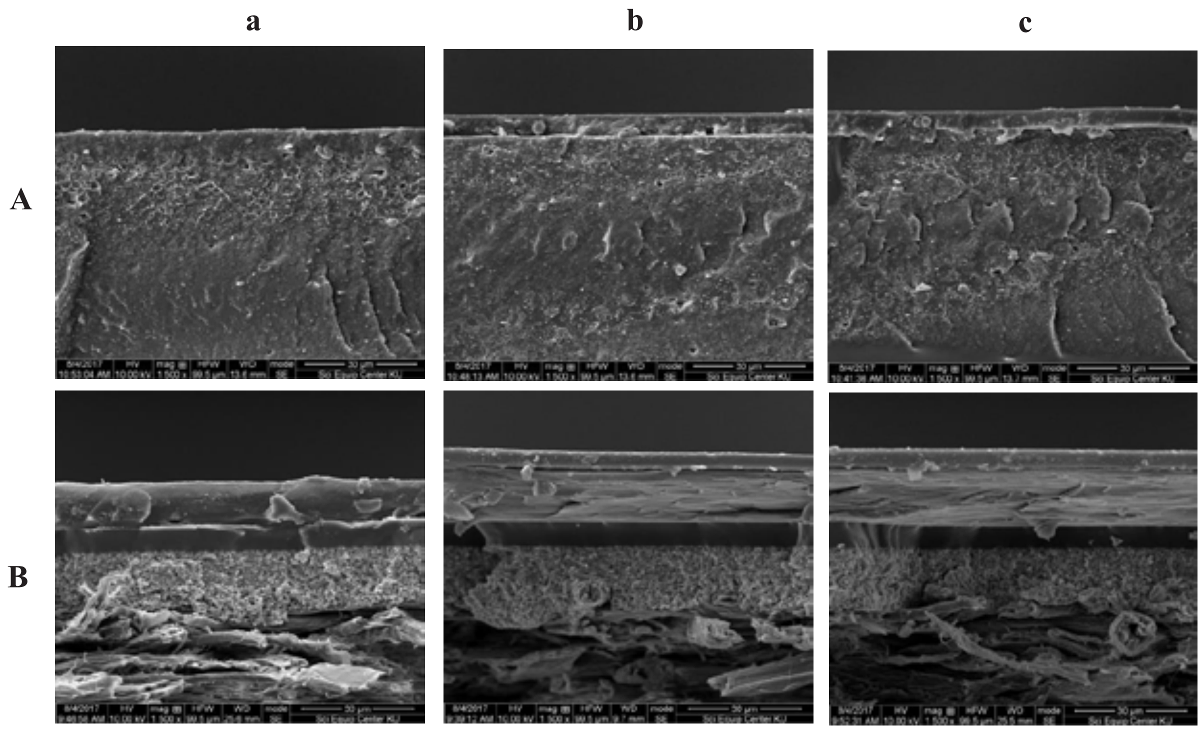


Figure 3. Morphologies in cross section of photograph paper(A) and aluminium foil coated paper(B) for un-coated substrate (a), UV-cured (b) and EB-cured (c) OPV coated

3. FTIR SPECTROSCOPY

The chemical structure or functional groups of UV OPV non-UV curing and UV curing were characterized by FT-IR (Figure 4). FT-IR spectra show C=C stretching at 1642 cm-1 of alkenes group, C-H in-plane bending at 1407, acrylate double bond at 810 and carbonyls group (C=O) at 1716 cm-1 (Figure 3(a)). After UV exposure, FTIR spectrum of cured OPV (Figure 3(a and b)) shows decrease of the alkenes group at 1642 cm-1 and FT-IR spectra of acrylate double bond at 810 were disappeared implying crosslinking-polymerization mechanism (curing). Moreover, the peak of C-O stretch at 1238 cm-1 appeared which influence the value of CIE b* (Peng Z., et al., 2018) and the intensity of carbonyl group increase when the UV exposure time increase (Table 3). (Saeid N, et al., 2017)

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Table 3: Intensity ratio between carbonyl group and aromatic ring

	OPV A		OPV B		OPV C	
	0.561 J/cm^2	1.612 J/cm^2	0.561 J/cm^2	1.612 J/cm^2	0.561 J/cm^2	1612 mj/cm^2
C=O/Aromatic ring	2.8687	2.9023	2.7862	2.9797	2.8343	2.9664

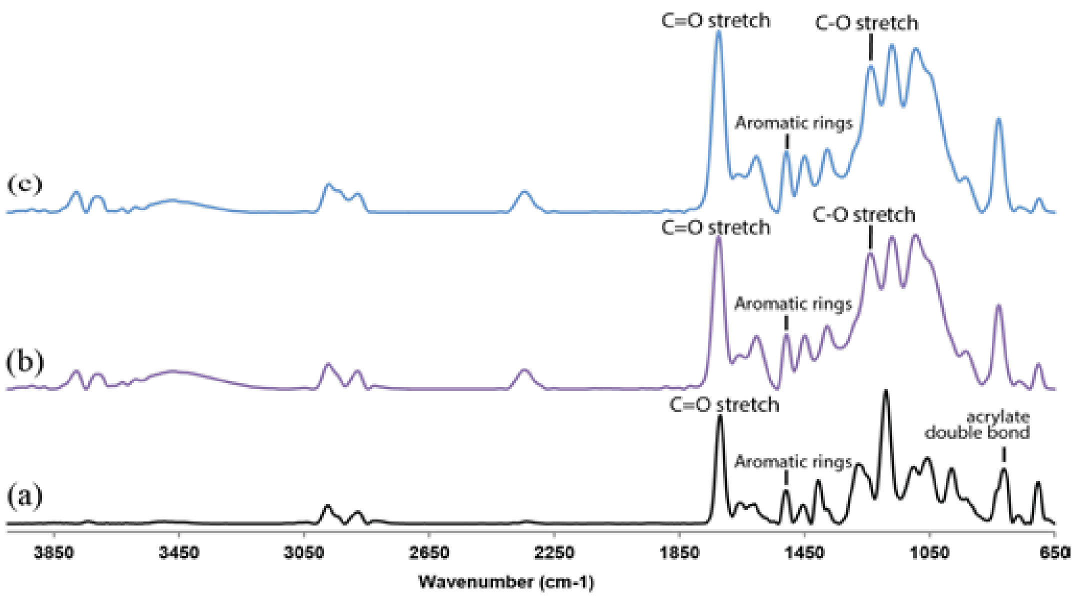

Figure 4: The FTIR of OPVs treated with no UV energy (a), lowest UV energy (b) and highest UV energy (c)

Figure 5 shows the yellowness index of UV curing compared with that of E-beam curing. The result showed that increasing of EB intensity did not cause yellowness although E-beam irradiation prolongs the duration. The E-beam radiation used under current study gives much more the energy than UV radiation which is the same as previous research (Ruengpattaradet, et al., 2018). Moreover, the UV-OPV plots shows that YI increased with the increase of the UV intensity and of the amount of photo-initiator. The result is consistent with the previous research (Cheng, et al., 2011). Table 4 shows Pearson correlation coefficient (r) of the relationship between doses and CIE a*, CIE b* and YI. The strong positive correlations were found between the UV doses, given to OPV-B (4% PI) and OPV-C (6% PI), and YI as well as CIE b*.

Table 4: Pearson correlation coefficients of the relationships of UV Doses and CIE a*, CIE b* and YI

	Yellowness Index	CIE b*	CIE a*
OPV-A (PI 2%)	0.81	0.81	-0.72
OPV-B (PI 4%)	0.92	0.91	-0.64
OPV-C (PI 6%)	0.99	0.98	0.28

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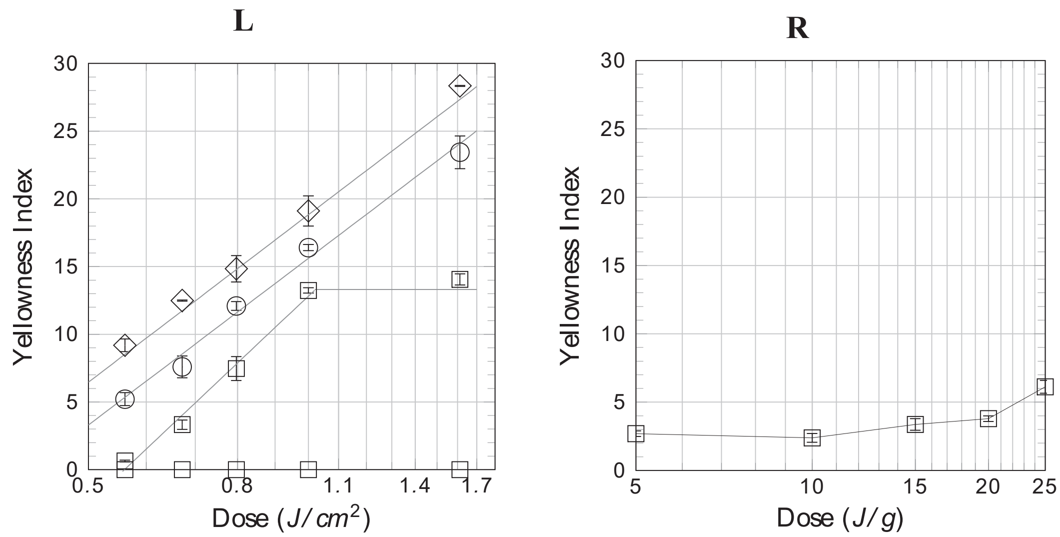

Figure 5: Semi-log plots of YI values of UV OPV (L) of 0%(□), 2% (☐), 4% (●), and 6% (◆) of photo-initiator concentration and EB OPV (R)

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CONCLUSION

Ultraviolet radiation energy induced yellowing of UV OPV at the beginning of exposing to UV but E-beam radiation did not induced yellowing. The yellowing effect of UV OPV increases proportionally with the intensity of radiation exposure and the concentration of photoinitiators in the varnish.

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INFLUENCE OF LED LIGHTS ON RESISTANCE TO COLOR CHANGE OF TEXTILES USED FOR JAPANESE KIMONO ACCESSORIES

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Keywords: Light, LED, Color fastness, Textile

ABSTRACT

A light-emitting diode (LED) light is replacing conventional lights such as an incandescent lamp and fluorescence light as both commercial and house lightings. A LED light allowed us to control the illuminance level and color quality. With these changing of the lighting environment, it is important to understand the influence of the LED light to Japanese Kimono textiles in order to inherit the Japanese culture. Therefore, experiments were carried out to investigate the resistance of color of textiles to various lights focusing on Japanese dyed silks used for Kimono and Kimono accessories. The results of the experiments demonstrated how sensitive the Kimono silks were to the LED lights as well as natural light. The results also suggested that the degree of the color changes could be influenced by the illuminance levels, characteristics of the SPD of the LED lights and the diffuse filters.

INTRODUCTION

Light environment has been dramatically changed over the last 100 years. An incandescent lamp had start spreading across Japan around 100 years ago. A fluorescence light then became popular. Nowadays, a light-emitting diode (LED) light is replacing an incandescent lamp and fluorescence light as both commercial and house lightings. Accordingly, the quality and characteristics of the lighting environment have been changing. For instance, the illuminance level such as the night environment is around 100 times brighter than 100 years ago [1]. As well as our light environment has been changed, our life style has been changed. Our life style, particularly our daily clothes, has been westernized. However Japanese tradition has still been kept and Japanese Kimono has been worn at special occasions in any generation as well as Kimono accessories which made from Japanese silk. These items are made in a conventional manner so that they are not suitable for heavy used like our daily clothes. In order to inherit a culture of Japanese kimono and moreover increase of the users, it is important to understand the characteristics of Kimono textile in our current environment. The resistance to lights, particularly a LED light which is becoming more widespread, is one of the important characteristics. Current LED lighting technology allows us to control lighting environment. The intensity of lightings can be higher than ever before and the color of the lightings can be more customized. The colors of Kimono textiles fade or change easily by exposed to lights. Since Kimono and accessories are not for daily use, a general durability assessment such as a color fastness assessment [2, 3] tends not to be applied and there is no required standard for the resistance to lights. Therefore, experiments were carried out to investigate the resistance of color of textiles to various lights focusing on Japanese dyed silk. In this study, the resistance of the color was evaluated by measuring color changes of textile samples along with the light exposure time.

METHODS

Light sources

The illuminance levels of LED lights used in the shops or at home in Japan are varied from a few hundreds to thousands lux and their shapes of the spectral power distributions (SPD) are also varied. Many of the typical consumer LED lights are generating white lights by use of phosphors together with a short-wavelength LED at around 450 nm. For example, when one phosphor material used in a LED light is illuminated by blue light, it emits yellow light having a fairly broad SPD. As a result it creates white color. Moreover, enhanced phosphors, for example an additional red phosphor, increase the quality of the white color which shows a high color rendering index (CRI). The CRI value is one of the indices to describe the ability of a light source how an object is shown to our eye based on an ideal or natural light. In this experiment, three different types of LED lights were utilized. As comparison, the samples were exposed to natural light from north facing window, which is a recommending condition for visual assessments of color in practice, since unwanted factors for assessing color such as specular and glare lights can be avoided. The SPDs of these lights measured using an illuminance Spectrophotometer *CL-500A* (Konica Minolta, Inc.) are shown in Figure 1. Light 1 was a typical white LED light which had a sharp peak at around 450 nm and thus bluish white color. The CRI value of this light was Ra = 70. Light 2 had the chromaticity close to D65 and also it was designed to eliminate the problem of chromatic aberration. Although there was a sharp peak at around 450 nm, the CRI value was as good as 97 by emitting more light with the middle wavelength. Light 3 also showed a good CRI value which was Ra = 90 and its peak was at around 610 nm. The specification such as illuminance (lux) and exposure times for each light at the experimental conditions are summarized in Table 1. The SPD of natural light varied over time. An example thus is given in Figure 1. An experimental setting for a LED light are shown in Figure 2. Illuminance level of all the lights used in this experiment was not adjustable, thus it was adjusted by changing the distances between the lights and samples. Two types of diffuse filters, the diffusing angles of 10° and 0.5° were used with Light 2 (only with 25000 lux condition) and Light 3, respectively. Figure 2 is an example of Light 3 with the diffuse filter.

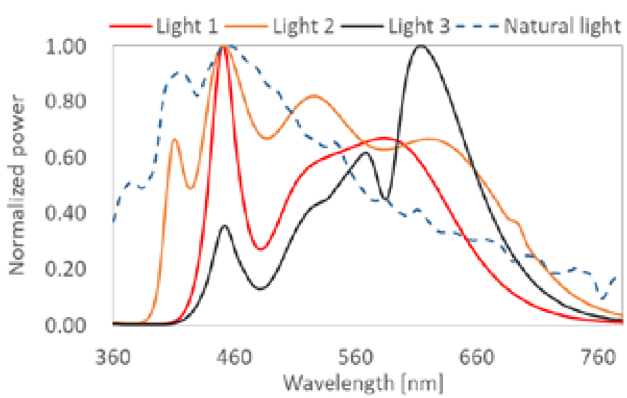

Figure 1. The SPDs of Light1, Light 2 (without filter), Light 3 (without filter) and natural light

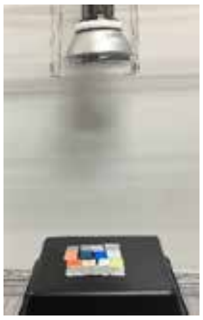

Figure 2. An example of an experimental setting for a LED light (Light 3 with a diffuse filter)

Table 1: The illuminance (lux) and exposure times

Light	Product name	CRI	Illuminance (lux)	Diffuser
Light 1	LDR12N-W (*TOSHIBA Lighting & Technology Co.)*	Ra70	50,000	-
Light 2	SOLAX-iO LH-9ND65 (*Seric LTD*)	Ra97	50,000/25,000	Without With 10° for 25000 lux
Light 3	LDR12L-D-W (*TOSHIBA Lighting & Technology Co.*)	Ra90	25,000	Without With 0.5°

Samples

The textile samples used in this experiment is shown in Figure 3. The sample number 1 to 4 were Japanese silks which were used for Kimono accessories. In addition to these samples, a white silk (undyed), and the 3rd grades of the Blue Standard [4] was also used as reference. In a practical quality assessment of the color fastness assessment, the degree of the resistance to light is assessed by comparing with the Blue Standard. If the color change of a sample is less than that of the 3rd Blue Standard, a fastness grade of the sample is better than 3. If the color change of a sample is larger than that of the 3rd Blue Standard, a fastness grade of the sample is worth than 3. In practice, a fastness grade of 3 or 3.5 can be a border to pass the quality control. However, this indication is for general daily clothes so that not necessary to apply to Kimono. The size of the samples were about 2 cm x 5 cm. The half of the sample was covered with aluminum foil, thus, the only the other half of the sample was exposed to the lights.

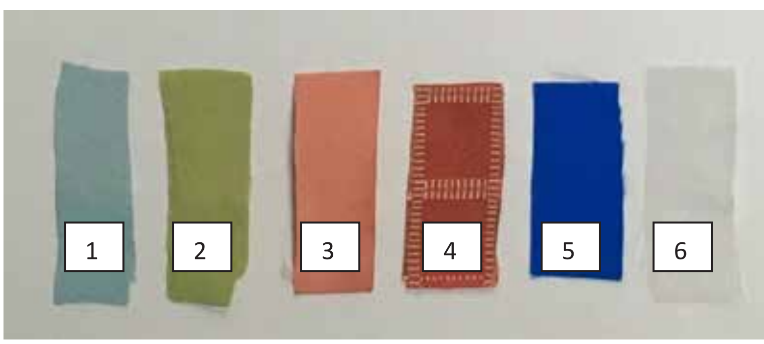

Figure 3. The textile samples with the indication of the sample number

RESULTS

The degree of the resistance of color change or fade of the samples to the lights were measured in terms of a color difference value *CIE* ΔE_{ab}^* value [5] of a sample between before and after exposed under the light. In order to calculate the ΔE_{ab}^* value, CIE XYZ tristimulus values [5] of the sample were measured using a two-dimensional color analyzer *CA-2000* (Konica Minolta, Inc.). This measurement was made for each sample at before and after exposed to the light in certain intervals. The ΔE_{ab}^* value was then calculated from the XYZ values and they were plotted along with the exposure time in Figure 4. Figure 4 (a) showed the comparison between Light 1 and 2 at 50,000 lux. It can be seen that the colors had been changed up to ΔE_{ab}^* values of 5 within 36 hours. If the ΔE_{ab}^* value the sample is larger than that of the 3rd Blue Standard (the sample number 5), that sample can be failed the color fastness quality assessment. By comparison, the results of the sample number 1 to 4 indicate the large color changes under these lights. The degrees of the color changes were different depending on the samples under Light 1 and 2s; however the Blue Standard equally faded.

In this case of Light 1 and 2, although the SPDs were not exactly same, both had a sharp peak at around 450 nm as well as they had the same illuminance level. On the other hands, the peak of the SPDs were different in Light 2 and 3. Their peaks were at around 450 nm and 610 nm for Light 2 and 3, respectively. A comparison of the result between Light 2 and 3 (Figure 4(b)) indicates the influence of the SPD on the color changes. Light 2 gave larger impact on the sample number 1 to 4 than Light 3, even their illuminance levels were both 25,000 lux.

The impacts to the Blue Standard (the sample number 5) and the Japanese undyed silk (the sample number 6) were relatively small under Light 1 to 3. It suggests how sensitive these Kimono silks are to the lights. This was also observed from the result of the result of the natural light as shown in Figure 5. Illuminance level were varied over time but the largest ΔE_{ab}^* value of the samples became over 3 after 360 hours. At that hour, the ΔE_{ab}^* value of the Blue Standard was still less than 1.

The efficacy of the diffuse filters was also evaluated. Figure 4 (c) and (d) show the comparison of the results with and without filters. Figure 4 (c) showed the result of Light 2 with or without the 10 ° circular diffuse filter. Similarly, Figure 4 (d) showed the comparison of Light 3 with or without the 0.5 ° circular diffuse filter. At both conditions, the illuminance level was 25,000 lux at the place where the samples were. Therefore, the samples were exposed at the same illuminance level regardless with or without filters. The ΔE_{ab}^* values of the samples under Light 2 with 10° circular diffuse filter were smaller comparing with the ΔE_{ab}^* values obtained from the same condition but without filter. However, in the case of the Light 3, the benefit of the filter was not clear. Namely, the 10° filter was effective but not the 0.5° filter. The light is diffused by the 10° filter more than by the 5° filter. This difference may help to protect the color of a textile even though it exposed under the same illuminance level of the lights.

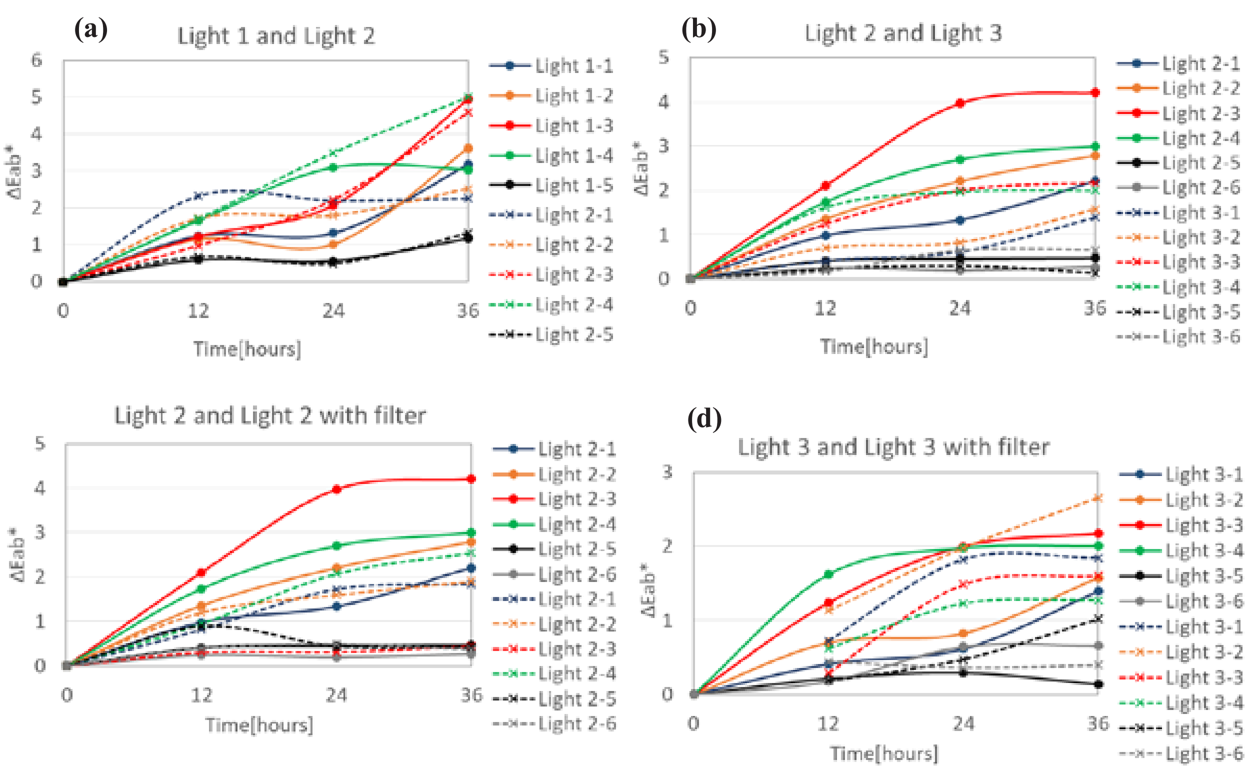

Figure 4. The ΔE_{ab}^* values of the samples between before and after exposed to the light along with the exposure time

CONCLUSION

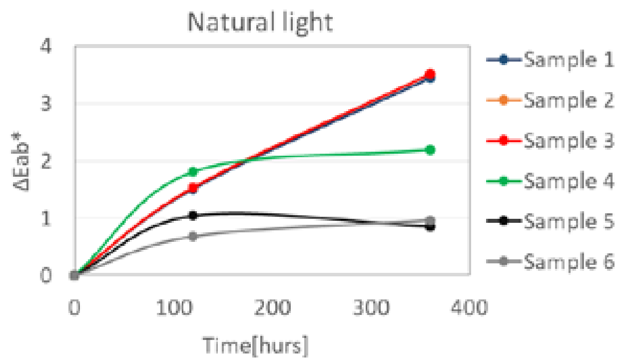

Figure 5. The ΔE_{ab}^* values of the samples between before and after exposed to the

The influences of the illuminance level, SPD of the LED lights and the efficacy of the diffuse filters were investigated in terms of the resistance of color change or fade of textile to the lights using Kimono silks as samples. The characteristics of the SPD of the light seemed to be important and influenced on the degree of the color change of the samples, even the lights had the same illuminance level. The color differences of the samples between before and after exposed to the lights tend to become larger when the SPD of the light had a sharp peak at around 450 nm than at around 610 nm. Since the color variation of the samples used in this study were limited, it cannot be concluded that the light with the peak at around 610 nm is better than with the peak at around 450 nm for any color of textiles in terms of the resistance to lights. It is therefore necessary to carry out the experiment using more various colors of the samples and the results should be analyzed in connection with dyestuff. Also, the experiment should be carried out using more various types of the SPDs of the LED lights to identify the influence of the SPD shapes.

From this study, the efficacy of the diffuse filter was observed. The influence of the light on color changes can be reduced by using a diffuse filter. When the illuminance level of the lights on the samples was same, the degree of the color change of the samples became smaller by inserting the 10° circular diffuse filter between the light and the samples; however this effect was not observed from the 0.5° circular diffuse filter.

Color fastness of Kimono silks is not as strong as our daily clothes. In order to inherit the Kimono culture, it is important to know the characteristics of Kimono silks and this study demonstrated the degree of the color changes by exposed to lights. The large color changes were observed in this study; however, the results also suggested that the color changes can be controlled by selecting the appropriate light and conditions.

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EFFECT OF THE PRESENTATION OF COLORS ON THE RECOVERY FROM EYE FATIGUE

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Keywords: VDT, eye fatigue, flicker, color, visual stimulation

ABSTRACT

Recently, technostress has been frequently cited as a problem among people who work with the visual display terminal (VDT) of computers on a regular basis. On the other hand, there is a belief that color might be helpful for resolving technostress, such as reducing eye fatigue and healing mental and physical fatigue. Therefore, the aim of this study was to clarify the effect of various colors on mental and physical fatigue. This experiment was designed to determine the level of fatigue recovery that could be achieved by looking at a visual stimulus that was composed of different colored objects after performing VDT work. Flicker and salivary amylase values were measured before and after the VDT work and after the presentation of the visual stimulus for the evaluation of fatigue. Comparisons between before and after VDT work showed that the flicker value decreased for all color conditions. This suggests that eyestrain occurred in subjects after they performed 90 minutes of VDT work. Furthermore, with the exception for purple, the flicker value increased after the presentation of all colors after VDT work and the subsequent visual stimulation. The largest recovery effect occurred after presenting the color blue in this study.

1. INTRODUCTION

Technostress is a feeling of anxiety or negative psychological pressure associated with an overexposure to computers or new technologies. Recently, technostress has been frequently cited as a problem among people who work with the visual display terminal (VDT) of computers on a regular basis. Katayama et al. suggest that the feeling of fatigue varies depending on the VDT color patterns[1]. Moreover, there is a belief that color might be helpful for resolving technostress, such as reducing eye fatigue and healing mental and physical fatigue[2]. Therefore, the aim of this study was to clarify the effect of various colors on mental and physical fatigue.

2. EXPERIMENT

This experiment was designed to determine the level of fatigue recovery that could be achieved by looking at a visual stimulus that was composed of different colored objects after performing VDT work. The experiment examined eight different conditions, including seven different presentations of color (red, blue, green, yellow, purple, white, and black) and one presentation without any visual stimulation. Table 1 shows the Munsell color system of experimental visual stimulation. Flicker and salivary amylase values were measured before and after the VDT work and after the presentation of the visual stimulus for the evaluation of fatigue.

Flicker values were measured in order to gauge eyestrain. The salivary amylase measurements were taken because it is thought that stress stimulates the excitatory signals of the sympathetic nervous system, and that salivary amylase activity is enhanced as a bodily self-defense reaction.

Table 2 shows the experimental condition.

The procedures performed in the experiment were as follows:

(1) The subject was first informed about the experiment.

(2) The subject was allowed to adapt to the lighting environment for 15 minutes in the experimantal room.

(3) Amylase and flicker values were measured in the subject.

(4) The subject performed VDT work for 90 minutes.

(5) Amylase and flicker values were measured a second time in the subject.

(6) The subject was presented a visual stimulation using a colored object for 5 minutes.

(7) Amylase and flicker values were measured a third time in the subject.

Steps (2) to (7) were performed after randomly changing the presentation order of each of the visual stimulation conditions for each subject.

Table 1: Munsell color system of experimental visual stimulation

Visual stimulation	Hue	Lightness	Chroma
Red	5R	5.0	12
Blue	10B	5.0	10
Green	5G	5.0	8
Purple	10P	5.0	10
Yellow	7.5Y	8.0	8
White	N	9.5	
Black	N	2.5	
None			

Table 2: Experimental condition

Illuminance	750 lx
Correlated color temperature	4500 K
Luminance of the monitor	30 cd/m^2
Subjects	7 mailes in their twenties

3. RESULTS AND DISCUSSION

Figure 1 shows the average values of amylase. Amylase values increased after VDT work for most all color conditions. These results suggest that subjects feel stress after performing VDT work for 90 minutes. Furthermore, amylase values decreased under most color conditions when subjects received visual stimulations after performing the VDT work. However, due to the very small changes in the measured amylase values, it was not possible to definitively determine the effect of colors on the stress.

Figure 2 shows the average values of flicker. Comparisons between before and after VDT work showed that the flicker value decreased for all color conditions. This suggests that eyestrain occurred in subjects after they performed 90 minutes of VDT work. Furthermore, with the exception for purple, the flicker value increased after the presentation of all colors after VDT work

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and the subsequent visual stimulation. These results demonstrate that after the occurrence of eyestrain, vision can be restored by a subsequent visual stimulus.

Figure 3 shows the change rate of the flicker value before and after the presentation of the visual stimulus that was normalized decrease rate of the flicker value by the VDT work. These results showed that the largest recovery effect occurred after presenting the color blue. In addition, the rate of the increase for the flicker value was higher after subjects looked at the three colors, red, blue and yellow, as compared to conditions without any visual stimulation. Furthermore, the recovery effects after red, blue, yellow, white, black and for conditions without any stimulus, appear to be greater than those observed after the presentation of green which expected to restore eyestrain in general. The reason why there was only a small rate of increase for the flicker value after the presentation of the green visual stimulus might be due to the fact that there was only a small rate of decrease for the flicker value after the VDT. It is thought that more detailed investigation is necessary for purple.

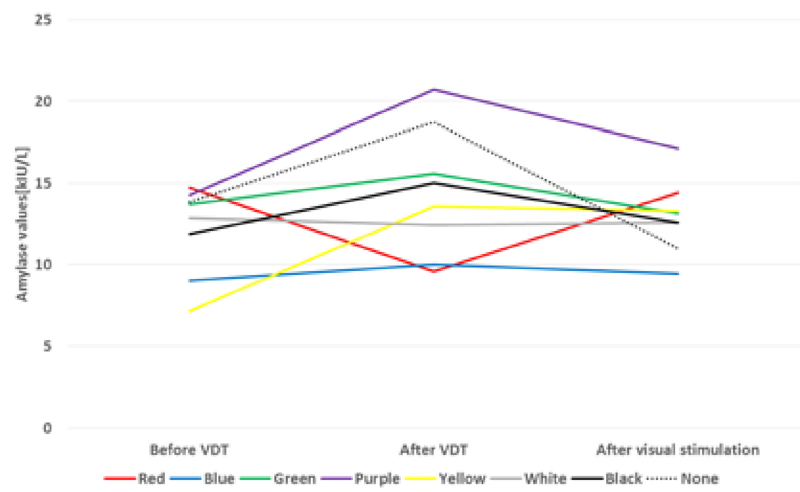

Figure 1. Average values of amylase

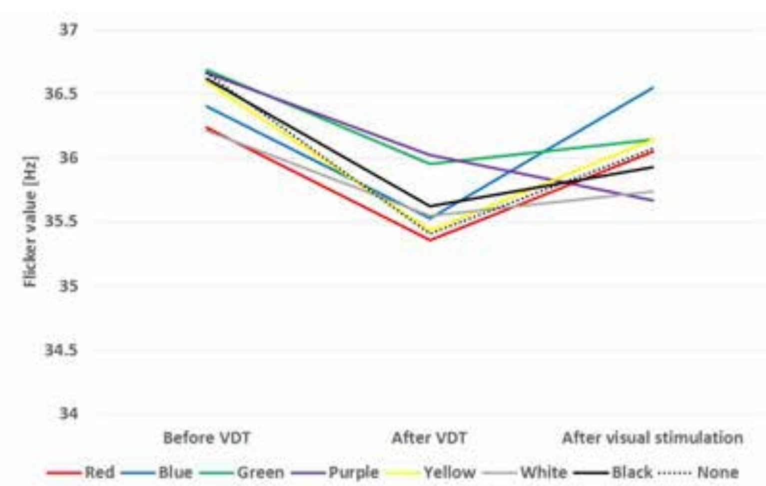

Figure 2. Average values of flicker

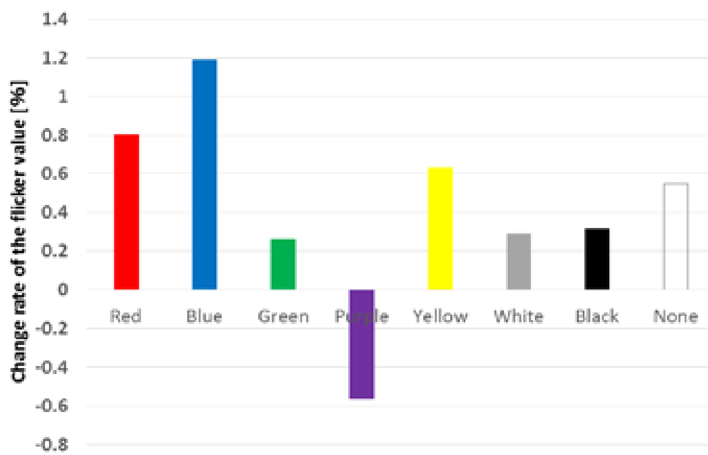

Figure 3. Change rate of the flicker value

4. CONCLUSION

This study measured flicker and amylase values for the purpose of clarifying the effect of the presentation of color on the recovery from fatigue. The results were as follows.

(1) Blue appears to have the most restorative effect during these types of visual stimulus conditions.

(2) It is suggested that there may be a color stimulus that is more effective in restoring eyestrain than green.

A more detailed investigation with an increased number of subjects will need to be undertaken in the future in order to confirm these initial findings.

This study was approved by the Ethical Review Board for the use of human subjects of Kanagawa Institute of Technology (No. 20170403-03)

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EFFECTS OF THE WAVELENGTH OF THE BLUE PRIMARY FOR THE METAMERIC COLOR MATCHING

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Keywords: Color matching, Metamerism, Color matching function, Nonlinearity

ABSTRACT

It has been known that the colorimetric match between two different media does not necessarily ensure the appearance match, and also observer dependent. One of the reasons for this phenomenon is considered to be the saturation dependent nonlinearity of color matching functions(CMFs). However, the effects of the nonlinearity of the CMFs on the metameric color match has not been clarified. In this study, we aimed to show empirically the effects of the nonlinearity of CMFs on the metameric matching between the reference stimulus with different saturation and the test stimulus composed of red, green and blue primaries. We adopted several different wavelengths of blue primary. Experimental results showed that the mismatch in chromaticities between the matched test stimulus and the reference stimulus were varied depending on the saturation levels. The more saturated the stimulus, the more the chromaticity difference. Moreover, the color difference increased with the shorter wavelength of the B primary.

INTRODUCTION

Recent years, color reproduction between different medias have become more important due to the advances in color reproduction technologies. Generally, it has been controlled so as to match the tristimulus values between the two medias. However, the colors still look different for real observers. One of the reasons for this phenomenon is considered to be the difference in color matching functions (CMFs) between real observer and the standard observer, which was defined by CIE in 1931. Moreover, failure of Glassman's law in the spectrum of the short wavelength range has been reported; the saturation dependent nonlinearity of CMFs, for instance, might play a role, as the CMFs measured for high saturated stimulus differ from those measured for low saturated stimulus in shorter wavelength region [1][2][3]. However, the effects of the nonlinearity of the CMFs on the metameric color match have not been clarified. In this study, we aimed to show empirically the effects of the nonlinearity of CMFs in short wavelength on the metameric matching between the reference stimulus of different saturation and the test stimulus composed of red, green and blue primaries. We adopted several different wavelengths of the blue primary.

STIMULUS

The test stimulus was composed of the mixture of red (peak: 643 nm), green (520 nm) LED and one of the four blue LED (415, 431 448 or 471 nm). The subject could alter the intensity of the three primaries. The reference stimulus was presented by using a programmable light source (The OneLight Spectra, Onelight Corp.). We made 10 color reference stimuli (Red, Green, Blue with three levels of saturation each, and White). The spectral radiances measured with a spectroradiometer (SR-3AR, TOPCON) are shown in Figure 1. Table 1 and Figure 2 show the luminances and chromaticities of the reference stimuli. Experimental apparatus is shown in Figure

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3. The test and reference stimuli were respectively diffused uniformly within the integrating spheres, and were presented in 2° bipartite field.

PROCEDURE

Before starting the experiment, the observer adapted for 3 minutes in an experimental booth. Then, one of the reference stimuli was presented to the right half of the bipartite area. The observer adjusted the intensities of RGB LEDs which were presented as the test stimulus (left half) to match the reference stimulus with a 6 buttons controller. When two fields were perfectly matched, the observer pressed the key, followed by a next trial. Each session was composed of 40 trials (reference stimuli of 10 colors × 4 blue primaries). We conducted 3 sessions for each observer.

Six observers, five males and one female, in their twenties participated in this experiment. All observers were confirmed to have normal color vision using the Ishihara-plate.

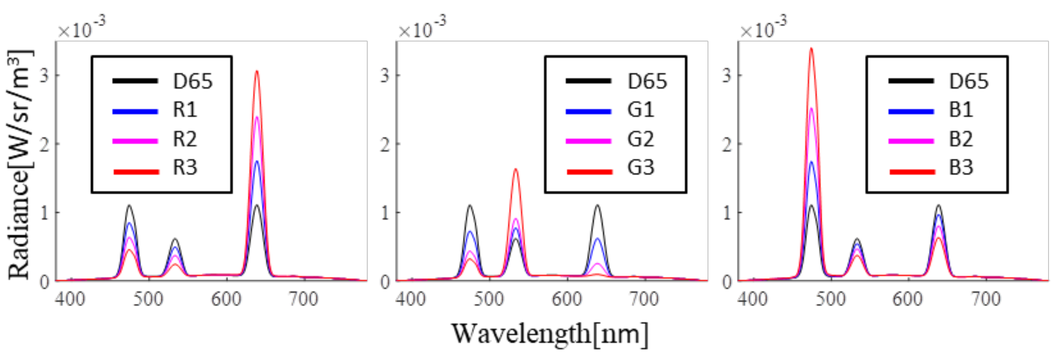

Figure 1: Spectral distribution of reference stimuli

Table 1: Luminance and chromaticity of reference stimuli

	u'	v'	Y
Red			
R1	0.2507	0.4777	15.1
R2	0.3029	0.4863	15.07
R3	0.3571	0.4932	15.11
Green			
G1	0.1652	0.4965	15.03
G2	0.1349	0.5233	15.17
G3	0.1031	0.5499	15.15
Blue			
B1	0.1869	0.4287	15.04
B2	0.1732	0.3904	14.99
B3	0.1617	0.354	14.89
White			
D65	0.1997	0.4668	15.22

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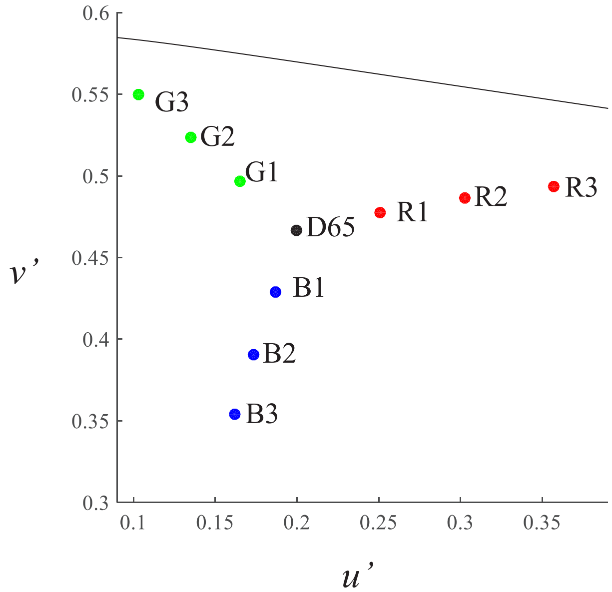

Figure 2: *u'v'*chromaticity diagram of the reference stimuli

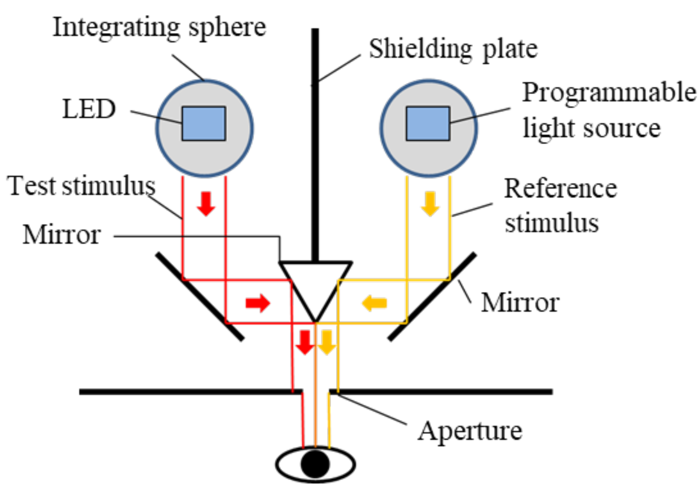

Figure 3: Experimental apparatus

RESULTS

On the left of Figure 4, the color matching results of all subjects are shown, and on the right of Figure 4 are shown the color matching results for the reference stimulus white and blue. A systematic color difference occurred in all reference stimuli. The chromaticity difference Δ*u'v'* was calculated from the color matching results. The results are shown in Figure 5. The chromaticity difference increased as the wavelength of B primary got shorter. Also, as the saturation of the reference stimulus increased, the chromaticity difference increased.

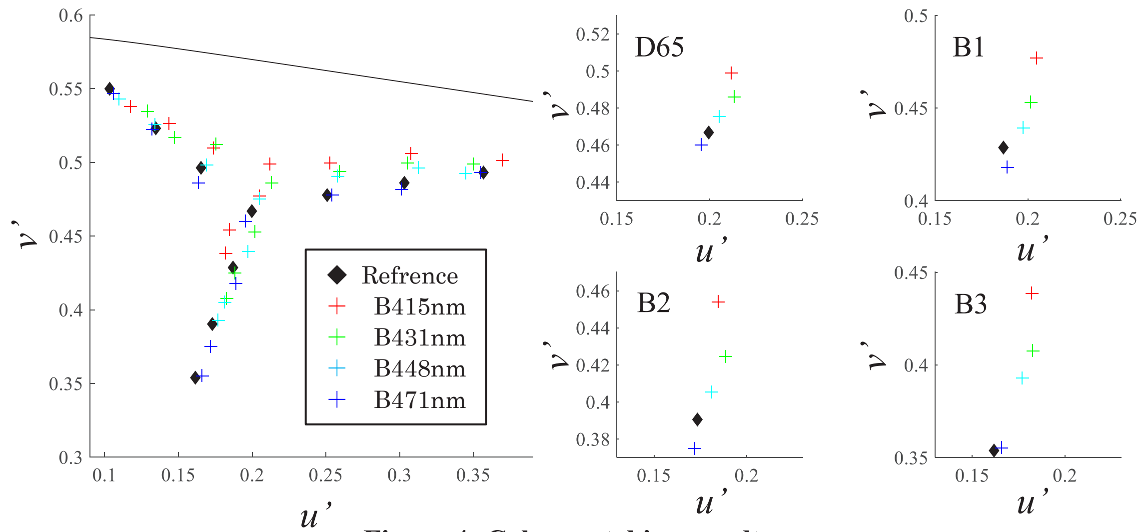

Figure 4: Color matching results

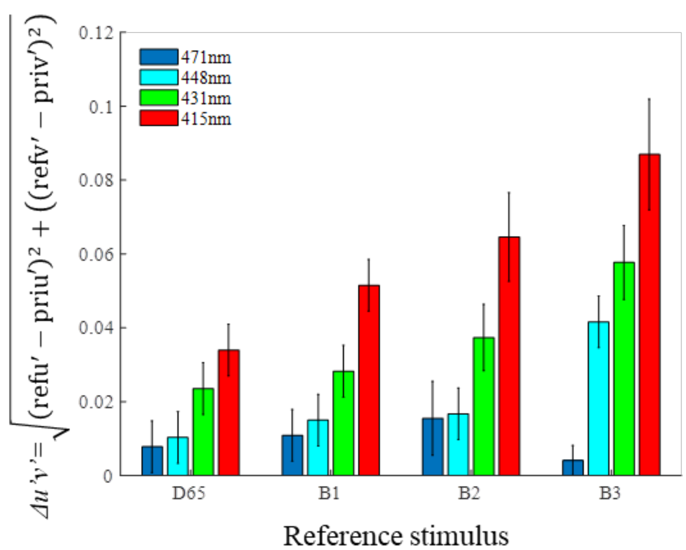

Figure 5: Chromaticity differences between matched reference and test stimuli

DISCUSSION

The color difference increased as the saturation of the stimulus increased. The color difference was larger with the shorter wavelength of the B primary. This trend is consistent with the previous study by Schanda et al. [4].

We further investigated the effect of short wavelength primaries on luminance difference, not only on chromaticity one, between the matched reference and test stimuli. Fig. 6 shows the luminance difference ΔY. As can be seen from the graph, as the peak wavelength of B primary becomes shorter, the luminance at the completion of the color matching tends to decrease. From this, it was found that the peak wavelength of the short wavelength primary has influence not only on the chromaticity but also on the luminance.

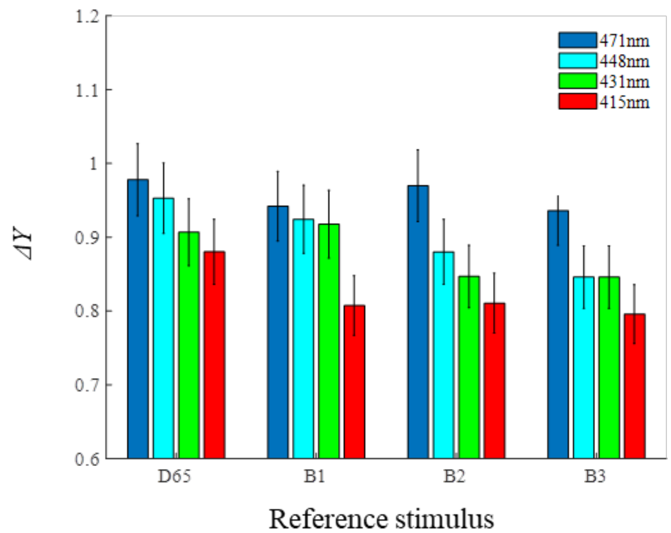

Figure 6: Luminance difference between reference and test stimuli

One of the reasons which may have caused our results is individual differences in color matching function. Therefore, we checked if individual color matching functions of the observers who participated in this experiment can reduce the color differences of the experimental results. The results are shown in Figure 7. The color difference remained, despite applying individual color matching functions. There was no significant differences when compared color differences obtained from CIE CMFs with those obtained from individual CMFs. From this results, we cannot conclude that the phenomenon obtained in our experiments is due to individual differences in color matching functions.

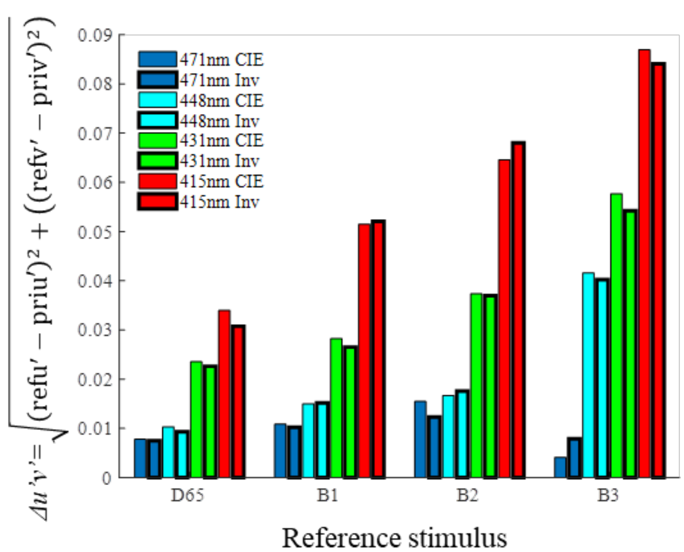

Figure 7: Color differences by individual color matching functions

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SUMMARY

In this study, color matching experiments were conducted between test stimulus which varied short wavelength primaries and the reference stimuli with different saturation. As a result, it was confirmed that color difference and luminance difference of matched colors were increased as the primary peak became shorter. The color difference may be caused by factors other than individual differences in color matching functions.

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RELATIONSHIP BETWEEN FACIAL PIGMENTATION DISTRIBUTION AND CONSPICUOUNESS

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Keywords: skin, pigmentation, conspicuity

ABSTRACT

Many people are interested in beautiful skin, and trouble with facial pigmentation such as spots or freckles. Otsuka et al. showed that the size of an individual spot has the strongest influence on the conspicuity of pigmentation [1]. However, their experiments were based on cheek images, and parameters are also number and area of pigmentation only. In this study, we investigated the effect of the distribution of pigmentation on the conspicuity of pigmentation on facial images. We conducted two experiments. In Experiment 1, we changed the density and position of pigmentation, and an image which pigmentation with original density was placed under the eyes was used as a reference image and the other modified images were used as test images. In Experiment 2, we changed the density and number of pigmentation while maintaining the total area of the pigmentations, and the image including one spot with the original density was used as a reference image and the others were the test images. A reference and a test image were presented side by side on an LCD monitor. Observers evaluated pigmentation on which image appeared more conspicuous. Our result suggests that the area of pigmentation affects conspicuousness the most, but there are also the influence of the density and position.

INTRODUCTION

Many people have trouble with facial pigmentation such as spots or freckles since they admire smooth skin. It is also well known that the pigmentation on the face greatly influences the impression from others. Masuda et al. proposed a method to measure melanin content for evaluating spots [2]. Ohtsuki et al. proposed a method to automatically detect spots from face images [3]. Various studies on facial pigmentation have been made, but a relationship between the characteristics of facial pigmentation and visual appearance has not been revealed sufficiently. Since we visually make a judgment whether the skin is good or bad, it is important to clarify what kind of facial pigmentation distribution influences our perception. Kikuchi et al. showed that the number and the area of facial pigmentation affect the conspicuity of facial pigmentation [4]. Otsuka et al. showed that the size of individual pigmentation has the strongest influence on the conspicuity of pigmentation. The conspicuity was higher in the uniform images and the pattern images than in skin images, suggesting that there is a visual characteristic unique to the pigmentation on the skin [1]. However, their experiments used cheek images, and parameters are also number and area of pigmentation only. If there is a visual characteristic unique to pigmentation on the skin, we expect that the same tendency would also appear for facial images. Also, it is thought that the density and position of pigmentation on a face influence the conspicuousness of pigmentation. In this study, we investigated the effect of the distribution of pigmentation on the conspicuity of pigmentation and a visual characteristic unique to the pigmentation on the skin by experimenting with facial images.

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EXPERIMENT

First, we prepared an average face of Japanese women. Since we used different female face in the previous study with the experiment of cheek images [1], the average $L^*a^*b^*$ values of the face image were adjusted to match the average $L^*a^*b^*$ values of the cheek image. Stimuli were created by combining the same pigmentation as the cheek image experiment with the adjusted face image. We prepared stimuli under two conditions. In Experiment 1, we changed the density and position of pigmentation as shown in Figure 1. The density was changed in three levels (light, original, and dark). $L^*a^*b^*$ values that moved 80% to the average $L^*a^*b^*$ value of the face on the straight line connecting the average $L^*a^*b^*$ value of the face and each $L^*a^*b^*$ value of the spot was taken as the color of the light pigmentation. The dark spots moved the $L^*a^*b^*$ value by the same amount in the opposite direction. The average $L^*a^*b^*$ value of face image and each pigmentation are shown in Table 1. The position was changed in three conditions (under the eyes, side of the cheeks, and under the cheeks). A total of nine stimuli were prepared by combining these parameters. The stimulus which pigmentation with the original density was located under the eyes was used as a reference image and the other modified images were used as test images. In Experiment 2, we changed the number of pigmentation (one or five) while maintaining the total area of the pigmentations the same, and density of pigmentation in three levels (light, original, dark) as shown in Figure 2. A total of six stimuli were prepared by combining these parameters. The stimulus which one pigmentation with original density was used as a reference image and the others were test images.

The experiment was carried out by presenting the images on an LCD (Liquid Crystal Display) in a dark room. Observers kept a viewing distance of 60 cm. The experimental procedure in both experiments 1 and 2 is the same and as follows. Following to a dark adaptation for 3 minutes, a gray background equivalent to Munsell N5 was presented for 2 seconds. Then, a reference and a test image were presented side by side at the same time for 2 seconds. After that, an observer evaluated the conspicuity of pigmentation on the test image while the gray background was presented again. The conspicuity of pigmentation on the reference image was set to 5 points and that of test image was evaluated using from 0 to 10 points. The score was higher than the 5 points if the test image was more conspicuous than the reference image, and vice versa. After the evaluation was completed, the reference image and the next test image were presented side by side. The order of presenting test images was random and the presentation repeated until all test images were evaluated. This process was set as one session, and three sessions were performed for each observer. The observers were two males and one female for Experiment 1, one male and one female for Experiment 2. Observers in Experiment 2 were the same as in Experiment 1.

Table 1: $L^*a^*b^*$ values of face image and the each pigmentation

	Face Image 	Light 	Original 	Dark 
L^*	73.90	73.18	67.58	62.57
a^*	11.57	11.41	11.10	10.62
b^*	19.15	21.55	28.05	34.79

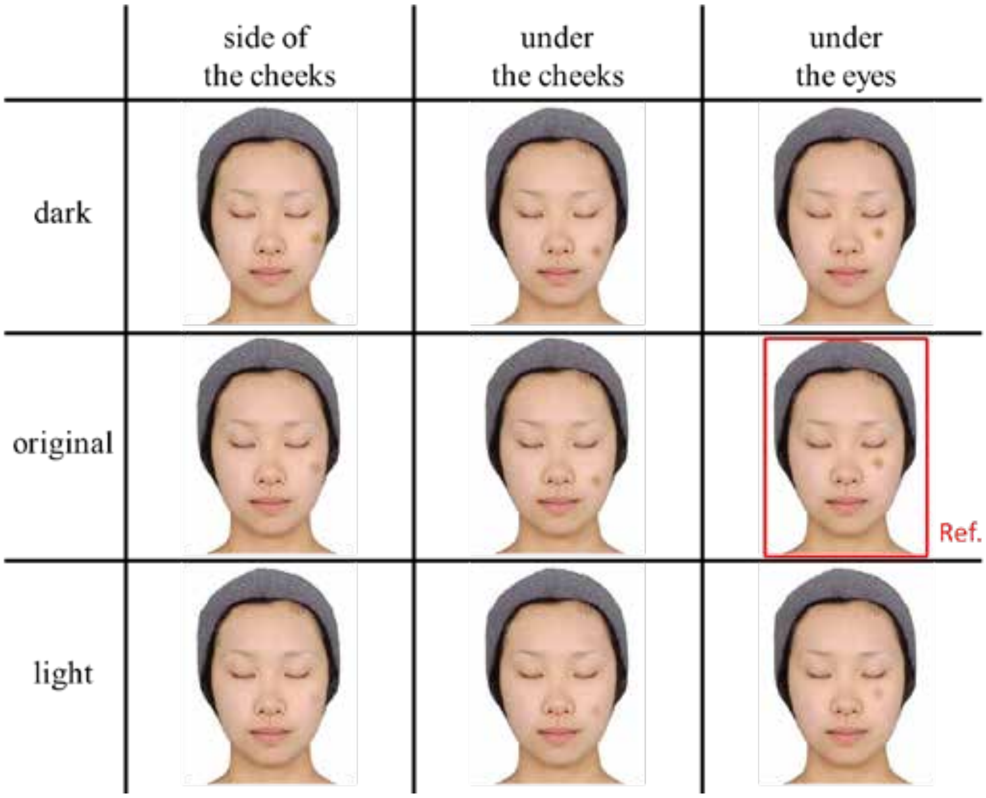

Figure 1. Stimuli of Experiment 1

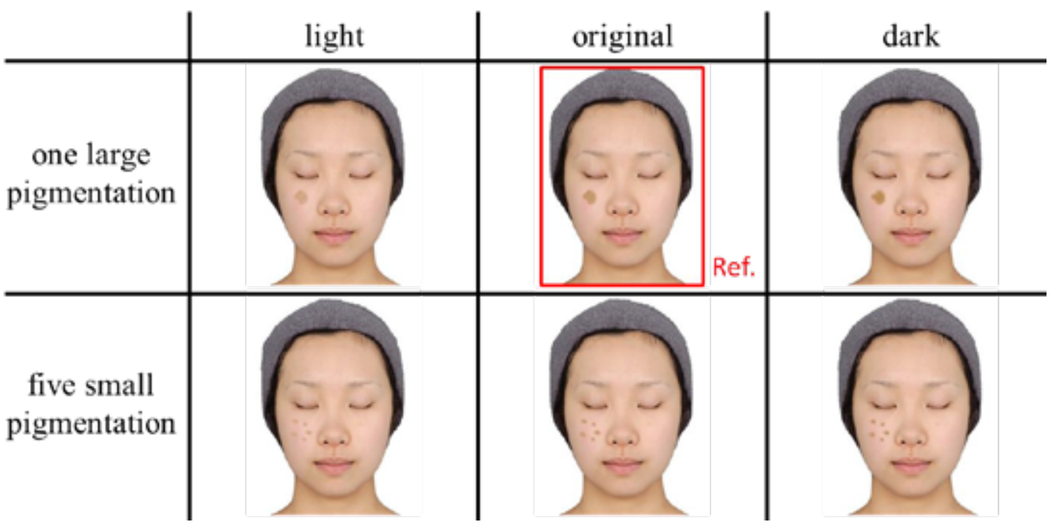

Figure 2. Stimuli of Experiment 2

RESULTS AND DISCUSSION

Figure 3 shows the results of Experiment 1. The value points are the average of three observers. Figure 4 shows the result of Experiment 1 summarized into a bubble chart. The horizontal axis shows the position of pigmentation and the vertical axis shows the density of pigmentation. The diameters of the circle represent the evaluation points, and the larger the diameter, the more conspicuous. From Figure 4, it can be seen that pigmentation is conspicuous as they are located under the eyes and are darker. It is suggested that the conspicuity of pigmentation in the center of the face was higher, and also the density of pigmentation affects the conspicuity of pigmentation. However, there is a noticeable difference from the reference when the pigmentation becomes lighter than when it becomes darker, which might suggest that conspicuousness does not change very much above a certain level of density.

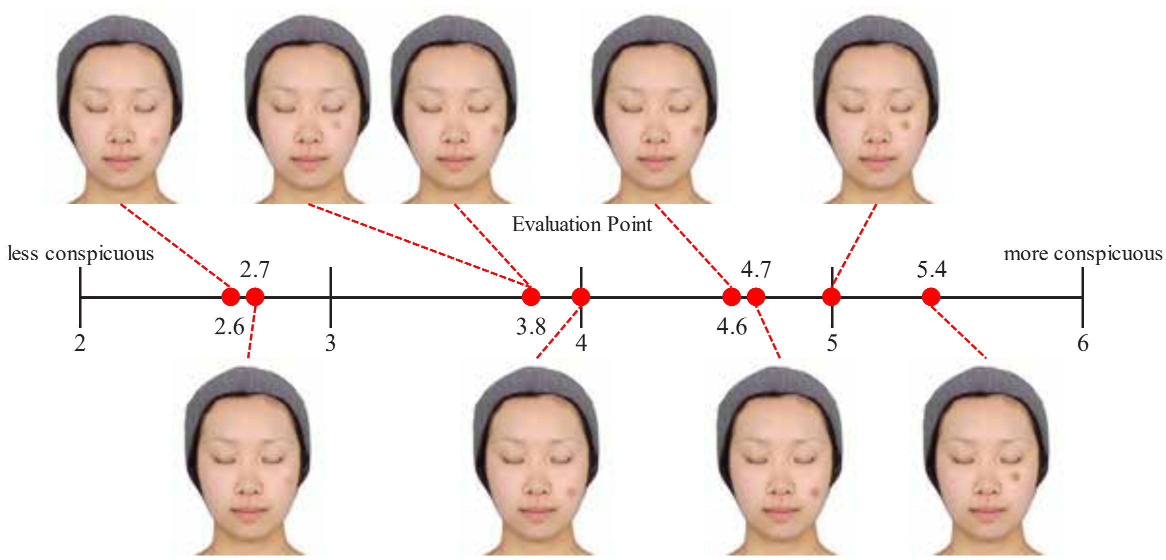

Figure 3. Results of Experiment 1

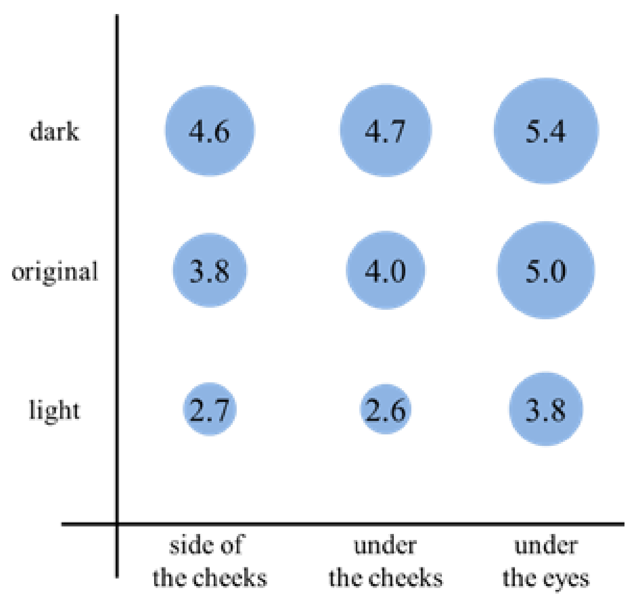

Figure 4. Results of Experiment 1 (circle)

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Figure 5 shows the result of Experiment 2. As can be seen from Figure 5, it tends to be conspicuous in the case that there is one large pigmentation compared to the case that there are multiple small pigmentations. This tendency is consistent with the result of the experiment for cheek images [1]. However, the conspicuousness evaluation of images with one light pigmentation and two or more dark pigmentations are almost equal. If a large pigmentation is simply more conspicuous, an image with one light pigmentation should be more conspicuous, but the result shows the influence of the density also.

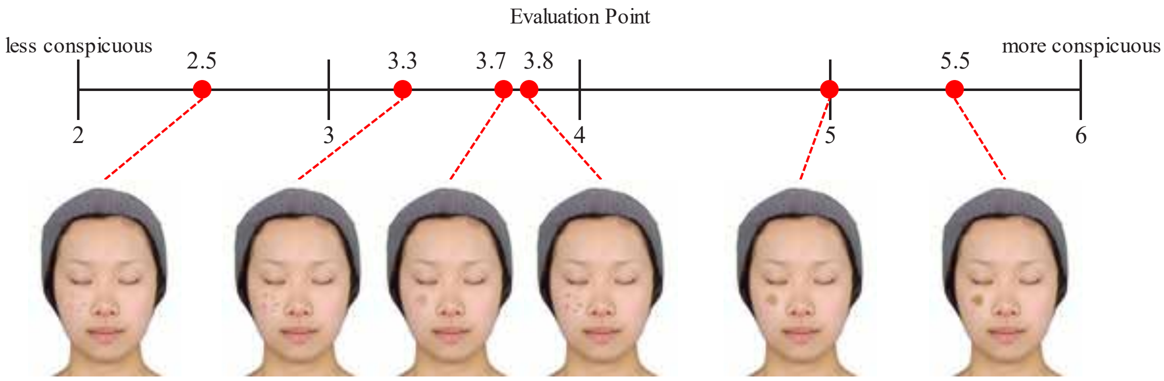

Figure 5. Results of Experiment 2

Our results revealed that the location and density of pigmentation affect the conspicuous of pigmentation, but the influence of the area of pigmentation on conspicuous was most significant. It is necessary to verify skin pigmentation by combining multiple parameters of the area, number, density, and position.

CONCLUSION

When the density and position of the pigmentation are changed, both parameters influenced the conspicuousness of pigmentation. When changing the density and the number of pigmentations, the influence on the conspicuousness of pigmentation is larger in area than in density. This trend is consistent with the experiment of cheek image in our previous research that the area of pigmentation significantly affects the conspicuity of pigmentation.

ACKNOWLEDGEMENT

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POSTER SESSION

SUBJECTIVE ASSESSMENT OF IMAGE QUALITY DEGRADED BY UNIFORM COLOR SHIFT

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Keywords: ACA2018, display, image quality, color shift

ABSTRACT

We conduct a study on the subjective image quality assessment of images in which the color is shifted uniformly. In the experiment, a reference image and a test image with a color shift were successively presented on a display screen. Observers evaluated the quality of the test image compared with the reference using nine grades of rating. Uniform color shifts were simulated on an image, under the assumption that the color shifts were caused by superimposition of colored lights cast on the display surface. Fifty-four variations of color shift were examined on 24 reference images. The experimental results showed that observers' ratings declined as the uniform color shift increased. The degradation of the image quality was observed in any direction of hue. The ratings were analyzed as a function of the mean values in a three-dimensional (3D) color space, such as the display RGB and the colorimetric $L^*u'v'$. The decline in rating fitted well to the 3D sigmoid function of the mean color shift in the $L^*u'v'$ space.

INTRODUCTION

As mobile devices such as smartphones and tablets are now widespread, their display screens are viewed in various lighting environments. In some situations, the colors of images may change depending on the influence of colored light. This results in a change in image quality. Although several studies have proposed image quality metrics such as SSIM [1] so far, only a few studies [2] [3] have focused on colors of images. Subjective assessment of image quality degradation caused by uniform color shifts restricted to the directions of red, green or blue was reported in a previous study [4]. In the present study, we subjectively assessed image quality when the colors of images were uniformly shifted in various hue directions.

When uniform light is superimposed on a display screen, the luminance increases, and the contrast decreases in inverse proportion. Therefore, it is possible to physically reproduce a color shift caused by colored light being superimposed on a display by adjusting the luminance and contrast in each RGB direction of an images. In this manner, we simulated a situation in which various colored lights were superimposed on an original image, and repeatedly conducted an evaluation experiment comparing the original image with the color-shifted image.

EXPERIMENT

Stimulus Images

In the experiment, 24 images downloaded from the Kodak Lossless True Color Image Suite [5] were processed to create reference and evaluation images. We adjusted the luminance of each of the RGB of each pixel of the Kodak images using equation (1) to create stimulus images.

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$$
\begin{aligned}
Y'_{Ri} &= I_R\overline{Y}_R + I_R C_R\left(Y_{Ri} - \overline{Y}_R\right)\\
Y'_{Gi} &= I_G\overline{Y}_G + I_G C_G\left(Y_{Gi} - \overline{Y}_G\right)\\
Y'_{Bi} &= I_B\overline{Y}_B + I_B C_B\left(Y_{Bi} - \overline{Y}_B\right)
\end{aligned} \tag{1}
$$

where Y_{Ri}, Y_{Gi}, and Y_{Bi} represent the RGB luminance values of the ith pixel in the original image, Y'_{Ri}, Y'_{Gi}, and Y'_{Bi} represent the RGB luminance values of the ith pixel in the stimulus image, and $\overline{Y}_R$, $\overline{Y}_G$, and $\overline{Y}_B$ represent the mean RGB luminance values of the original image. Images of varying brightness and contrast were reproduced by changing the luminance adjustment coefficients (I_R, I_G, I_B) and the contrast adjustment coefficients (C_R, C_G, C_B) in (Eq. 1).

In this experiment, we set $I_R = I_G = I_B = 0.5$ and $C_R = C_G = C_B = 0.5$ to create reference images without the superimposition of colored light. By this reduction, all the colors of the test images could fit within a display gamut. There were 24 reference images, and Figure. 1(a) shows a subset of them. To create test images to be evaluated, I_R and I_G were set to either 0.5, 0.55, 0.6, 0.7, 0.8, or 0.9, and I_B was set to either 0.5, 0.7, 0.9, 1.1, 1.5, or 1.9, simulating situations in which various colored lights were superimposed. The contrast adjustment coefficients were set inversely proportional to the luminance adjustment coefficients, i.e., $C_R = 0.25/\,I_R$, $C_G = 0.25/\,I_G$, $C_B = 0.25/\,I_B$. There were 54 combinations of luminance adjustment coefficients, and 1296 test images (24 reference by 54 color shifts) in total. Figure 1(b) shows a subset of the test images. Stimulus Images were generated and presented using Matlab and PsychToolbox [6] [7] [8] .

(a) Reference Images **(b) Test Images**

Figure 1. Subset of stimulus images

Method

The experiments were conducted in a dark-room. In the experiment, a reference image and a test image with a color shift were successively presented on a display screen. Figure 2 illustrates the flow of the experiment. In one sequence, an observer was presented with a reference image, a blank, and a test image in order, and finally conducted the evaluation. Observers evaluated the image quality of the test image compared to the reference using an extended degradation category rating (DCR) method described in Table 1. DCR is one of the experimental methods prescribed in the ITU-T Recommendations [9], where observers evaluate image degradations using a score of 1–5. As conventional DCR does not consider image improvements, we adopted extended DCR where observers evaluate both the degradation and improvement using a scale of 1–9.

Table 1. Extended degradation category rating (DCR)

score	Rating Word
1	Very annoying
2	Annoying

3	Slightly annoying
4	Deterioration perceptible, but not so annoying
5	Imperceptible
6	Improvement perceptible, but not so favorable
7	Slightly favorable
8	Favorable
9	Very favorable

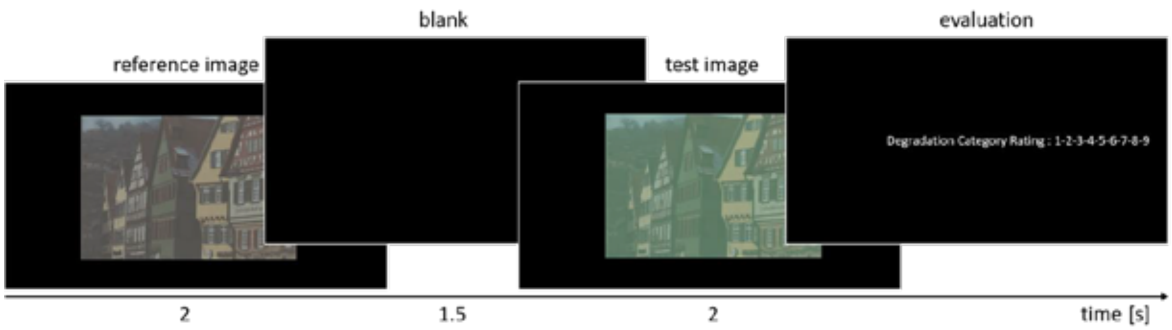
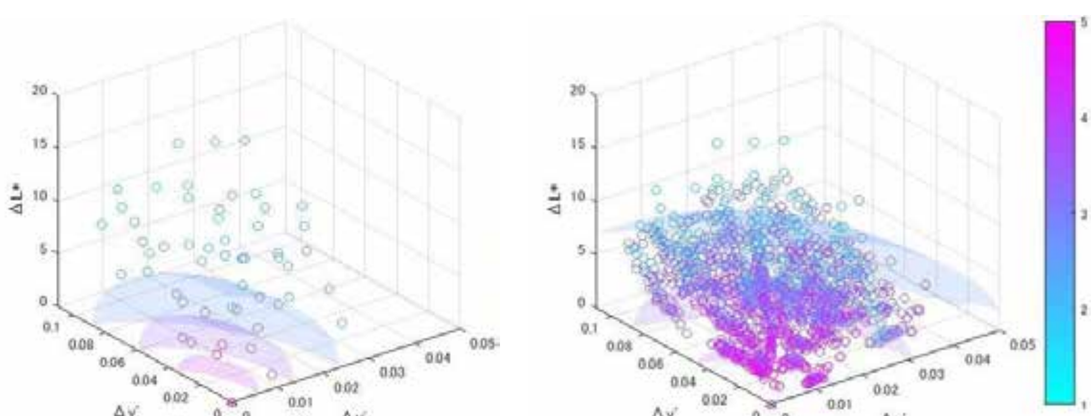


Figure 2. Experiment flow

EXPERIMENTAL RESULT

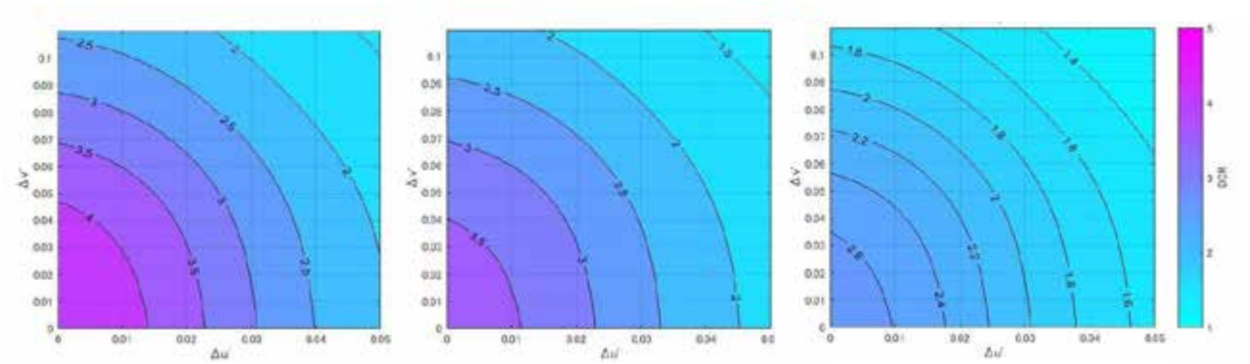
The experimental results showed that the observers' ratings declined with increasing uniform color shift. A degradation in image quality was observed in any hue direction. Because modification of the luminance adjustment coefficients (I_R, I_G, I_B) modulated different magnitude of the color shift among images, we introduced $L^*u'v'$ three dimensional (3D) color space. Here, $(\Delta L^*, \Delta u', \Delta v')$ represents the color difference between the mean chromaticity and the psychometric lightness of a reference image and those of a test image. Then the mean ratings of all observers were fitted with a 3D sigmoid function of $(\Delta L^*, \Delta u', \Delta v')$ shown in (Eq. 2). The mean ratings and contour surfaces at $DCR = 2, 3, 4$ of the sigmoid function are shown for one of the reference images in Figure 3(a) and those for all 24 reference images in Figure 3(b). Cross-sectional views of the sigmoid function from Figure 3(b) at $\Delta L^* = 0, 5, 10$ are shown in Figure 4.

$$\mathrm{DCR} = 1 + 4 * \left\{1 + exp\left(\frac{\Delta u' - \mu_{\Delta u'}}{\sigma_{\Delta u'}}\right)\right\}^{-\frac{1}{3}} * \left\{1 + exp\left(\frac{\Delta v' - \mu_{\Delta v'}}{\sigma_{\Delta v'}}\right)\right\}^{-\frac{1}{3}} * \left\{1 + exp\left(\frac{\Delta L^* - \mu_{\Delta L^*}}{\sigma_{\Delta L^*}}\right)\right\}^{-\frac{1}{3}} \quad (2)$$



(a) One reference image **(b) All 24 reference images**

Figure 3. Mean rating and contour surfaces of fitting 3D sigmoid function



(a) $\Delta L^* = 0$ (b) $\Delta L^* = 5$ (c) $\Delta L^* = 10$

Figure 4. Cross-sectional view of the sigmoid function from Figure 3(b)

DISCUSSION

From the analysis focusing on the differences in rating value declines among 24 references, it was found that $\mu_{\Delta L*}$ became smaller as the average psychometric lightness of a reference image became higher. For this reason, we believe that a reference image with a high mean psychometric lightness gave observers the impression that it was too bright with a small color shift, and this led to the result that the rating asymptotically approached 1 (the lowest score) with smaller ΔL^*.

Furthermore, for reference images whose average chromaticity was far from the achromatic color, the rating did not change significantly with changes in $\Delta u'$ or $\Delta v'$. On a deeply-colored image, color shifts in a similar direction, i.e. in saturation, might be hardly perceptible.

In this study, we attempted to establish an image quality assessment index based on color difference. However, our experimental results indicated that the image quality degradation depends not only on the color difference, but also on the original image itself. In order to establish an image quality assessment index with a higher accuracy, the mean psychometric lightness and chromaticity (L^*, u', v') of an original image as well as the mean color shift $(\Delta L^*, \Delta u', \Delta v')$ should be incorporated as input values of the image quality assessment function.

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Structure and Appearance of All-Organic Gold Metallic Lustrous Films

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Keywords: Color material: Gold ink: Organic chemistry

ABSTRACT

Gold metallic luster is one of the most attractive colors in human arts and crafts. However, no metal-free goldlike ink is in commercial use. Under these circumstances, our group has been studying metal-free goldlike lustrous films of 3-methoxythiophene oligomer. In this study, the effect of polymerization conditions on the color and film structure was investigated. Specifically, it was found that reaction time and adding speed of oxidant solution to the monomer solution influenced the color and surface condition of films. In this chemical synthesis of 3-methoxythiophene oligomers, copper(II) tetrafluoroborate was also used as a nonexplosive oxidant as well as Iron(III) perchlorate which has been used in our previous study. The color of oligo 3-methoxythiophene film varied depending on the synthesis conditions and dopant species, ranging from copper color to greenish gold color. The surface condition was also changed by the synthesis conditions.

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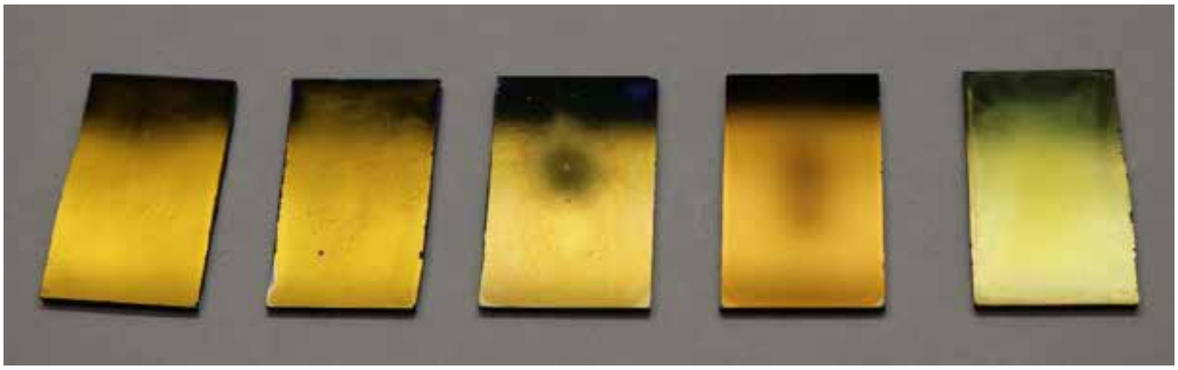
INTRODUCTION

Gold color is distinguished from other metals by the selective reflection from red to green. It is well known that metal gold has various color tones such as pink, yellow, green, and white gold, and the color tone is determined by the purity and impurity species. In commercially available gold color inks, use of metal flakes (aluminum, copper, zinc, copper-zinc alloys, etc.) is most common way to express metallic luster in printed materials; however, metal flakes are too large in specific gravity to be stably dispersed in inks. It is also widely known that some insects have metallic appearances such as golden beetles, morpho butterflies, buprestids. Their metallic color is created through the submicron structures. Such structural colors are studied by biologists and mimicked by photonic liquid crystals. With this situation as a background, some candidates for alternative nonmetallic materials to metal flakes have been developed in response to the rapid growth of printing techniques. Some research groups developed all-organic nonmetallic goldlike materials, but they won't appear in the market [1-8]. Our group has reported all-organic goldlike films of 3-methoxythiophene oligomer [9-14] which was the first to be dissolved in solutions, coated in the form of a film, and stable in air. Quite recently, our group also reported that the electrochemical oxidation provided the similar goldlike lustrous films on the electrode [15-17]. In a series of these studies, we found that the oligomers self-organized into the lamellar structure on a substrate during the coating and drying processes to provide films with a goldlike luster, i.e., goldlike luster was caused by the compact lamellar crystallites. The major synthesis process of the 3-methoxythiophene oligomers is the chemical oxidation polymerization, and therefore, in this study the effect of the polymerization conditions on the color and film properties were investigated. As a result, it was revealed that the lustrous color tone was modified by varying the polymerization conditions.

METHODS AND RESULT

The 3-methoxythiophene oligomers were prepared by dropping the acetonitrile solution of iron(III) perchlorate, $Fe(ClO_4)_3$, into the acetonitrile solution of 3-methoxthiphene in an inert atmosphere. The resulting product was filtrated, washed with methanol, and dried to provide the oligomer powder with a navy blue color. A coating solution was prepared by dissolving the oligomer powder in nitromethane. The surface properties (color, luster, and roughness) of the films were greatly affected by the dropping time (Figure 1a – 1d). As described above, the solution of $Fe(ClO_4)_3$ was added through dropping funnel into the 3-methoxythiophene solution. A prompt dropping led to the formation of a film with more surface smoothness and yellowness, however, a slow dropping resulted in a film with less surface smoothness and yellowness. The time of agitation after the dropping affected neither the film color nor the reaction yield. It seems that one hour agitation is enough for the oligomerization to be completed. The gel permeation chromatography and elemental analysis revealed that the 3-methoxythiophene oligomer had a weight-averaged molecular weight of 2.4×10^3 and doped with perchlorate anion (doping level, 30%). Copper(II) tetrafluoroborate was used as an oxidant instead of the above iron(III) perchlorate, and the films doped with tetrafluoroborate were prepared. The color was more greenish than that of the perchlorate-doped films (Figure 1e). The color and surface properties of the films were not affected by the dropping time, and the time of agitation after the dropping affected the reaction yield, being in contrast to the case of the perchlorate-doped films.



(a) (b) (c) (d) (e)

Figure. 1 Photographs of goldlike lustrous films of perchlorate-doped 3-methoxythiophene oligomers which were polymerized by dropping the oxidant solution for few seconds (a), 5 min (b), 20 min (c), and 60 min (d). The image (e) shows the 3-methoxythiophene oligomer film doped with tetrafluoroborate, BF_4^-.

CONCLUSION

The goldlike lustrous films of 3-methoxythiophene oligomer were prepared by the oxidative polymerization while varying the polymerization conditions and the kind of oxidant. The results revealed that the goldlike color and surface properties were tuned by controlling the dropping speed of oxidant solution, agitation time, and oxidant species. These results should contribute to the development of goldlike color library of all organic materials.

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THE DESIGN OF INTERACTIVE VIRTUAL BOARDS FOR DRAWING AND PAINTING USED LED LIGHT AND INFRARED PEN: A CASE STUDY OF GRADE-1 STUDENTS OF SIRINUSONVITAYA SCHOOL

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Keywords: Interactive Virtual Board, Human Computer Interaction, User Interface Design, Drawing and Painting, LED Light and Infrared pen

ABSTRACT

A Virtual Board is a kind of new technology that can increase the interest of learning and supporting development of the primary school students. This paper studied interactive virtual boards for drawing and painting used LED Light and infrared pen in the case of Grade 1 students of Sirinusonvitaya School. The purpose of this research is composed of 1) to study the number of tools clicking interacting with devices of virtual drawing and painting board and 2) to design the user interface and experiences. The researchers contacted 15 grade-1 students from Sirinusornvitaya School who were tested to evaluate by observation and questionnaires. When the devices were set up and connected by using Computer (15.6" FHD Dell), Wii-mote and a projector to control the program and toolbar to draw and paint the virtual board software. The result showed in the part 1 that big size of brush was mostly selected, and it was high frequency click at orange, green, pink, light blue respectively. In addition, the most selected color we can divide into 2 tones that was warm and cool tone, but it was not shown statistically different among the two tones color, so based on the result the varieties color may be proper for grade-1 students. The result of part 2 experiment showed high score of Drawing and Painting Virtual Boards at easy to use with 73.33% of responses, the colors and sounds of the program were appropriate, the infrared pen was convenient, and wallpapers were various to choose. Therefore, the Virtual Model is satisfied.

INTRODUCTION

The amount of clicking to choose tools represented an important index of success for design and was resulted in the interest of the children towards learning of designing and painting. The picture design was associated with imagination and trend of color selection of products and works in different professions for children who in the future will develop their careers in the society. Virtual Whiteboard, which probably is an alternative solution for modern electronic whiteboards based on electronic pen and sensors, was presented. The presented tools enabled the user to write, draw and handle whiteboard contents by using LED Light and infrared pen. The users' interaction with the Virtual Whiteboard computer application was based on dynamic hand gesture recognition. A typical interactive whiteboard setup consisted of four main components; a computer, a digital projector, devices for interaction and software tools which were compatible with the operating system and hardware. In this case, the interaction could be illustrated in different ways such as optical, capacitive, resistive, electromagnetic and ultrasonic. These methods or techniques were divided into two categories as active markers and passive markers. The markers were used to interact with the board

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surface. The active markers were a source of signal such as light with good stability, e.g. Infrared LED, Laser pointer. The passive markers carried a wide range of reflection, which were unstable to detect signal, e.g. Retro-reflective tape, color tape, color token, etc. For the price, the active markers were expensive but carried a high detection rate while the passive markers had low cost and low detection rate. The Wii-based interactive whiteboard was invented by Johnny Lee, in 2007. The setup consisted of a computer, projector, a Wii-remote and an infrared pen. The Wii-remote was connected to the computer via Bluetooth and had an IR camera acted as a tracking device which sensed the infrared light emitting from the infrared pen. The projector projected the computer content on the board surface and then the users used the infrared pen as a pointer to operate or control the content on the board surface. This approach was user-friendly, highly flexible and moderately inexpensive.[1)] In Human Computer Interaction (HCI)[2)], the users interacted with the computers through keyboard and mouse requiring physical touch to these devices. But, the camera-based perceptual system provided an alternative way to interact with the computer. In this system, generally a webcam was used to track the movement made by users and the tracked movement was then translated to the motion parameters to operate the computer. The field of Computer Vision, Human Computer Interface (HCI), and Perceptual User Interface (PUI) had provided a way to ease the interaction with computing systems. Aniket Kudale and Kirti Wanjale,[3)] proposed an interaction-based projection display system in which the projector projected computer's desktop on board surface where users could interact with the content projected on the surface by using infrared LED pen, the study showed that the prototype was comparatively low in cost, compatible with windows and Linux platform and also easy to use. The basic framework of interactive projection system was presented in Figure 1.

Figure 1: Basic Framework of Interactive Projection System Overview

Generally, the projector and camera were fixed. The computer screen could be projected on the wall or whiteboard or any other flat surfaces by adjusting the projection angles of the projector. Since the size of the screen was adjustable, it satisfied the most of the applications' requirements.

EXPERIMENT

In this section, the experiments included Drawing and Painting Virtual Board software, experimental setup and controllable factors. The experiment of this research was divided into four parts: **Firstly**, two categories of virtual mode selected (Fig. 2a) were Virtual Painting Mode (Fig. 2b) and Virtual Drawing Mode (Fig.2c) as shown in Figure 2. Each category was divided into three parts (Farm, Town and Sea) and none was in drawing mode as shown in Figure 2. Then, five paintings for painting mode and three backgrounds in the drawing mode were prepared as shown in Figure 3.

(a) 2 selected categories

(b) Virtual Painting Mode

(c) Virtual Drawing Mode

Figure 2: Drawing and Painting Virtual Board

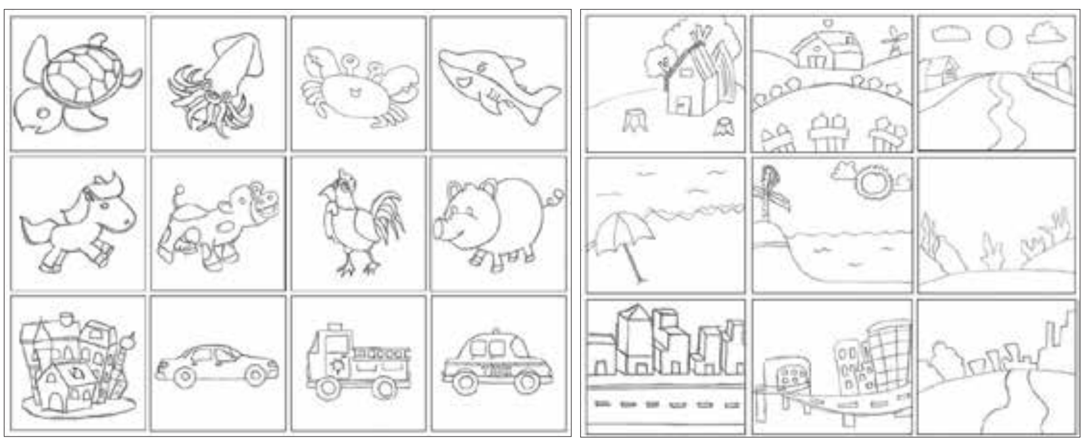


Figure 3: Examples of Painting Picture and Drawing Background

Secondly, this research was conducted by testing and recording. The interaction of software development was also divided into four groups of features: 1) Paintbrush (p0 was a small size of paintbrush, p1 was a middle size of paintbrush, and p3 was a big size of paintbrush) 2) Geometry (s0 was circle, s1 was square, and s2 was line) 3) Colors (c0 was white, c1 was black, c2 was brown, c3 was blue, c4 was light blue, c5 was purple, c6 was pink, c7 was green, c8 was light green, c9 was yellow, c10 was orange and c11 was red) and 4) Rubber as shown in Figure 4.

Figure 4: Drawing and Painting Design (3 Paintbrush, 12 Color, Pencil and Rubble).

Thirdly, the researcher contacted and asked 15 grade-1 students from Sirinusornvitaya School to test for an evaluation by observation and questionnaires, when done with setup devices and connecting with Laptop (Dell), Wii-mote and Projector to control the program and toolbar to draw and paint the virtual board software shown in Figure 5. The hardware prototype consisted of the projector, an Infrared LED pen and the computer. The projector was connected to the computer, which projected computer content on plane surfaces (e.g. LED Board, whiteboard, walls) while the infrared LED pen was used to interact with the content projected on LED small portable. The infrared pen is Infrared LED connected to a battery in series with momentary switch shown in Figure 6.

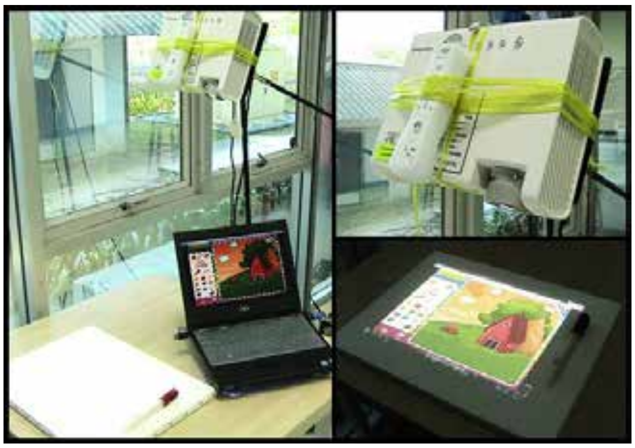


Figure 5: Setup and Connection Device

The main components of the system were: Initially, AV-YG320 Mini LED Pocket Projector 1080P (HDMI/USB/SD), its native resolution was 1280x800 (WXGA) with focus adjustment which allowed screen sizes from 20 inches up to 240 inches. Secondly, Infrared LED pen dimension was 5mm (TSAL6400 940nm, Wave length: 940nm, Battery: 2xAA one button, Pen length :14.3cm, Pen diameter:1 cm, Pen weight: 18 grams, its shell material: ABS plastic, Color: White). Thirdly, Wii-mote (Wireless remote controller, 8-way cross button, Motion control with built-in, speaker and vibration.

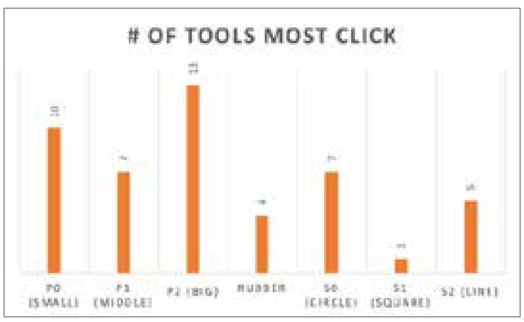
Next, the LED small portable drawing tool for children was used to study drawing and painting with tracing light pad (Coupled with the PVC reflector on the bottom, which the light pad was a very uniform illumination effect and the intensity of the light was 10000-20000 LUX). Finally, the laptop (15.6" FHD, Intel Core i7 @ 2.90GHz CPU, 512 GB HDD and Quad-CORE RAM Dell Notebook) was to interact the ended-users and software.

Figure 6: Infrared pen, Computer, Wii-Mode and Projector.

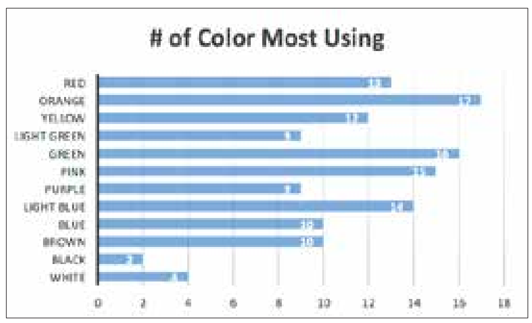
Fourthly, the questionnaires were separated into two sections (interactive and user interface design). The subjects must be in the age of 6-7-years old in the experiment which were 15 subjects of grade 1 in Sirinusonvitaya School and 10 minutes per player were limited. The scale was divided into 1 for not interactive and very satisfactory, 2 for interactive for 1-5 times and less satisfied, 3 for interactive for 6-10 times and moderately satisfactory, 4 for interactive for 11-15 times and very satisfactory, 5 for interactive for 15 times or more and highly satisfactory.

RESULTS AND DISCUSSION

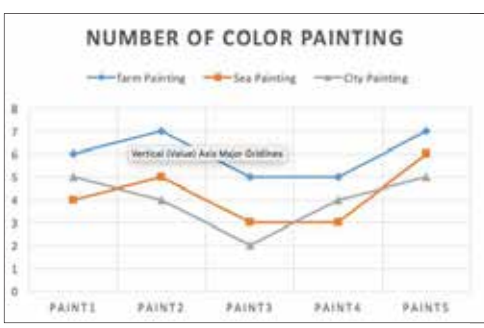
15 grade-1 students were classified in genders of six females and nine males. The results were divided into two parts: **Part I,** this research showed that 1) The highest number of times selecting tools was 13 with large brush, the second highest tool was small brush (Fig.7a) 2) The most used color was orange with 17 times which was followed by 16 times of green and 15 times of pink (Fig.7b) and the lowest was black for two times 3) The most chosen picture pattern in color painting of Painting Mode was farm painting, sea painting and city painting respectively (Fig.7c) 4) The most chosen pattern in color painting for Drawing mode was city drawing, none background, sea drawing and farm drawing respectively (Fig.7d) and 5) The relation between pictures and colors was the same picture and color selection which were black, light blue, pink and green respectively.

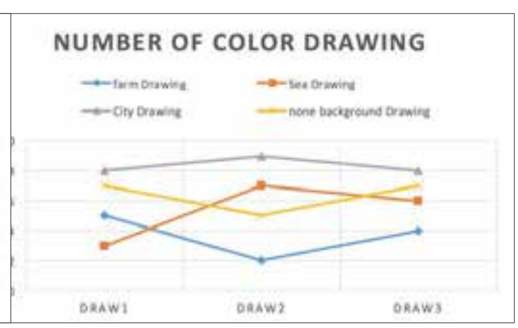


(a) Number of users clicking on the widget.



(b) Number of users clicking on the color





(c) The color painting most chosen by students (d) The picture most chosen to draw by students

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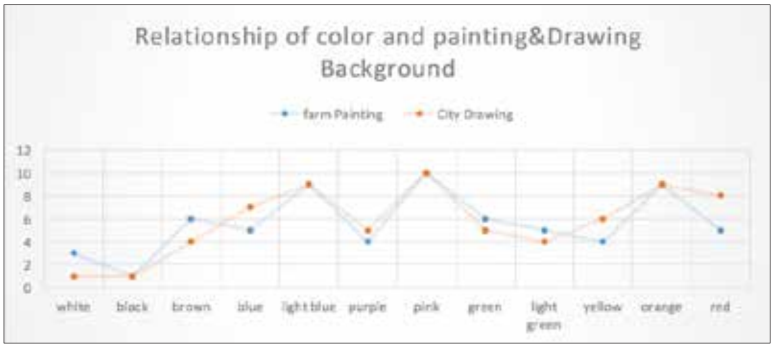

(e) Relation between colors and drawing pictures, and color painting pictures

Figure 7: The overall of interactive tools and coloring.

Part II, the result showed that the highest score went to Drawing and Painting Virtual Board with its capacity of easiness to use, appropriateness of its program colors and sounds, convenience with its infrared pen and various wallpapers of the virtual Model. So, the overall was good shown in Figure 8.

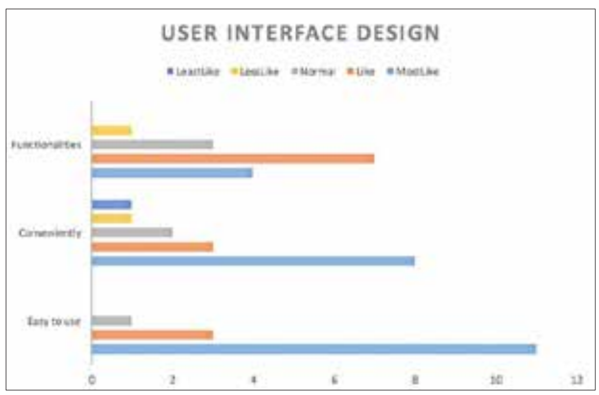

Figure 8: User Interfacing Design

This research found that the most chosen tool was the huge brush. When stating of art and color painting, pre-kindergarten and kindergarten students would initially think of brushes for painting art because teachers or babysitters as well as families in Thailand have been cultivated that art needs to be used by brushes. The most used colors in this research, based on the total of 12 basic colors in the normal color pencil boxes which have been widespread in the stationary market, was orange followed by green which the clicking number was different only one click. Both orange, which was in warm color tone, and green, which was in cool color tone, were described in the child psychology that the warm color tone affect feelings of excitement, enthusiasm and vigorousness was warm caste and cool color tone has given the feelings of peace and freshness.

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POSTER SESSION

A NOVEL COLORIMETRIC BIO-BASED INDICATOR USING NATURALLY EXTRACTED DYE FROM RED DRAGON FRUIT SKIN

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Keywords: Color Transition, Betacyanin, Natural Dye, Red Dragon, Indicator

ABSTRACT

The natural dye is increasingly interesting for many applications such as in food and drug additive and with the environmental-friendly concept used in textile, pulp and paper, as well as printing ink. The study aimed at investigating the effects of pHs and temperatures of the color transition of naturally-extracted dye from the skin of red pitaya (RP) or red dragon fruit (*Hylocereus costaricensis*) which is waste product appearing in deep red-purple consisting of high concentration of betacyanin which can be possibly used in intelligent packaging technology as well as commercial bio-indicator ink. High concentration of RP solution (h-RPs) was extracted by solvent-soaking method. The 1:10 ratio diluted h-RPs with distilled water was tasted under different temperatures and also different pH buffer solutions. The results revealed that the L* a* and b* values of h-RPs were 83.20, 7.13, and -7.30, while a maximum absorbance (Abs_{max}) was 540 nm. The h-RPs could change color shades from pink to red-orange and yellow, respectively, depending on the temperatures and alkaline solution. The time of color transition was related to initial rate (ki) which could be calculated from the activation energy (Ea) of the RPs which was 51.1752 kJ mol^{-1}.

INTRODUCTION

Natural colorants used as colorimetric bio-indicator is interesting todays due to the perception of consumer for its lower risk. However, there are few published data in the scientific literatures related to bio-indicator for intelligent packaging and anti-counterfeiting applications [1], [2].

Many kinds of natural colorants can be used as a natural indicator of temperatures in intelligent packaging systems since its characteristic of color changed when exposed to different temperatures and light [3]. There are various natural colorants such as curcumin from turmeric (curcuminoid), lycopene from tomatoes (carotenoid) and anthocyanin from blue flowers [4], vegetables and fruits (flavonoid), etc. [5].

Hylocereus cacti, known as pitaya or pitahaya, has recently been drawn much attention of growers worldwide, not only because of their economic value as food products but also for their antioxidative activity from the betacyanin content. The pitaya, a kind of fruits with some strains under the cactus family, is native to the tropical forest regions of Mexico and South America. The skin of pitaya is covered by bract scales, so-called dragon fruit. Currently, it is commercially grown in Taiwan, Nicaragua, Colombia, Vietnam, Israel, Australia and the USA as well as Thailand [6].

Nowadays the variety of dragon fruit, which are more productive and low price, is the *Hylocereus undatus* that is pink-skinned with white flesh, while the *Hylocereus costaricensis* which has red-skinned with red flesh is sweeter and smaller than other varieties. As the nutrient content of raw dragon fruit showed that a 100 g amount of dragon contains 66 kilocalories, 12.4 g of carbohydrates, 1.4 g of protein, 32 mg of phosphorus, 9 mg of calcium and 7 mg of vitamin C, as well as 2.6 g of fiber [6], [7], [8], [9]. Hence, the dragon fruit has gained popularity as healthy food.

However, many reports found that 33% wt. of dragon fruit has skin which contains many ingredients such as amylase enzyme, cellulose and betalain. Betalain is one of natural colorants which are incomparable and unique color because almost every colorant in natural plants and flowers is chlorophyll, carotenoid, flavonoid, and anthocyanin. Betalains are composed of betacyanin (appearing in red-violet color) and betaxanthins (appearing in yellow color), which are water-soluble pigments that provide colors in flowers and fruits, especially in red dragon (*Hylocereus costaricensis* or *Hylocereus polyrhizus*) fruit skin [7], [8].

This study demonstrated the use of red dragon or red pitaya (RP) skin which is waste from agriculture by using high polar solution and developing for a colorimetric bio-indicator film. This also investigated the effects of temperatures and pHs of RP solution, and RP indicator film that their colors and structures could be changed. The color change affected by RP will be novel covert technology that is an effective and convenient visual tool for intelligent packaging technology and anti-counterfeiting technology in a category of security printing and packaging technology.

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EXPERIMENTAL

Materials and Chemicals

Red dragon (red pitaya (RP), *H. costaricensis)* from Chantaburi province was purchased from Talaad Thai market (Agricultural Wholesale Center, Klong Luang, Pathumthani, Thailand) and chosen by its appearance of red and clear skin as well as weight of each RP sample of 230.00 ±10.00 g. Then, all samples were cautiously transported to the laboratory within 2 h and stored under refrigerator with storage temperature of 4 ±1 °C until used.

Ethanol (C_2H_6O) was used as a main solvent for extracting betacyanin (betalain) dye from red dragon peel. Acetic acid ($C_2H_4O_2$, Merck KGaA, Germany) and sodium hydroxide (NaOH, Ajax Finechem, Australia) were used to verify pH conditions of the RP-dye solution. In order to fabricate the RP indicator film, methyl cellulose (MC, Methocel®, Dow Chemical, USA) was used as a bio-film former (bio-based polymer) and distilled water (DI-water) was used as a solvent.

Betalain extraction from red dragon peel

Betalain is a natural colorant that can dissolve in polar solvent. In this experiment, red dragon peel was prepared by cutting out all dirty surface, dried skin and bruised area. After that, the sample was washed, peeled and removed fruit pulp as well as separated the red dragon peel for the dye extraction step. 30 g of grinded Red dragon peel were placed into a 250 ml flask followed by 100 ml of 50 wt.% ethanol. Then, it was immediately stirred intensively for 10 min. Homogeneous solution was closed with paraffin film and aluminum foil, and kept under lab condition in the dark for 24 h. The solution was filtrated by using a Buchner-funnel with no. 4 filter paper (Whatman™, 90 mm Ø).

Preparation of red pitaya solution (RPs) and red pitaya bio-indicator label (RPi)

RPs can be prepared by following [2] adaptation. The high concentration of RPs was diluted with distilled water with a ratio of 1:10 parts. 10 parts of 10 wt.% MC were mixed with 1 part of RPs and gradually stirred at least for 10 min or until they were in the same composition. After that, 10 g of the bio-indicator solution were fabricated to a thin bio-indicator film by casting film method, using a petri dish (20 × 100 mm), and then dried under lab condition (60 %RH, 25 °C) for 24 h. The dried film was gradually peeled and cut into a small square label with average size of 15 × 15 mm, and kept under vacuum packaging with high barrier material (Nylon/Al/LLDPE) until used.

Determination of color transition of red pitaya solution (RPs) and red pitaya bio-indicator label (RPi)

RPs were stored under different accelerated conditions which were 60, 75, 90 and 120 °C, respectively. Color transition of the samples was monitored in light absorbance (Abs) with time intervals of 5, 10, 15, 30 or 60 min by using a visible spectrophotometer (CM-3700A, Spectrophotometer, Konica Minolta, Japan) with a plug-in software (SpectraMagic NX, Konica Minolta). In the meantime, color transition of the RPi was checked in L* a* b* mode by hand-held spectro-densitometer (X-rite eXact, D65, USA). The L* a* b* chroma system used the corresponding value of total color difference (ΔE) as dynamic parameters was used to analyze the dynamic change in the bio-colorimetric solution. The total color difference (TCD) was expressed as follows:

$$\Delta E = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2} \quad (1)$$

Where ΔL* is the brightness difference between initiation and each time interval, Δa* is the redness-greenness difference between initiation and each time interval, and Δb* is the yellowness–blueness difference between initiation and each time interval.

From the latter, the ΔE value reveals the color transition of RP which is affected by temperatures. Hence, the linear relationship between color transition and temperature can be calculated for the reaction initial rate (ki) and activated energy (Ea) using Arrhenius's equation as follows:

$$\ln k = \ln Ae^{-Ea/RT} \quad (2)$$

Characteristic of red pitaya bio-indicator label (RPi)

Thickness of the RPi is measured by digital micro meter (Mitutoyo, Japan). Color value and density of the RPi were measured by using hand-held spectro-densitometer (X-rite eXact, D65/2°, USA) and glossed with 60 degrees with gloss meter (Multi Gloss 268Plus, Konica Minolta, Germany).

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RESULTS AND DISCUSSION

When the red dragon peels were extracted with red bio-colorimetric solution (i.e. red pitaya solution, RPs), the initial color of RPs appeared in pink color and the color between sonication and soaking methods were not significantly different.

A bio-colorimetric dye contained in RPs, namely 'betalain', could be divided into two main structures which were betacyanin (betanin) group (i.e. betanidin and betanin) and indicaxanthin (betaxanthin). The first structure, betacyanin, showed purple and red color (Fig. 1), whereas the second (indicaxanthin) was yellow or orange color [6], [7].

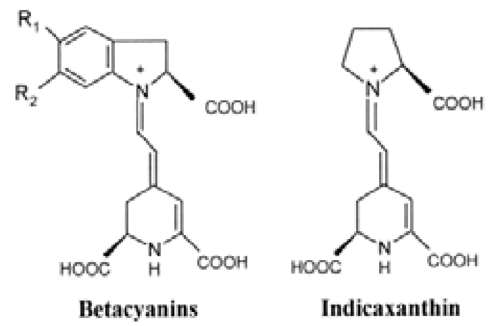

Figure 1. betacyanin (left) and indicaxanthin (right), the principal and transition structures which are subsets of betalain group that contained in RPs [7]

In addition, the results showed that betacyanin in RPs revealed pink solution and gradually changed to red, orange and yellow respectively within 23.5 min when stored under high temperature (120 °C). It was also found the maximum absorbance (Abs_{max}) of 540 nm (Fig. 2) which could be explained that the structure of betacyanin completely transformed to indicaxanthin.

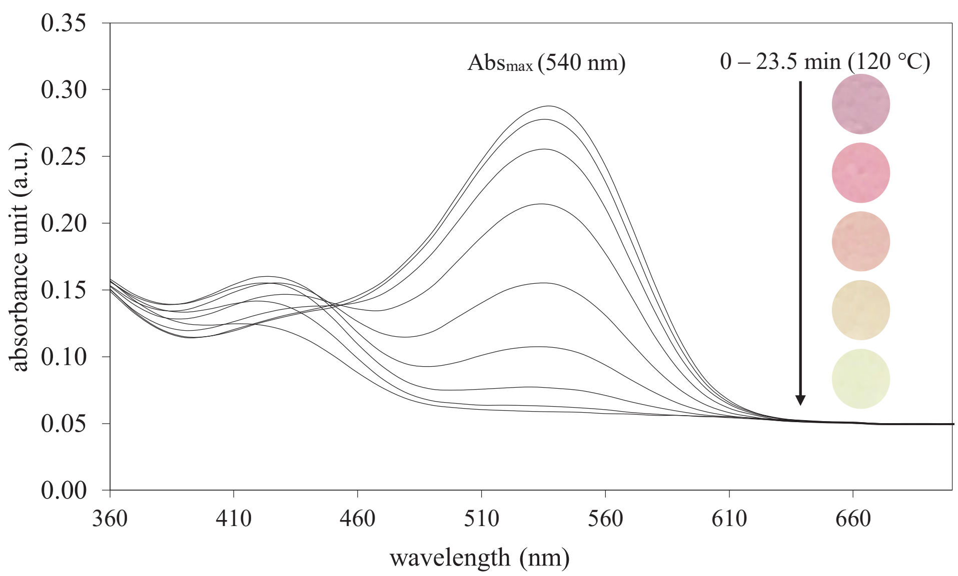

Figure 2. Effects of temperatures on spectra absorption and example photographs of color changes of RPs

When considering the times of color transition of RPs, it was at the maximum absorbance of 540 nm which was stored under different temperatures. The results found that the time of color change was depended on the stored temperatures. As shown in Fig. 3, the color changing time was continuously decreased when increasing the temperatures from 60, 75, 95 and 120°C respectively, and this also affected the rate of color changing time which increased the linear relationship. Based on Arrhenius's equation, the Activation Energy (*E*a) could be calculated from the rate of color change with temperature in Kelvin (°K) and it was 51.1752 kJ mol-1, (as shown in Fig. 3).

Many researchers reported that the *E*a of betalain of RP was also depended on pH of the solution. As reported in the result of Reynoso and others (1997), the study of the RP dye bleaching with the pH condition of 5.5 revealed the *E*a of this reaction of 87.09 kJ mol^{-1} [10]. This report was also related to the results of Tsai and others (2010) portraying that the *E*a of betalain was low at low pH and continuously increased from the pH value until the maximum point [11]. When 0.1 M of NaOH was added into the RPs test tubes, a visual color shade of RPs continuously changed from pink to purple and green, and the total color difference (TCD) or ΔE was increased to 24.25. It was resulted in a visual purple-green color (Fig. 3).

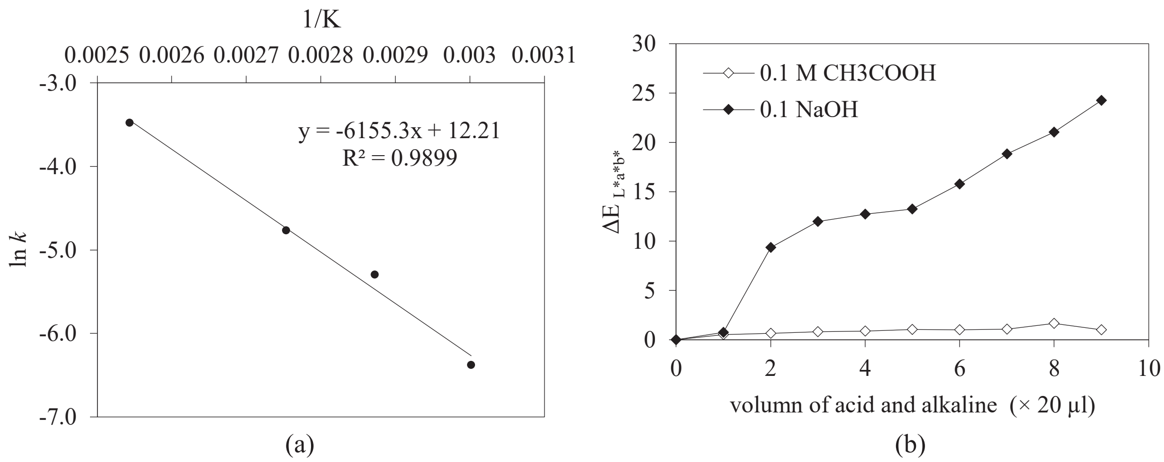

Figure 3. Linear regression relationship between *k* (color transition rate of RPs) and reciprocal temperature (1/K) (a), and change of a total color difference (ΔE) of RPs affected by acid and alkaline solutions (b)

This results related to other naturally extracted dye, such as anthocyanin, that could also change in colors and shades under alkaline solution causing the decrease of hydronium ion (H_3O^+) in its system and also changing effects in its structure. This color changing concept of RPs could be developed for a diagnostic indicator that was either directly or indirectly monitored the pH level of a product such as food spoilage indicator (FSI) and ready-to-serve indicator (RSI).

Furthermore, the RPs was mixed with a biopolymer (MC) which was used as a film former and fabricated to form a thin RP indicator film (RPi) when the RPi was dried. So, it revealed a transparent pink film. The original color of RPi was light-pink that could be observed by eyes and it was immediately changed to light-yellow within 5 sec when exposed to alkaline vapor (when placed over the headspace of ammonia solution under glass package). This reaction could be explained that the sensitive hydroxyl group (-OH) MC absorbed water vapor and also alkaline vapor from ammonia solution.

Besides that, the RPi-film revealed a maximum light absorbance of 540 nm ($Abs_{max}540$) with L* a* and b* of 83.20, 7.13 and -7.30 respectively. The results also found that some characteristics of a thin RPi film which its density gloss and thickness were 0.093 ±0.005, 36.70 ±0.40 and 127.67 ±5.86 respectively.

CONCLUSIONS

Extracted Red dragon (red pitaya) solution contained high concentration of betalain which could change color and shade from pink to yellow causing betacyanin structure changed to betaxanthin indicaxanthin. The RPs and RPi were also very sensitive to change in colors when stored under high temperatures (60-120 °C) and high pH (alkaline condition) which illustrated the *E*a of 51.1752 kJ mol^{-1}. This characteristic of a novel bio-colorimetric dye from RP can be developed for many applications such as diagnostic indicator in intelligent packaging technology and security printing ink for anti-counterfeited products.

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POSTER SESSION

POSTER SESSION

ESTIMATION OF SPECTRAL REFLECTANCE USING A PROJECTOR-CAMERA SYSTEM

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Keywords: Spectral reflectance, Spectral sensitivity

ABSTRACT

In recent years, technologies for modeling objects in the real world have been actively utilized in the field of computer graphics. Spectral reflectance is important in modeling, but this approach has limited practical value because it requires specialized equipment for measurement. Therefore, in this study, the aim is to measure spectral reflectance using a technique that exploits components that are relatively inexpensive and easily accessible.

The proposed algorithm was verified using a digital camera and a lighting apparatus, via experiments. Twenty-four color chips on the Macbeth chart were used both to acquire sensor sensitivity data and to estimate spectral reflectance values. The Macbeth chart was photographed under eleven different illuminations using a projector. To obtain linear RGB responses to the different light intensities, high dynamic range images (HDRIs) were created from RAW images acquired for different exposure times [1]. The estimated reflectance values were compared with those measured by a spectrophotometer to evaluate the performance of the proposed algorithm.

INTRODUCTION

In recent years, technologies for modelling objects in the real world are actively performed in the field of computer graphics. Color information of objects is generally extracted from images captured by a digital camera. Consequently, the obtained values include information of environments such as spectral sensitivities of the camera sensors and spectral power distributions (SPD) of illumination. The spectral reflectance that is an intrinsic color property of object must be extracted from images. The spectral reflectance is an inherent characteristic of an object that is independent of lighting conditions and image capture equipment.

There are approaches based on the use of multispectral images [2][3] or the use of an RGB camera under 3 different illuminations [4]. However, the cost of the equipment required for these methods is high. In this study, we aim to develop a method of spectral reflectance estimation using a digital camera and a projector which are relatively inexpensive and easy to implement without specialized equipment.

The proposed method consists of two sets of procedures: determination of the camera sensor's spectral sensitivity and the estimation of spectral reflectance. During the process of spectral-sensitivity acquisition, the sensors' spectral sensitivities are estimated by capturing images of color chips with known spectral reflectance values under various illuminations. During reflectance estimation, the spectral reflectance of an object is estimated using a similar procedure based on the spectral sensitivities of the RGB sensors. In the proposed method, various illuminations were generated using a projector.

PRINCIPLE

Suppose the RGB sensors of a camera respond linearly to light intensity, each response is an integral of the product of the SPD of incident light and the spectral sensitivity of the sensor. The incident light to sensor is a light that is emitted from a light source and reflected from one local point of the surface of interest. Thus, RGB values of the image of an object are a series of integrals of products of three components: an illuminant's SPD, a surface's spectral reflectance, and the RGB sensors' spectral sensitivities. This process can be expressed as Eq. (1).

$$\boldsymbol{g_k} = \int \boldsymbol{P}(\boldsymbol{\lambda})\boldsymbol{f}(\boldsymbol{\lambda})\boldsymbol{S_k}(\boldsymbol{\lambda})\, \boldsymbol{d\lambda} \tag{1}$$

where $\boldsymbol{g_k}$ represents the RGB value, $\boldsymbol{P}(\boldsymbol{\lambda})$ the spectral irradiance of the illuminant, $\boldsymbol{f}(\boldsymbol{\lambda})$ the spectral reflectance, $\boldsymbol{S_k}(\boldsymbol{\lambda})$ the spectral sensitivity of $\boldsymbol{k}$th sensor of R, G, or B. Ideally, if any two of them are known, then the third component can be calculated from that relationship using the least squares method. In order to estimate the spectral reflectance $\boldsymbol{f}(\boldsymbol{\lambda})$ from Eq. (1), spectral irradiance $\boldsymbol{P}(\boldsymbol{\lambda})$ of the light source and spectral sensitivity $\boldsymbol{S_k}(\boldsymbol{\lambda})$ of the camera sensor must be acquired beforehand. The RGB value $\boldsymbol{g_k}$ can be acquired from the photographed image. For the calculations in the computer, Eq. (1) was replaced by Eq. (2).

$$\boldsymbol{g_k} = \sum_{\boldsymbol{l=1}}^{\boldsymbol{L}} \boldsymbol{P_l}\, \boldsymbol{f_l} \boldsymbol{S_{kl}} \Delta\boldsymbol{\lambda} \tag{2}$$

where $\boldsymbol{L}$ represents the number of wavelengths, and $\Delta\boldsymbol{\lambda}$ the wavelength interval. Eq. (2) can be expanded to Eq. (3) to correspond to multiple illuminations and color chips.

$$\boldsymbol{g_{kij}} = \sum_{\boldsymbol{l=1}}^{\boldsymbol{L}} \boldsymbol{P_{jl}} \boldsymbol{f_{il}} \boldsymbol{S_{kl}} \Delta\boldsymbol{\lambda} \tag{3}$$

where i represents $\boldsymbol{i}$ th color chip, and j represents $\boldsymbol{j}$ th illumination. In the proposed method, in order for the spectral irradiance $\boldsymbol{P_l}$ to be treated as known, it is measured by a spectrophotometer in advance.

Acquisition of the spectral sensitivity of the camera sensor

Several illuminants with known SPDs $\boldsymbol{P_{jl}}$ provided by a projector are used to illuminate color chips with known spectral reflectance $\boldsymbol{f_{il}}$. The color chips are then photographed with a digital camera and the spectral sensitivities of sensors $\boldsymbol{S_{kl}}$ are acquired from the RGB values $\boldsymbol{g_{kij}}$, illuminants SPDs $\boldsymbol{P_{jl}}$ and the spectral reflectances $\boldsymbol{f_{il}}$.

Estimation of the spectral reflectance of the surface

The color chips, as the estimation targets, are illuminated by several illuminants provided by the projector with known SPDs $\boldsymbol{P_{jl}}$ and photographed with the camera with known spectral sensitivities $\boldsymbol{S_{kl}}$. The spectral reflectance $\boldsymbol{f_{il}}$ is estimated from the RGB values $\boldsymbol{g_{kij}}$, illuminants SPDs $\boldsymbol{P_{jl}}$ and the sensors' spectral sensitivities $\boldsymbol{S_{kl}}$.

EXPERIMENT

The experiment was conducted in a dark room to exclude stray light. The twenty-four color chips of the Macbeth chart (X-rite, Color Checker CLASSIC) were photographed by a digital camera (Nikon, D750) from the distance of 85cm under several illuminants. Eleven illuminants with different SPDs shown in Fig. 1. were provided by a LED luminaire (NAMOTO, LED Cube), not a projector this time. As the SPD of the illuminant $\boldsymbol{P_{jl}}$, a spectral irradiance was measured in front of the chart using an illuminance spectrophotometer (Konica Minolta, CL-500A). Spectral reflectance of the color chips $\boldsymbol{f_{il}}$ were measured by a spectrophotometer (Konica Minolta, CM-3700d) prior to the acquisition of $\boldsymbol{S_{kl}}$.

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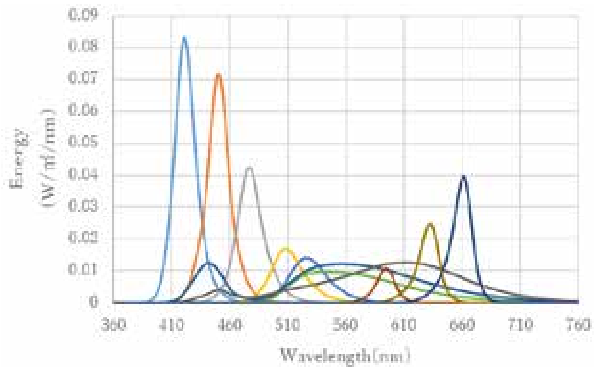

Figure1. Spectral irradiance of eleven types of illumination

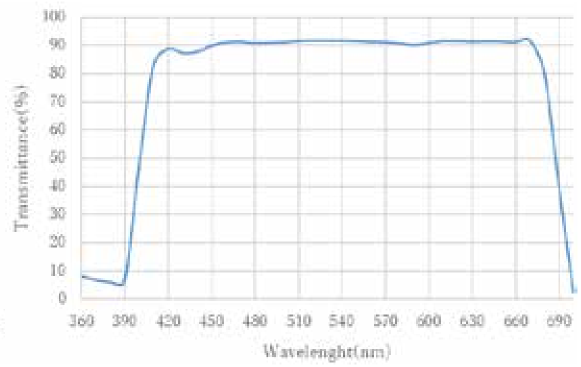

Figure2. Transmittance of filters

The camera's ISO was set at 100, the aperture was set at F5.6. To obtain a linear RGB response from the captured RAW data and to eliminate blown out highlights or blocked up shadows, high dynamic range (HDR) images were generated by photographing with 5 different shutter speeds of 1/40, 1/20, 1/10, 1/5, 1/2, 0.8, and 1.6 (s). Two filters (ASAHI SPECTRA, LUX400 SVX690) with a transmittance shown in Fig. 2 were attached to the camera lens so that light outside the range from 400 nm to 680 nm in wavelength would be attenuated.

Both spectral sensitivities and spectral reflectance of 29 wavelengths ($\boldsymbol{L = 29}$) were calculated in the range between 400 and 680 nm with the interval of 10 nm. To calculate the spectral sensitivity of the camera sensor $\boldsymbol{S_{kl}}$ for 29 wavelengths, 264 combinations of $\boldsymbol{P_{jl} * f_{il}}$ were prepared by eleven different illumination $\boldsymbol{P_{jl}}$ and 24 color charts $\boldsymbol{f_{il}}$. In calculation of the spectral reflectance $\boldsymbol{f_{il}}$ for 29 wavelengths, 33 $\boldsymbol{g_{ki} * P_{jl}}$ were prepared by eleven different illuminants $\boldsymbol{P_{jl}}$ and 3 RGB values $\boldsymbol{g_{ki}}$.

RESULT AND DISCUSSION

Acquisition of the spectral sensitivity of the camera sensor

The spectral sensitivity of the camera sensor for this experiment is shown in Fig. 3. The solid line represents R, the broken line represents G, and the dotted line represents B spectral sensitivity curves. Since the spectral sensitivity of the camera sensor is not provided by the manufacturer, it cannot be judged whether it was accurately obtained or not. As shown in Fig. 3, however, they have peak values in each preferable wavelength ranges, and the spectral sensitivity are low in the other wavelength ranges, proving the validity of the proposed method of acquisition of camera's spectral sensitivities.

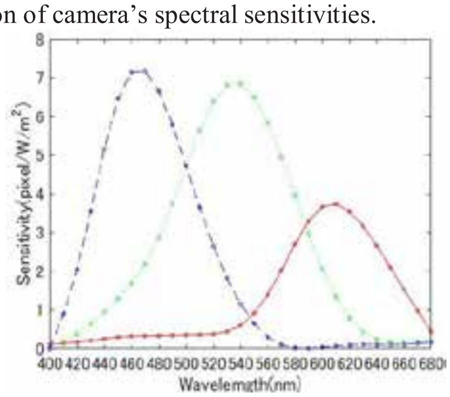

Figure3. Spectral sensitivity of the camera sensor

Estimation of the spectral reflectance of the surface

As an example, spectral reflectance of the four color chip of the Macbeth chart is shown in Fig 4. The red solid line represents the spectral reflectance estimated by the proposed method, and the blue broken line

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represents the one measured with CM-3700d. Errors were calculated across wavelength to evaluate the accuracy or the effectiveness of the proposed method. In the case of blue chip (No. 3), error was 0.034 on average across wavelengths. The average error of all color chips is shown in Table 1.Across all 24 color chips, error of 0.047 was recorded on average and that of 0.101 for a color chip of the lowest accuracy.

It might be possible that estimation error could be reduced by increasing the number of the types of illumination used, i.e., eleven in this experiment. As an alternative, reducing the number of components to estimate using a principal component analysis [5] may improve the accuracy of the proposed approach in a similar viewpoint.

In the present study, the LED luminaire was used instead of a projector for the reason that light was not emitted in short wavelength range from some projectors. In the absence of effective energy, it is thought that neither of the sensitivity or the reflectance is properly estimated. Therefore, it is crucial that various illuminants with SPDs covering a wide range of wavelength must be used in the proposed method.

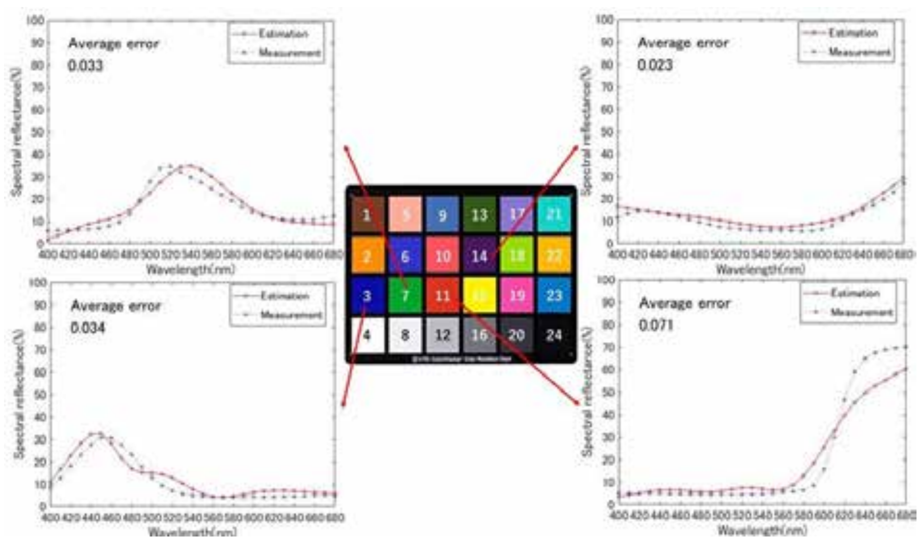

Figure4. Spectral reflectance color chip

Table 1: Average error of 24 types of color charts

Nunmer	1	2	3	4	5	6	7	8	9	10	11	12
Average error	0.048	0.046	0.034	0.097	0.101	0.044	0.033	0.074	0.061	0.034	0.071	0.048
Nunmer	13	14	15	16	17	18	19	20	21	22	23	24
Average error	0.042	0.023	0.019	0.016	0.082	0.056	0.047	0.018	0.087	0.021	0.034	0.007

FUTURE PROSPECTS

In this study, spectral reflectance was estimated from the known state of spectral irradiance of the illumination, but in the future we aim to estimate the spectral reflectance in situations where the spectral irradiance of the illumination is unknown.

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CREATION DIGITAL VIDEO TO GIVE A CHARACTERISTIC VISUAL LOOK BY COLOR GRADING PROCESS

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Keywords: Color grading, Color transfer, Color palette, Video, Visual look

ABSTRACT

In most professional cinema productions, the color palette of the movie is painstakingly adjusted by a team of skilled colorists – through a process referred to as color grading – the process of adjusting the color and tonal balance of a movie to achieve a specific look. The Color grading process that always uses in the movie. This is a critical step in post-production process to create some audience perception and give more feel when he or she watches a movie. The time and expertise required to grade a video makes it difficult for amateurs to manipulate the colors of their own video clips. In Thailand, there are few expertise colorists. In my experiment, I presented a method that allows a user to transfer the color palette of a model video clip to their own video sequence. There are few steps for the study. I estimated a per-short color transform that maps the color distributions in the input video sequence to that of the model video clip. The results showed that the color grading process created a characteristic visual look and gave more feel horrifying to the audience.

INTRODUCTION

In film industry, the color grading process is a critical step in post- production process to create some audience perception and give more feel when he or she watches a movie. At present, the color palette used in a movie often plays a critical role in establishing its visual look. It can be used to locate a movie in place and time. This relationship between visual styles and the process of storytelling[1)] makes color management a critical part of film production. The visual style of a movie is often carefully devised by the cinematographer and executed by a team of skilled colorists who manipulate the colors of the movie footage – through a process known as color grading – to match his or her vision. While in the past color grading was done using photo-chemical processing, most modern post-production pipelines digitize the movie footage and use a combination of hardware and software tools to digitally color grade the movie.[2)] Today, color grading tools are even part of popular video processing software such as After Effects, Final Cut Pro, Davinci resolves etc. This experiment, I created a unique and interesting digital video by color grading process and used Davinci resolves program for color grading processing.

However, I achieved the experiment by using an example-based approach; users should to specify a model video (or image) that represents the color grading style they like, and our technique transfers the color palette of this model video to their clip. This approach offers two advantages; first, it allows users to specify the visual style they would like in an intuitive manner, and second, it allows us to leverage the skill and time that went into the grading of the model video clip.

EXPERIMENT

(a) Input video

(b) Model video "It follow"

(c) Our result

Figure 1: Color grading is the process of adjusting the color and tonal balance of a movie to achieve a specific look. This is a critical step of the movie editing to process the input sequence (a) to reproduce the characteristic visual style of "It follow" (b) to convey a similar tense mood (c). Our approach produces results that are free from artifacts and temporally coherent, as can be seen in the companion video. Video credits: "It follow"(2014) © Radius TWC (model).

Our color grading method works in two steps. In the first step, I would like to transfer the color palette of the model video frame to an input video.

Model

In put

In the second step, observe hightlight and shadow in the model video, and would be to apply histogram matching in each color channel and tone (and the foreground and background) independently (the simplest way to do this). While this might match the color styles, it often produces artifacts.

Per-short color matching | Representative model frames

I 1 | M 1

I 2 | M 1

I 3 | M 1

I 4 | M 1

\

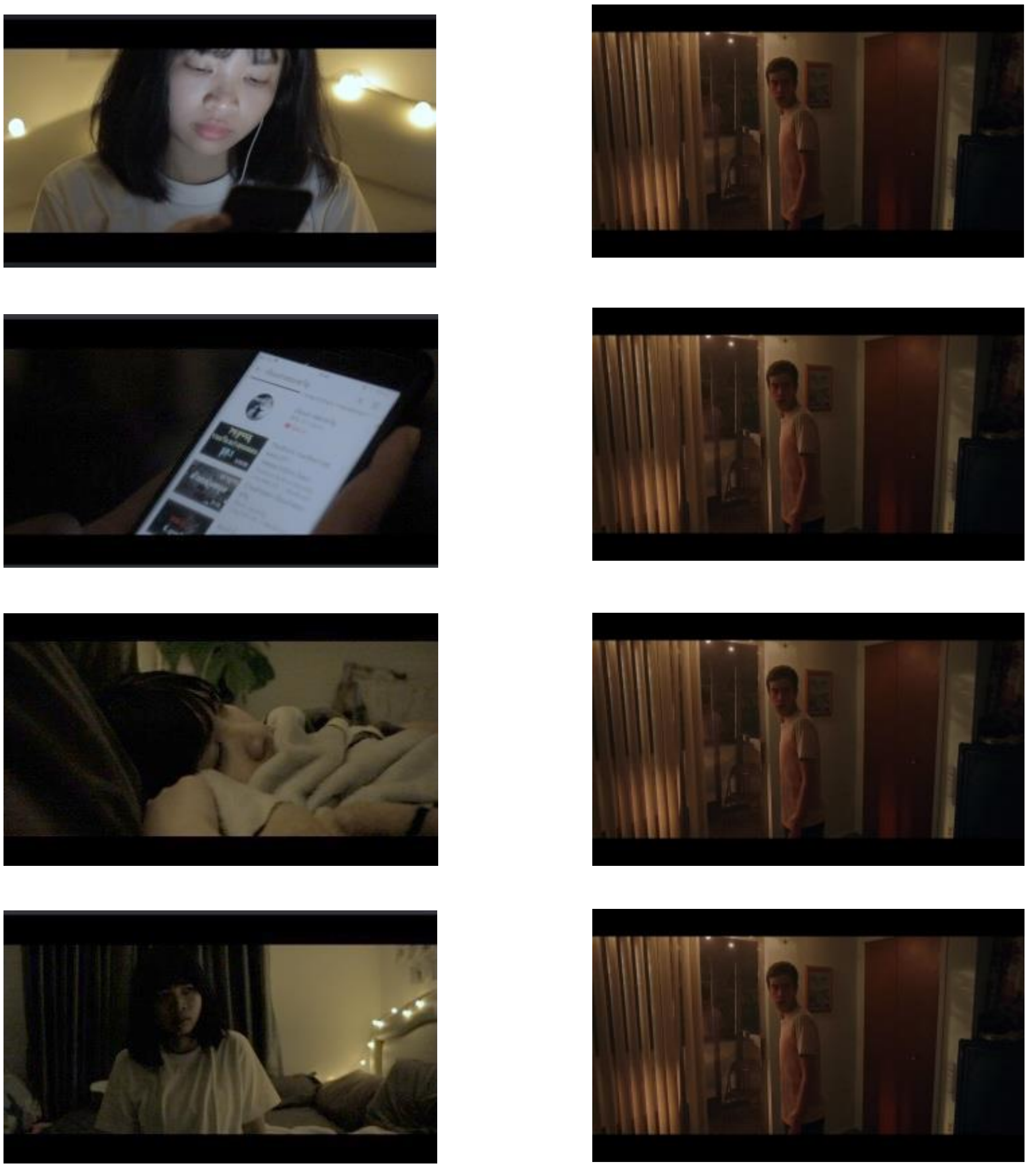


Figure 2 : Shows an overview of our process. Given a user-specified model video **M** and an input clip **I**

Our color transfer model is able to produce an equivalent result without any artifacts.

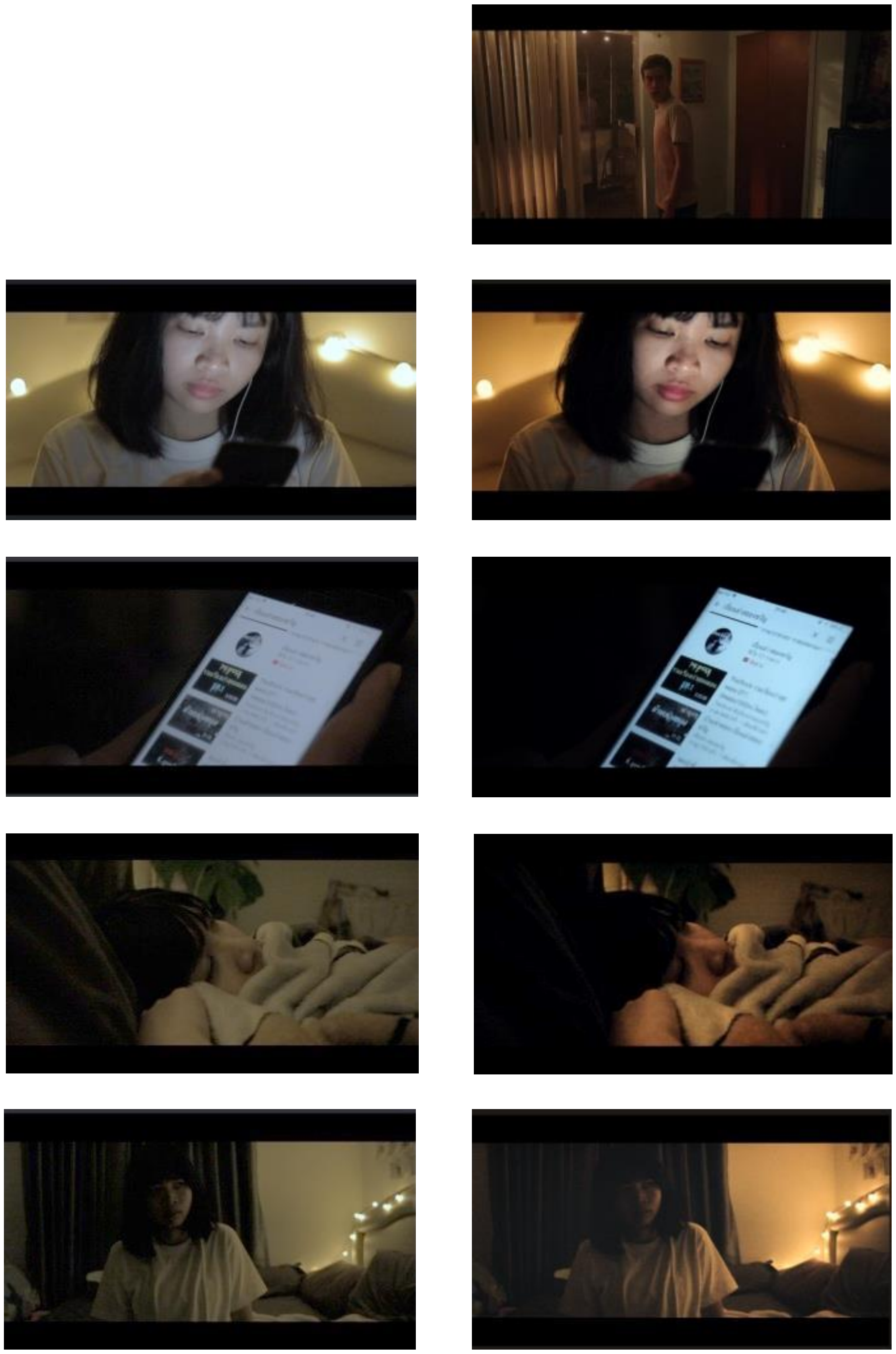


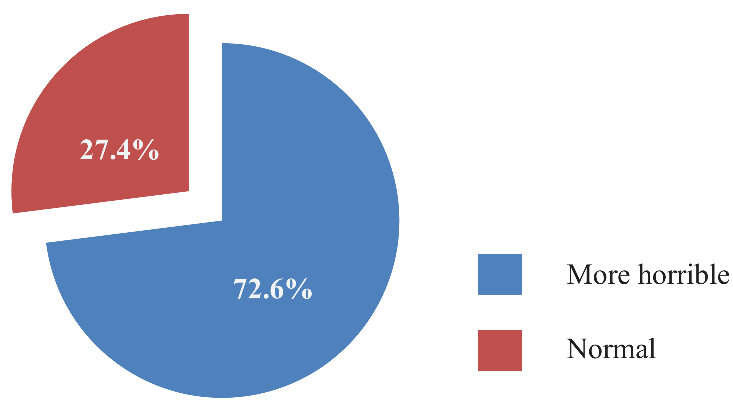
Figure 3 : The color grading method can successfully transfer a variety of color styles to a range of input video sequences.

RESULT AND DISCISSION

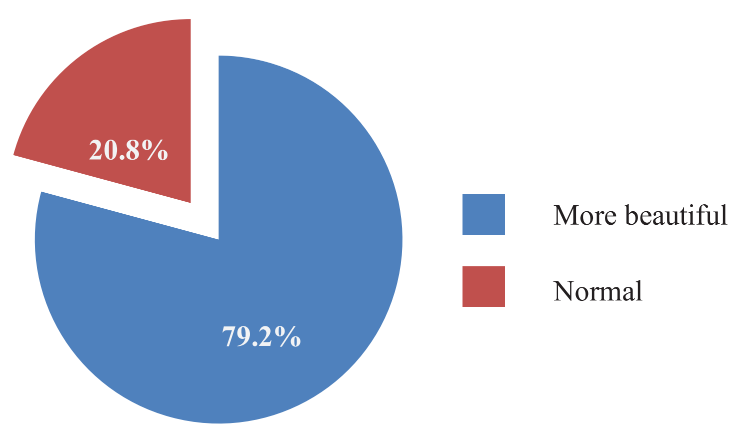
In this experiment, there are 30 subjects participate watched a movie and selected movie between original movie (no color grading process) and movie with color grading process.

The results of experiment shown that movie with color grading process give more feel horrifying, more beautiful than the original movie.

1. Which version of the movie feels the most horrible? The result shows 72.6% of respondents chosen blue and chosen red 27.4% are normal.



2. Which version of the movie is the most beautiful? The result shows 79.2% of respondents chosen blue and chosen red 20.8% are normal.



According to the result we can conclude that, the movie with color grading process makes subjects feel more horrible and more beautiful than the original version. However, this study the results obtained form 30 subjects. To obtain more precisely results I will continue with more subjects for increase performance and attempt to improve the reliability in the future study.

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ACQUISITION OF SPECTRAL POWER DISTRIBUTIONS OF DISPLAY USING A DIGITAL CAMERA

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Keywords: Display, Camera spectral sensitivities, spectral power distributions

ABSTRACT

Display calibration is usually performed with XYZ tristimulus values using a colorimeter. In this study, we propose a method to estimate the spectral power distribution of a display using a digital camera. The tasks of the proposed method are acquisition of the spectral sensitivities of camera sensors and estimation of the spectral irradiances of display primaries. The proposed algorithm was verified by an experiment using a digital camera and a liquid crystal display. Various colored lights emitted from the display with known spectral power distributions were used to estimate the camera sensors' spectral sensitivities. Then the spectral irradiances of the display primaries were recovered by photographed image with the camera whose sensors' spectral sensitivities were obtained. The recovered spectral irradiances of the display primaries were compared with those measured by a spectrophotometer to evaluate the performance of the proposed algorithm.

INTRODUCTION

Colors on a display are created by the additive color mixture of three primaries, i.e., RGB. The additive color mixture is calculated by vector summation in CIEXYZ color space. Therefore, display calibration is usually performed with XYZ tristimulus values using a colorimeter. However, there is a limit to processing the color of the display in CIEXYZ color space. For example, when an anti-glare or anti-reflection filter is overlaid on display screens, when some people wear specific glasses designed to prevent eyestrain or sleep disorder caused by blue light, to evaluate the color of light reaching the viewer's eye, not only the filters' spectral transmittance but also the spectral power distribution (SPD) of the display is required. With respect to the recovery of spectral reflectance of surfaces, several methods using multispectral images [1][2] or using an RGB camera under three different illuminations [3] have been proposed. However, these methods require specific instruments for measurements. Therefore, in this study, we propose a method to estimate the SPD of a display using a relatively inexpensive digital camera. The method consists of two tasks: acquisition of the spectral sensitivities of camera sensors and estimation of the spectral irradiances of display primaries.

PRINCIPLE

Acquisition of spectral sensitivities of camera sensors

Suppose the RGB sensors of a camera respond linearly to light intensity, each response is an integral of the product of the SPD of incident light and the spectral sensitivity of the sensor. Such a relationship among the RGB values of a captured image, the spectral irradiances of incident light, and the camera sensors' spectral sensitivities are expressed by Eq. (1).

POSTER SESSION

$$g_{kj} = \sum_{l=1}^{L} s_{kl} D_{lj}\, \Delta\lambda, \quad j = 1 \dots J,\ k = 1,2,3 \tag{1}$$

where $\Delta\lambda$ is the wavelength interval, g_{kj} is the j-th RGB values of the captured image for the k-th camera sensor, D_{lj} is the spectral irradiance of the j-th patch at the l-th wavelength, s_{kl} is the spectral sensitivity of the k-th sensor at the l-th wavelength, J is the number of patches, and L is the number of wavelengths.

Therefore, by photographing patches with known spectral irradiances, the camera sensor's spectral sensitivities s_{kl} are derived from the RGB values g_{kj} from the photographed image and the spectral irradiances D_{lj} using Eq. (1).

Estimation of spectral irradiances of display primaries

Several patches presented on a display are photographed by the digital camera whose sensors' spectral sensitivities s_{kl} are obtained in advance. The spectral irradiances D_{lj} of these patches are estimated by the camera sensor's spectral sensitivity s_{kl} and the RGB values g_{kj} obtained from the photographed image via Eq. (1). The spectral irradiances D_{lj} can be expressed by Eq. (2).

$$D_{lj} = \sum_{\mathrm{m}=1}^{3} d_{lm} f_{mj}^{\gamma_m} + e_l \tag{2}$$

where f_{mj} is the RGB input values (0~1) of the m-th channel of the display for the j-th patch, e_l is the spectral irradiance of background, when $f_{mj} = 0$ at the l-th wavelength, γ_m is the gamma characteristic of the m-th channel, and d_{lm} is the maximum spectral irradiances of the m-th channel at the l-th wavelength.

What we need to estimate in the proposed method are the maximum spectral irradiances d_{lm} and γ_m for the display RGB primaries. All the f_{mj} for the presented patches have non-zero values. Therefore, a single spectral irradiance for one of the display primaries must be derived from the difference between a pair of D_{lj} and D_{li} in which two of the input values f_{mj} and f_{mi} are the same, as shown in Eq. (3). Finally, using a steepest descent method, γ_m and d_{lm} are estimated so that the sum of squared errors shown by Eq. (4) can be minimized.

$$d_{lm}(f_{mi}^{\gamma_m} - f_{mj}^{\gamma_m}) = D_{li} - D_{lj} \tag{3}$$

$$SSE_m = \sum_{l=1}^{L} \{(D_{li} - D_{lj}) - d_{lm}(f_{mi}^{\gamma_m} - f_{mj}^{\gamma_m})\}^2 \tag{4}$$

EXPERIMENT

Acquisition of spectral sensitivities of camera sensors

The experiment was conducted in a darkroom to avoid stray light. The distance between the display (Eizo, CE240W) and the digital camera (Nikon, D750) was 70 cm. To limit the wavelength range of incident light onto the camera, a short-wavelength cut filter (Asahi Spectra, LUX400) and a long-wavelength cut filter (Asahi Spectra, SVX690) were attached in front of the camera lens. In the wavelength range of 400-680 nm with the interval $\Delta\lambda$ of 10 nm, spectral sensitivities and spectral irradiances were calculated for 29 wavelengths ($L = 29$). The camera's aperture and sensitivity were set F 5.6 and ISO 100. To obtain a linear RGB response from the captured RAW data and to eliminate blown out highlights or blocked up shadows, high dynamic range (HDR) images [4] were generated by photographing with 7 different shutter speeds: 1/250, 1/125, 1/60, 1/30, 1/15, 1/8, and 1/4 seconds. MATLAB was used for computation and analysis. Input RGB values for color patches on the display are shown in Table.1.

Table.1 RGB input values for display color patches

#	R	G	B	#	R	G	B	#	R	G	B	#	R	G	B	#	R	G	B
1	0	0	0	***3***	160	96	96	***9***	192	128	64	***15***	192	64	64	***21***	192	96	32
2	128	128	128	***4***	96	160	96	***10***	192	64	128	***16***	64	192	64	***22***	192	32	96
				5	96	96	160	***11***	64	192	128	***17***	64	64	192	***23***	32	192	96
				6	160	160	96	***12***	128	192	64	***18***	64	192	192	***24***	96	192	32
				7	160	96	160	***13***	128	64	192	***19***	192	64	192	***25***	96	32	192
				8	96	160	160	***14***	64	128	192	***20***	192	192	64	***26***	32	96	192

Procedures were as follows. First, 26 colors of Table.1 were presented on the display successively one by one and their spectral irradiances D_{lj} were measured with an illuminance spectrophotometer (Konica Minolta, CL-500A). Then, a tile of the 26 patches presented on the display were photographed with the digital camera. The camera sensors' spectral sensitivities s_{kl} were derived via Eq. (1) using the RGBs g_{kj} of the captured image and the spectral irradiances D_{lj} measured beforehand.

Estimation of spectral irradiances of display primaries

The spectral irradiances d_{lm} and gammas γ_m were recovered for the same display (Eizo, CE240W) used for acquisition of spectral sensitivities of camera sensors. Experimental environment and condition were the exact same as in the experiment of acquisition of sensors' sensitivities. First, the spectral irradiances D_{lj} of the 26 patches on the display were estimated via Eq. (1) by the acquired spectral sensitivities s_{kl} of camera sensors and the RGB values g_{kj} from the captured image. Then, as shown in Eq. (3), $d_{lm}(f_{mi}^{\gamma_m} - f_{mj}^{\gamma_m})$ for each of the display primaries were derived by subtractions among D_{lj}. Using a steepest descent method, the best display gammas γ_m and maximum irradiances d_{lm} were obtained so that the sum of squared errors of Eq. (4) can be minimized. The obtained d_{lm} and γ_m were compared with those measured with the CL-500A to evaluate the performance of the proposed algorithm.

RESULT

Acquisition of spectral sensitivities of camera sensors

The obtained spectral sensitivities s_{kl} of camera sensors are shown in Fig.1. Since the spectral sensitivity of the camera sensor is not provided by the manufacturer, it cannot be judged whether it was accurately obtained or not. However, as shown in Fig.1, they have peak values in each preferable wavelength ranges, and the spectral sensitivity are low in the other wavelength ranges.

Estimation of spectral irradiances of display primaries

The spectral irradiances $d_{lm}(f_{mi}^{\gamma_m} - f_{mj}^{\gamma_m})$ are shown in Fig.2 for each of the RGB primaries. They have peak values in each preferable wavelength ranges. However, negative values are found in R and G.

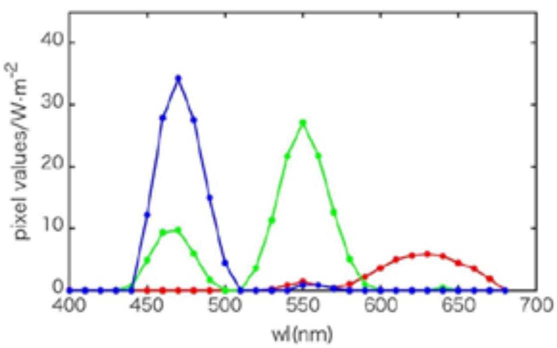

Fig.1 Sensors' spectral sensitivities

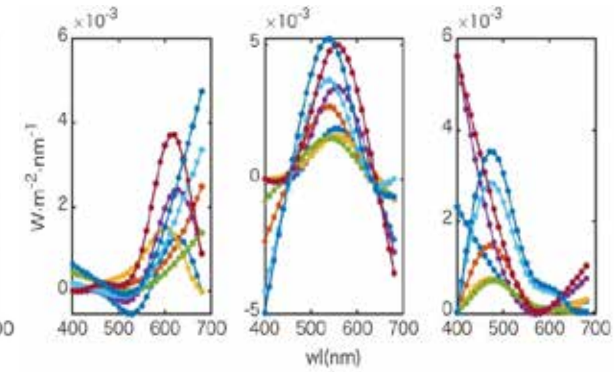

Fig.2 Spectral irradiances of a RGB $d_{lm}(f_{mi}^{\gamma_m} - f_{mj}^{\gamma_m})$

Table.2 shows the estimated γ_m with the γ_m calculated from the measurement with CL-500A. The estimated gammas are close to the measured gammas. The maximum spectral irradiances d_{lm} of the display primaries are shown in Fig.3. The d_{lm} measured with CL-500A are on the left and the estimated d_{lm} are on the right. The estimated d_{lm} have peaks around each preferable wavelength ranges but they are quite different from the measured ones. The estimated d_{lm} have negative values in R and G primaries which may originate from negative values in $d_{lm}(f_{mi}^{\gamma_m} - f_{mj}^{\gamma_m})$ of R and G.

Table.2 Display gamma γ_m

	γ_R	γ_G	γ_B
Measured value	2.04	2.01	2.07
Estimated value	2.00	1.99	2.00

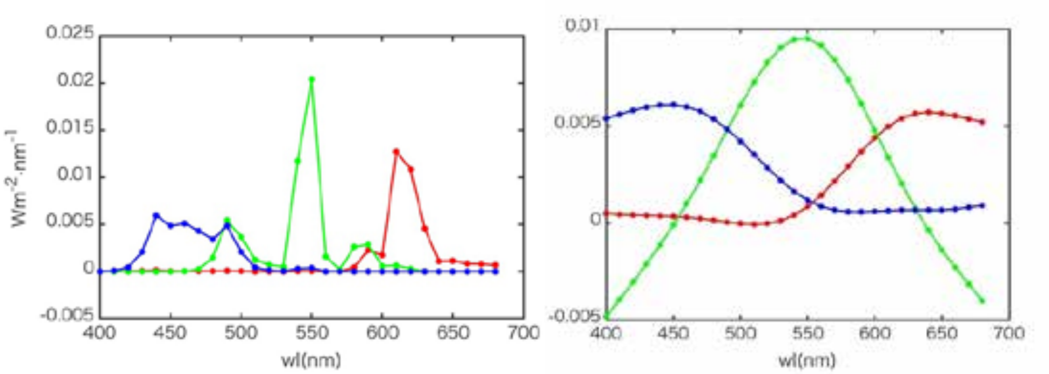

Fig.3 Maximum spectral irradiances d_{lm} of the display primaries

DISCUSSION

The estimation accuracy of the sensors' spectral sensitivities obviously affects subsequent estimation of the maximum spectral irradiances d_{lm} and γ_m of the display primaries. In the experiment of spectral sensitivities estimation, 29 unknowns (corresponding to the number of wavelengths L) were estimated from the photographed image of 26 patches (corresponding to J). Increasing the number of photographed color patches relative to the number of unknown to estimate might improve the accuracy of sensitivity estimation. However, in the estimation of spectral sensitivities for 15 wavelengths with $\Delta\lambda = 20$ nm in the same range of 400-680nm, the accuracy was not improved. Therefore, increasing the number of color patches might not improve the accuracy.

As shown in Fig.3 (left), no light was radiated from the display in vicinities around 410, 520, 530, and 570 nm. As a result, the number of spectral irradiances D_{lj} that were substantially effective for the estimation of the spectral sensitivities might be smaller, and therefore acquisition of the spectral sensitivities might have been less accurate. A light source which emits light over the whole range of wavelength should be used for estimation. Moreover, though the light at the both ends of wavelength range were supposed to be shut off by the filters, small amount of light transmitted through the filters might have affected the calculations.

As shown in Fig.2 and Fig.3 (right), negative values in the estimated $d_{lm}(f_{mi}^{\gamma_m} - f_{mj}^{\gamma_m})$ or d_{lm} is a critical problem. In the proposed method, d_{lm} and γ_m are estimated via $d_{lm}(f_{mi}^{\gamma_m} - f_{mj}^{\gamma_m})$ derived from D_{lj}. Since the RGB values g_{kj} of captured images can be expressed as a function of d_{lm} and γ_m in Eq. (5), which is obtained by substituting Eq. (2) into Eq. (1), by minimizing the sum of squared errors of g_{kj}, both of d_{lm} and γ_m for display primaries could be directly obtained without the estimation of D_{lj}. This optimization problem only has to be solved with the constraints of $d_{lm} \geq 0$ and $\gamma_m \geq 0$.

$$g_{kj} = \sum_{l=1}^{L} s_{kl} \left(\sum_{m=1}^{3} d_{lm} f_{mj}^{\gamma_m} + e_l \right) \Delta\lambda \tag{5}$$

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UNDERSTANDING OF BODY LANGUAGE IN 3D ANIMATION WITH MOTION CAPTURE TECHNOLOGY

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Keywords: Body Language, 3D Animation, Motion Capture Technology

ABSTRACT

Body language is a gesture that expresses meaning without using words but it is a reaction and people's physical signals. Which indicates its behaviour, personality and social roles to convey the meaning. [1] For the use of body language in the animation, it is sometimes found that the body language cannot make the audience understand the mood or meaning of the story since the performance of body language is complex and diverse. There are many details to express in order to understand the meaning of communication. Including the camera angle in the presentation, [2] creating animations for characters may be unrealistic. [3] Therefore, the researcher came up with the concept of motion capture technology to help create the movement of the character to be able to communicate body language better. [4] The objectives of this research are 1) to study the gestures of 11 universal body language. 2) to study about using camera angles to convey meaning for animation. 3) to create data set about body language movement with Motion Capture Technology. And 4) to evaluate understanding of the sample on body language data with Motion Capture Technology. And the research showed that there are 6 gestures in which the sample can understand the meaning of gesture. There is 1 gesture that is quite understandable. There are 3 gestures that are understand less and there are 2 gestures that the sample does not understand due to the reason that the two gestures have similar meaning. It makes sure that gesture is meaningful.

INTRODUCTION

Body Language is a gesture language that expresses meaning without words. It is a gesture, reaction and body signal of people. It can be said that personality, behavior and social role. [1] To convey the meaning. The use of body language in Japanese animation in many times cannot make the audience understand the mood or meaning of the story as the manufacturer wants. Especially western audiences who may not be familiar with the characters' expressive manner. It is a problem to watch the animation to enjoy. [2] Nowadays, in creating 3D animations, we can use computer tools to create characters for movement in the workplace. If the manufacturer is not very competent can cause problems with the movement. The Motion Capture technology makes it easy to perform realistic motion capture. More interesting and natural shifting. It must learn the movement of the body physiology to indicate the emotional expression be clear through the body language, emotional conveyance. Animation is interesting in character expression, so there must be a unique movement. Such expressions of gesture, joy or sadness will make the audience more understanding. But because of the body language is complex and multi-movement. There are many details to express in order to understand the meaning of communication. Make it understandable under the same or different societies.

From the source and importance of such problems. Researchers have developed the concept of body language to convey meaning and use in 3D animation to give the characters emotional. Using Motion Capture Technology to store actor movement data. To get the most realistic motion information.

METHOD

Subjects

The samples used in the research were Rajamangala University of Technology Thanyaburi Faculty of Mass Communication Technology, academic year 2/2560

Method

The instruments used in the study consisted of

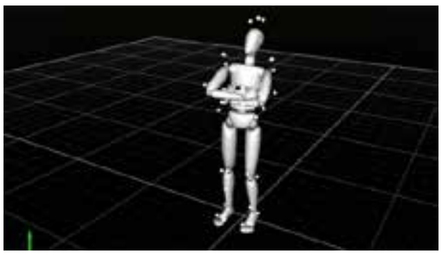
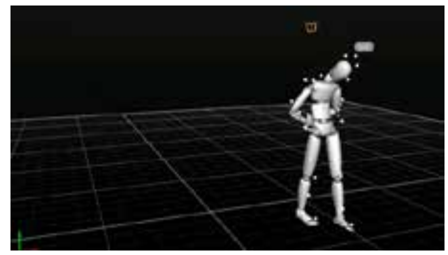
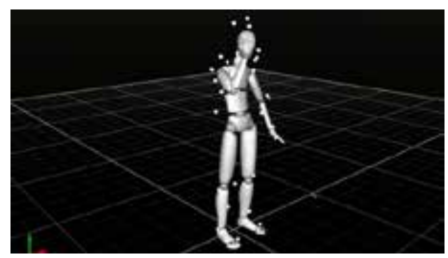
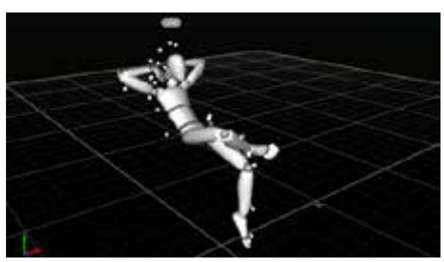
1) Animated Gestures Body language to convey meaning. Animation with Motion Capture Technology

2) Test your understanding of the sample to the series animated body language, the motion capture.

Researchers have defined the scope of body language expression of 3D animation characters to be used in the study. The movement of emotions in the characters in the animation.

1. Emotions give an awkward meaning.
2. Waistline, meaning aggressive, confident
3. A clasp on the back, pacing nervously meaning.
4. A clasp on the back, pacing to ensure meaningful.
5. The posture gives the meaning of fear.
6. The forehead rub gives meaning, anxiety, awkwardness.
7. Dubious
8. Sit back and let your hands sit on your shoulders.
9. Happy Group
    - 9.1 less happy
    - 9.2 moderate happy
    - 9.3 very happy
10. Angry Group
    - 10.1 less angry
    - 10.2 moderate angry
    - 10.3 very Angry

11. Sad Group
    11.1 less sad
    11.2 moderate Sad
    11.3 very Sad

Gesture		
 Cross arm	 Place hand on hip	 Clasping the hands behind the back_A
 Clasping the hands behind the back_B	 Backward	 Rub forehead
 Rub neck	 Sit down	 Happy Lv. 1
 Happy Lv. 2	 Happy Lv. 3	 Angry Lv. 1

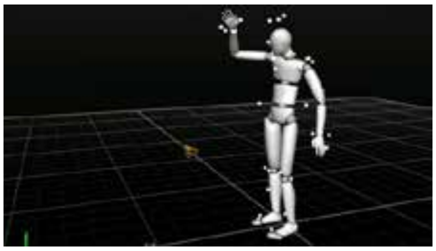
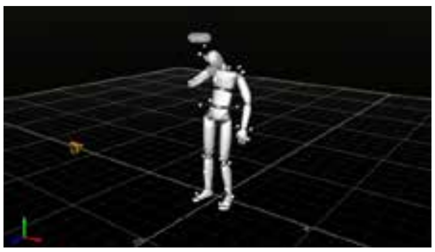
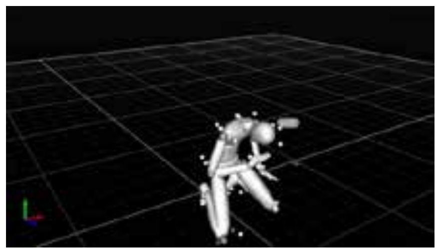
Gesture		
 Angry Lv. 2	 Angry Lv. 3	 Sad Lv. 1
 Sad Lv. 2	 Sad Lv. 3	

Figure 1: Picture of Body Language

Data collection

1) Create animated gestures with 11 gestures with motion capture.

2) Let the sample view the animations and take the comprehension test with 2 parts.

2.1 Choose the cheapest answer in 2 options.

1 point is to understand the meaning of the gesture.

0 points means do not understand the meaning of the gesture.

2.2. Sort the least of the least emotional groups.

3) Bring the score to the conclusion. And analyze the results.

RESULT

Table 1: Result of Understanding Test (1)

Gesture	Number of respondents	percentage
Gesture 01. Emotions give an awkward meaning.	9	30%
Gesture 02. Waistline, meaning aggressive, confident	19	63%
Gesture 03-A. A clasp on the back, pacing nervously meaning.	24	80%
Gesture 03-B. A clasp on the back, pacing to ensure meaningful.	13	43%
Gesture 04. The posture gives the meaning of fear.	6	20%
Gesture 05. The forehead rub gives meaning, anxiety, awkwardness.	15	50%
Gesture 06. Dubious	0	0%
Gesture 07. Sit back and let your hands sit on your shoulders.	29	97%

From Table 1, the sample of 30 subjects were found to be more than 50% correct. The subjects were Gesture 02, Gesture 03-A, Gesture 05 and Gesture 07

Table 2: Result of Understanding Test (2)

Mood	Understanding			percentage		
	0	1	2	not understanding	quite understanding	understanding
Happy Group	2	17	11	6%	57%	37%
Angry Group	-	15	15	0%	50%	50%
Sad Group	5	10	15	17%	33%	50%

Table 2 showed that

The group is happy. There are 2 people who sort out all of their emotions. 6% of the sample had 17 subjects, one of whom was emotional (57%) and 11 (3%). Accounted for 37% of the sample.

There are 15 people in the group who are in the mood to be angry. They are 50% of the sample and 15 of them are in the same group.

There are 5 people in the queue of emotions. (17% of the sample). There were 10 people in the group who had one emotional level (33%) and 15 (3%). Accounted for 50% of the sample.

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CONCLUSION

The results of the research. Motion Capture to detect motion to communicate body language have a look that can be easily understood and some difficult to understand gestures. Because the gesture used in the presentation. References from different books may misrepresent the meaning. Some books are a gesture that, if it happens, must be under pressure. For example, the FBI's suspected case of suspected fraud, which corresponds to that of a body language expert, suggests that What kind of people will show up, maybe it does not have a fixed motion. And the meaning that translates out of gestures does not mean as well. Because of a gesture There may be several meanings. Therefore, finding references that are based on books may not be meaningful. So many people do not understand the meaning or understand the wrong. So referral gestures should bring the play or screenplay let the actors read understand. This shows how much more emotion is evident in the use of gesture reference from a book. And expert advice also corresponds to the result of understanding the gestures of the sample in the second part of the test. This section uses gesture reference from the movie. Actors Have more emotional access than showing based on gesture reference from the book. The sample was able to accurately classify the emotions. The gestures referenced from the book in the first test. And the experts in the animation are also suggested that many reasons do not understand. Some bodies such as fingers do not move constantly. And not move according to the gesture reference. The Capture device cannot capture the finger. If you want to make more meaningful. Should move in a discrete and non-natural part.

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INSTRUCTION MEDIA DESIGNS AND DEVELOPMENT THE 2D ANIMATION "CHARACTER DESIGNS AND DEVELOPMENT"

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Keywords: 2D Animation, Character designs and development

ABSTRACT

Current teaching must recognize that audiovisual plays an important role in enabling instruction to be more effective. Attract more attention, the understanding of the teacher's lesson and autonomous learning of students.The purposes of the study to design and create 2D animation "Character designs and development" for second year student of multimedia major at rajamangala university of technology thanyaburi and examine the satisfaction of multimedia technology. There are three main processes in the research implementation. First is the process of creating 2D animation. Second is the process of making an evaluation form for the animation by 3 animation specialist. Third is the process of examine the satisfaction of 2D animation "Character designs and development" by 120 second year students of multimedia major. The results of the study were as follows: the examine of satisfaction of the specialist on the 2D animation for the content, technic and Audio and Video average of satisfaction is 3.93, 3.93, 3.67 respectively. The examine of satisfaction of student on the 2D animation for the content, beauty and design and technic average of satisfaction is 4.06, 3.97, 3.97 respectively. Satisfaction of the specialist on the 2D animation for the content, technic and Audio and Video average of satisfaction is good and satisfaction of student on the 2D animation for the content, beauty and design and technic average of satisfaction is good.

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INTRODUCTION

Current teaching must recognize that audiovisual plays an important role in enabling instruction to be more effective. Attract more attention. And more understanding of the teacher's lesson. One type of media that is effective in motivating students to access content is not tiring. And better content. Is the use of educational video media.

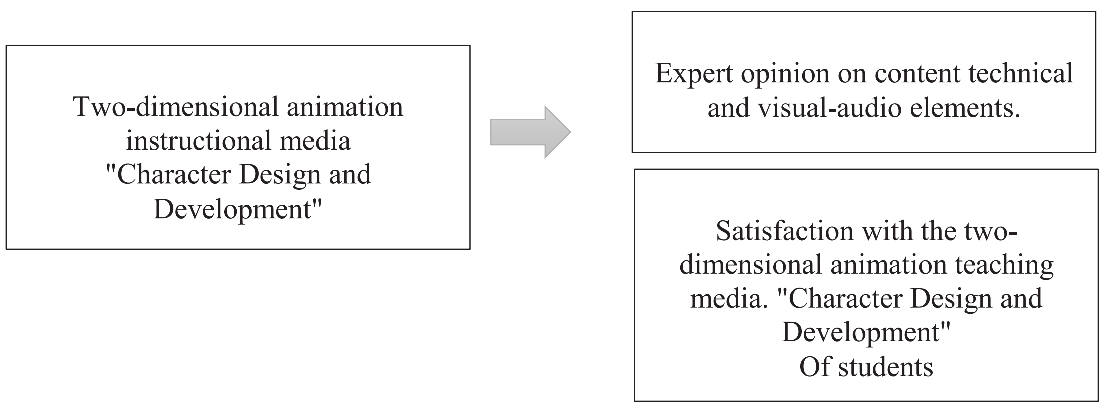
Video are very useful for studying because they can be presented with audio and video content. [1] This corresponds to the perception of human perception that 75% of people perceive hearing, 13% of hearing, 6% of hearing, 3% of smell, and 3% of hearing. [2] The study of the learner's knowledge is mainly based on the visual and auditory experience of the eye. Animated media can inspire students to learn better than still images. Animations can promote learning related to motion, as well as explaining with still images. [3] Animation videos in animated presentations are called "animations." Animations are divided into two categories: two-dimensional animation. And three dimensional animation. The image will look different by the 2-dimensional image. It is a 2-dimensional image to feel flat. Increase the depth of the image only small. [4]

Researchers have developed the concept of learning media. "Character Design and Development" in Character Design and Development. For 2nd year students, Rajamangala University of Technology Thanyaburi Multimedia. Two-dimensional animation media is used to create useful learning materials for students. Enhance knowledge and stimulate imagination, creativity this is an important feature in the future of graphic design.

OBJECTIVES

1. To develop two-dimensional animation teaching materials on "character design and development"
2. To evaluate the satisfaction of teaching media. Two-dimensional animation For students of Rajamangala University of Technology. 2nd Year Multimedia

THINKING FRAMEWORK



METHODS

Population and sample

Population

Students of Multimedia, Rajamangala University of Technology Thanyaburi 400 people who have study in the academic year 2016.

Sample

Students of 2 nd Multimedia major, Rajamangala University of Technology Thanyaburi and 120 people who have registered for the course in character design and development in the academic year 2016.

Tools & Questionnaire

1. Two dimensional animation teaching materials on "character design and development"
2. The questionnaire evaluates the quality of two dimensional animation evaluated by content and visualization experts.
3. The questionnaire to assess the satisfaction of Rajamangala University of Technology Thanyaburi students on two-dimensional animation learning media on "Character design and development"

Data collection

1. Study concepts, theories about character design and development, as well as related papers and research.
2. Design and development of two-dimensional animated learning media. Character design and development About 15 minutes
3. Assess the quality of two dimensional animation. By technical content and audio-visual experts.
4. 2-dimensional animation media was distributed to students of Rajamangala University of Technology Thanyaburi. There are 120 students who have registered for the course in character design and development in the academic year 2016 and the satisfaction of teaching materials developed.
5. Analyze results and discuss results.

Statitical analysis

Statistics use in research is Mean and Standard Deviation.

RESULTS

Based on research. Design and Development of Two Dimensional Animation Teaching Materials. "Character Design and Development" in Character Design and Development for Rajamangala University of Technology Thanyaburi 2nd Year Multimedia. The organizer designed and developed two-dimensional animation teaching materials. "Character Design and Development" is used as a tool for measuring and evaluating. The expert opinion on the content technical and visual-audio content and the satisfaction of the students of Rajamangala University of Technology Thanyaburi on the two-dimensional animation learning media. The design and development of the character of 120 people. The study is divided into two sections, the examine of satisfaction of the specialist on the 2D animation for the content, technic and Audio and Video average of satisfaction is 3.93, 3.93, 3.67 respectively. Degree of satisfaction is good. The examine of satisfaction of student on the 2D animation for the content, beauty and design and technic average of satisfaction is 4.06, 3.97, 3.97 respectively. Degree of satisfaction is good. as shown in Tables 1 and 2.

Table 1 : Expert opinion on the content technical and visual-audio elements.

Elements	Satisfaction		
	$\bar{X}$	S.D.	Degree of satisfaction
1 .Content	3.93	0.58	Good
2. Technical	3.93	0.58	Good
3. Visual-audio	3.67	0.75	Good

Table 2 : Student Satisfaction with Two Dimensional Animation Teaching "Character Design and Development"

Elements	Satisfaction		
	$\bar{X}$	S.D.	Degree of satisfaction
1 .Content	4.06	0.54	Good
2. Beauty and design	3.97	0.60	Good
3. Technical	3.97	0.62	Good

CONCLUSIONS

The results of a study on the quality of two-dimensional animation teaching materials. "Character Design and Development" by a panel of 3 experts for technical content and visual and audio elements. There are 3 topics. These are summarized in each section. The content is good. The mean was 3.93. The conclusion was that the content was accurate. Easy to understand the target audience. The technical level is good. The mean was 3.93. It was concluded that character design was appropriate for the content. The scene is beautiful. Characters and scenes are consistent. Character movement is continuous. And the color of the picture. The image and sound are good. The mean value was 3.67. Image composition is consistent with the content. It should be further improved in terms of music and music.

Summarize the results of the animation media. From the sample to the overall content elements in the picture. The mean of 4.06 was found to be good. The beauty and overall design in the picture. The mean score was 3.97. The conclusion was that the characters were appropriate for the content. The scene is beautiful. Characters and scenes are consistent. In technical terms, the overall picture is good. The mean value was 3.97. Character movement is good. The light used in the picture is beautiful. The soundtrack is appropriate.

DISCUSSIONS

The content of the design and development of the character. Finding information is quite difficult. Because of the content, the character design will not find content in the character development. Researchers have to find information and analyze and design the presentation to suit the target audience how to be appropriate. It stimulates the imagination in the design and development of the characters of the second year students, thus presenting the bringing together of two things to create new things.

The results of the study on the quality of the experts found. The low score is an interesting presentation. At the moderate level. It may be because the researcher has given weight to the exaggerated example of design. As for music and music, it is also the other side that scores in quality assessment less than other aspects as well as moderate level. Probably due to the music may not be consistent with the content. And the weight is quite light.

SUGGESTION

1. Two dimensional animation media should be developed. Available in a variety of formats, such as online media, or as an in-app media in IOS and Android.
2. Two-dimensional animation media should be developed in the form of teaching media that bring about the effectiveness of learning achievement. In order to benefit the teaching in related subjects.

ACKNOWLEDGEMENT

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EFFECT OF WINDOW VIEW ON PERCEIVED BRIGHTNESS OF INSIDE THE ROOM EVALUATED ON A DISPLAY

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Keywords: Space brightness, Window, Daylight, Display, Horizontal illuminance

ABSTRACT

Horizontal illuminance has been used as an indicator of brightness in lighting environments. When people see the space, however, not only the floor but also overlook the entire room. That means the horizontal illuminance does not always represent the perceived brightness. Various brightness indices have been developed in consideration of the characteristics of visual perception. But these indicators are considered only in a windowless room. Windowless rooms are not generally preferred, and the need to assess the effect of windows on interior brightness has increased for energy-saving lighting with daylight.

In the experiment, two monochromatic images, a matching image and test image, were successively presented on a liquid crystal display. Subjects were instructed to alter the intensity of the interior lighting of the matching image until its interior brightness appeared the same as that of the test image. The experimental results showed a similar tendency as in previous studies using scale models. That is, in a room with a bright window scenery, the subject required higher intensity of interior lighting, indicating the brightness inhibition by bright scenery.

INTRODUCTION

The diversification of lighting methods enables us to create various visual environments. However, recent studies have reported many situations in which the horizontal illuminance (generally used as a brightness index) does not correspond to human perception. When people see the space, they overlook not only the floor but also the entire room. This means that the horizontal illuminance does not always represent the perceived brightness. Various brightness indices have been developed in consideration of the characteristics of visual perception. Although these indicators function well for windowless rooms, the influence of daylight is not considered. In this research, we examined the space brightness of a room with a window through which daylight enters and the outdoor scenic view can be seen.

In the previous studies [1][2], the effects of space brightness were investigated using scale models. As a result, the previous studies reported that the space brightness of a room with a window was lower than that of a windowless room with equivalent horizontal illuminance. Other studies [3][4] have shown that such brightness inhibition was stronger in a room with any type of scenic view through the window compared with a room with a frosted window. However, it has been cited as a major problem in the previous studies that the conditions are limited or difficult to change in the experiments using scale models.

In this study, we evaluated space brightness using a display where the experimental condition is easy to change. We examined whether the influence on the space brightness of daylight or window scenic

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view would show the same tendency as in the previous studies where the perceived brightness was evaluated using scale models.

METHOD

The image of the room with a window (Window Room Image) is presented on the display (EIZO CS230), which was created by combining the image of the indoor space illuminated by daylight and the scenic view through the window (Window-Daylight Image) and the image of the indoor space illuminated by the ceiling light (Ceiling Light Image). When performing the image calculation, values converted to the luminance values were used instead of the display RGB values. Therefore, the actual physical conditions were faithfully recreated on the display screen. Furthermore, by multiplying each image by the intensity adjustment coefficient, various outdoor and indoor conditions were expressed (Figure. 1). These images were generated and presented using Matlab and Psychpysics Toolbox version 3 [7][8][9]. In the experiment, the test image and matching image were alternately presented to the subject. In the test image, the window-daylight intensity adjustment coefficient tD and the ceiling light intensity adjustment coefficient tC were set to predetermined values. In the matching image, the window-daylight intensity adjustment coefficient mD was fixed while the ceiling light intensity adjustment coefficient mC was freely adjustable. The subject adjusted mC of the matching image so that the space brightness of the room in the matching image was equal to the space brightness of the room in the test image.

Experiments were conducted in a dark room using a liquid crystal display. The subject viewed the display through a D-up viewer designed to occlude one eye and restrict the visual field to the display image. The image was perceived as a three-dimensional space because the D-up viewer prevented recognition of a flat display panel by depriving a binocular disparity cue; the image itself also contained several pictorial cues for depth such as a linear perspective.

In order for the image to be displayed within the display upper limit luminance, the actual luminance was compressed to 1/137. The tD and tC of the test image and the mD of the matching image were set to either 1, 1/4, or 1/16. The subject performed five times of space brightness matching for all conditions.

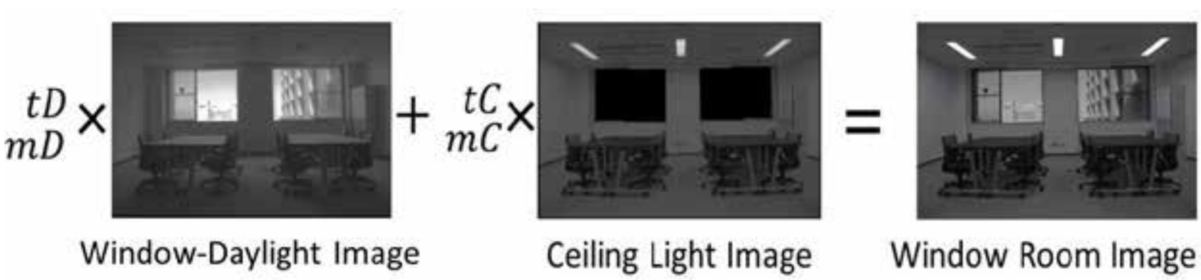

Figure1. Experimental image

RESULT AND DISCUSSION

The experimental results are shown in Figures. 2, 3, and 4. Matching data lack in some conditions where required luminance would exceed the luminance range of the display. The graph is displayed for each mD of the matching image. The different symbols represent differences in tD of the test image. Three data points with the same symbol connected by straight lines correspond to the three conditions of tC. The horizontal and vertical axes of the graph indicate the mean horizontal illuminance (lx) in the room corresponding to the test image and the matching image, respectively. Both of the mean illuminance values were calculated as the sum of the mean illuminance values corresponding to the window-daylight image and the ceiling light image. The broken lines show the baseline where the corresponding illuminance of the test image and matching image are equal. In other words, matching data on the baseline represent situations where the equal space brightness would be achieved in the equal illuminance.

The results show that when tD and mD are equal, matching data are plotted on the baseline. However, under the condition tD < mD, they are plotted above the baseline, indicating that the subject set the matching image to a higher illuminance than the test image. In other words, if the indoor illuminance of the matching image and test image are the same, then the inside of the matching image appears darker. On the other hand, under the condition tD > mD, they are plotted below the baseline, indicating that the room illuminance of the matching image was set to a lower illuminance.

The above results show that the space brightness of the window room was affected not only by the change in illuminance due to daylight entering the window but also the perceived brightness for the scenic view seen through the window. In other words, even if the illuminance increases owing to daylight incidence, if the scenic view from the window is recognized as a bright space, then the indoor space appears darker in comparison with the bright outdoor space. This tendency is similar to the phenomenon observed in the previous studies using scale models, indicating that the evaluation of the space brightness on a display would be useful and valid in future studies.

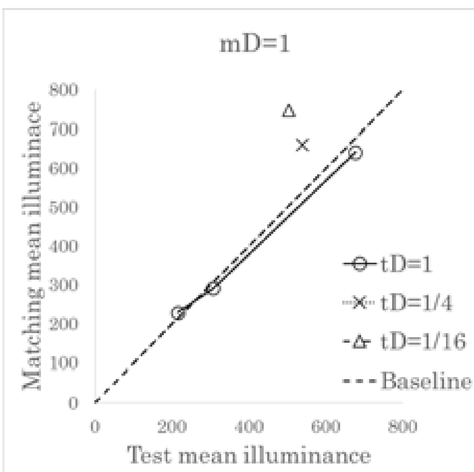

Figure2. Experiment result, mD=1

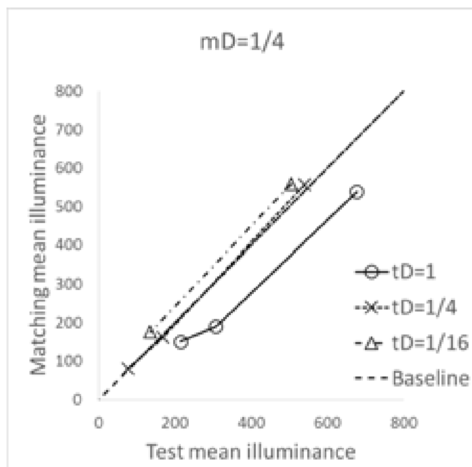

Figure3. Experiment result, mD=1/4

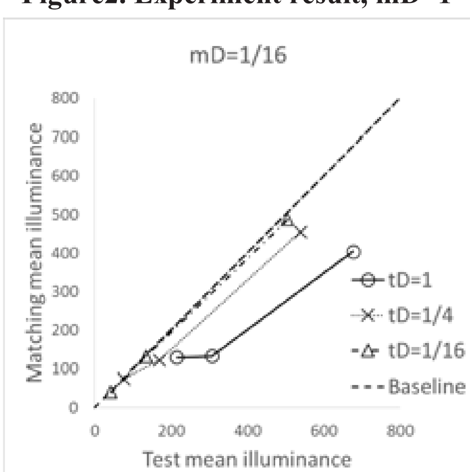

Figure4. Experiment result, mD=1/16

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A BASIC RESEARCH ON REALISTIC TEXTURE REPRODUCTION OF PHOTOGRAPHIC PRINT BY DISPLAY MONITOR

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Keywords: photographic print, display monitor, color gamut, texture reproduction, viewing conditions

ABSTRACT

Digital archives of cultural artifacts, works of art, and historical materials are popular, but there are few examples of exhibition images that faithfully reproduce the texture of the original. There are over 10,000 valuable photographic prints in the SHADAI Gallery of Tokyo Polytechnic University, and some of the works have been opened to the public. However, not all the works can be displayed because of limited exhibition space; digital exhibitions are expected as a new means of showing. For this reason, a basic study was conducted with the aim of faithfully reproducing the texture of photographic prints on the screen of a display monitor for a digital gallery of photographs. We examined whether the reflection luminance and color gamut of a photographic print under certain illumination conditions can be reproduced by using a liquid-crystal display and an organic electroluminescent (EL) display. It was found that the liquid-crystal display is more suitable at present for excellent color reproducibility, although it cannot reproduce the black in the photographic print. We also studied the characteristics of gloss as a texture element of photographic prints.

INTRODUCTION

Digital archives of cultural artifacts, works of art, and historical materials are popular, but there are few examples of exhibitions that can accurately express the texture of the original work. The SHADAI Gallery of Tokyo Polytechnic University has a collection that includes over 10,000 valuable photographic prints taken by famous photographers, and some of these works are open to the public at exhibitions that are held several times a year. However, as there is limited exhibition space, the number of works displayed is limited. Therefore, it is expected to display works as digital images. In this work, for the purpose of the high-quality digital exhibition of photographic prints, we examined the conditions necessary to faithfully reproduce the texture on a display screen.

EXPERIMENT

In order to reproduce the texture of a photographic print on the display screen, it is necessary to accurately grasp the difference between the reproduction characteristics of both. For this purpose, the following measurements were made.

Reproduction of luminance and color

Illuminance for light-sensitive objects, such as photographic prints, is recommended to be 50 lx or less to protect the works [1]. Therefore, to satisfy this condition, LED light with a color temperature of about 6000 K is illuminated from the front of a photographic print and the illuminance is set to 34 lx to reproduce the luminance range (maximum and minimum luminance) and color gamut of the photographic print. The range and color gamut were measured, and the characteristics of both were compared between the photographic print and display. In the case of the photographic print, the measurement was carried out obliquely from a position slightly shifted upward so that the measuring instrument would not overlap the light source.

For the photographic print, the ISO 12641 color target made with high-gloss color photographic paper (FUJIFILM) shown in Figure 1 was used. For the display, a liquid-crystal-type ColorEdge CG248-4K (EIZO) and an organic electroluminescent (EL) display (also called an organic LED, or OLED, display) mounted on an Alienware 13 OLED VR (Dell) laptop were used.

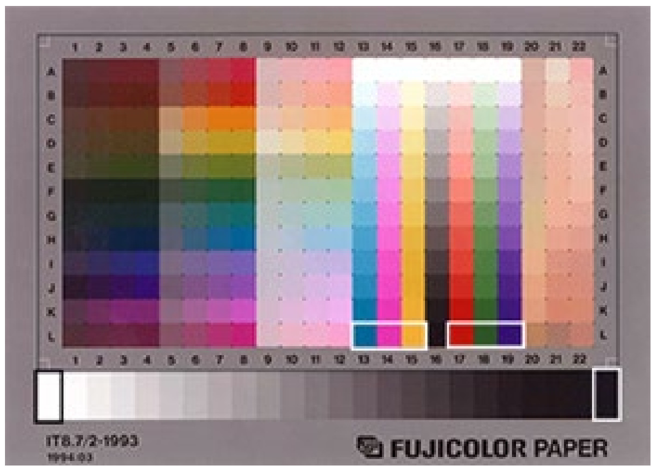

Figure 1. ISO12641 color target made of photographic paper used to measure luminance and color range.

The color target includes cyan, magenta, yellow, red, green, and blue color scales reproduced with one or two kinds of cyan, magenta, and yellow dyes and grayscales with three kinds of dyes. Each color scale, with maximum density and the white of the photographic paper, were measured to determine the reproduction range of light, darkness, and color. The displays use Photoshop to set primary colors of red, green, and blue (RGB) and combinations thereof to the maximum luminance, and displays thus red, green, blue, cyan, magenta, yellow, white, and black color patches. For the measurement of color patches, a non-contact spectrophotometer (Topcon SR-3) was used to acquire XYZ tristimulus values.

Effect of observation angle

Because photographic prints change in appearance depending on the illumination and observation angles, it is desirable to take this into consideration when reproducing the appearance of prints on the display screen. Therefore, for both the photographic prints and the displays, changes in luminance depending on the illumination angle and the observation angle were measured. In measurement, the photographic print or display was placed on an electric rotary table, as shown in Figure 2. XYZ tristimulus values were measured at an interval of 15° from 75° left to 75° right, with the front facing 0°.

For the photographic print, measurement was carried out by illumination under two conditions from the front and 45° to the right side. At this time, the light source was fixed on the rotating table so that the illumination angle was constant. However, when the illumination angle and the measurement angle are the same, measurement was impossible because the light source and the spectrophotometer were coaxial. Black-and-white photographic paper (FUJIFILM) was used for the photographic print.

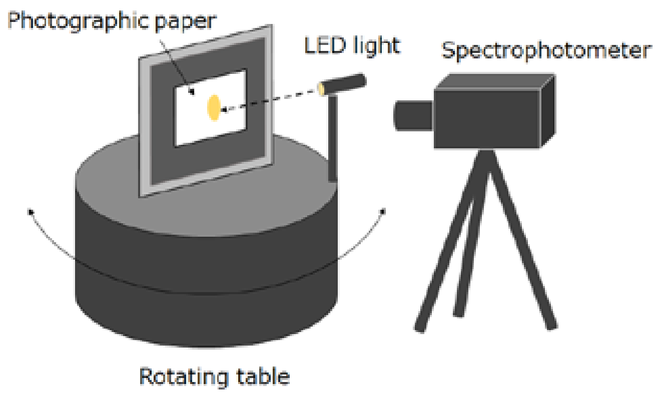

Figure 2. Arrangement of measuring apparatus.

RESULTS

Table 1 shows the measurement results of the maximum and minimum luminance. Compared with liquid-crystal displays, organic-EL displays have very low black luminance, and the black of a photographic print can be reproduced within a margin. Figure 3 shows the reflection luminance when photographic paper is illuminated from the front (0°) and 45° to the right. It is understood that the luminance is nearly constant except for the regular reflection direction.

Table 1 Maximum and Minimum Luminance in cd/m^2.

	Maximum Luminance (White)	Minimum Luminance (Black)
Color Photo Paper/34.1[lx]	4.45	0.0376
Liquid Crystal Display	115	0.143
Organic Light Emitting Display	361	0.000908

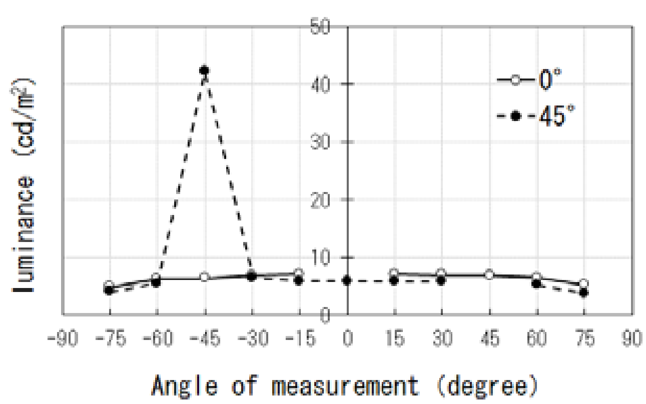

Figure 3. Reflection luminance of photo paper.

Figure 4 shows the luminance change of the displays with respect to the observation angle. The luminance gradually decreased as the observation angle moved farther from the front, and it decreased to about half once the observation angle reached 45°. There was not much difference in the change in luminance between the liquid-crystal and organic-EL displays. From the change in the luminance of the photographic paper according to the observation angle, a sharp rise in luminance was observed at the specular reflection angle, and it was found that it exhibits a high gloss characteristic.

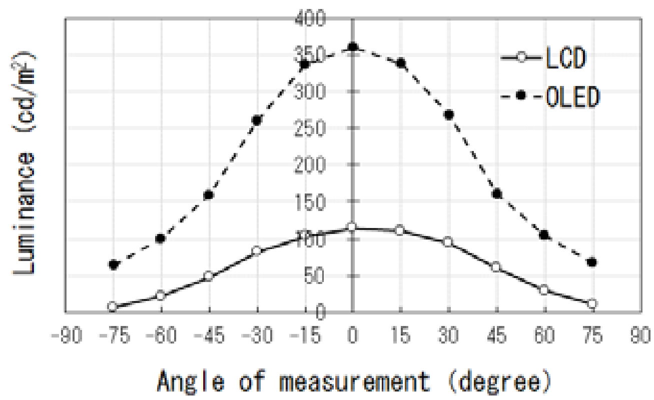

Figure 4. Luminance of display monitor.

Figure 5 shows the range of colors reproducible with the photographic paper and on the displays on the chromaticity diagram. Both displays have a wide color gamut and encompass the color gamut of photographic prints. Figure 6 shows the change in the xy-chromaticity coordinates of white according to the observation angle. It is understood that the color change in the liquid crystal display is smaller than that of the organic EL, due to the observation angle.

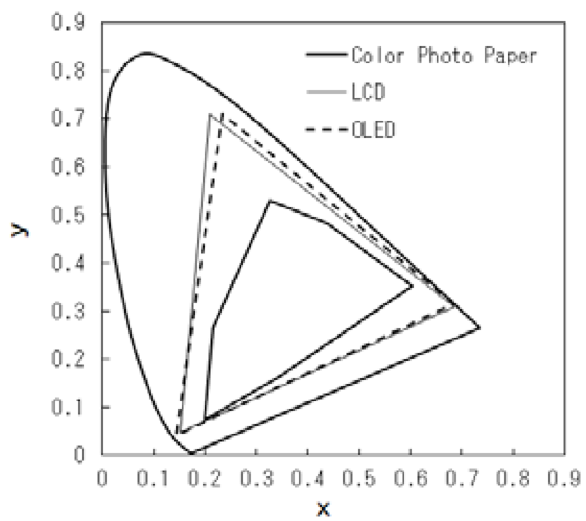

Figure 5. Color gamut of photo paper and display.

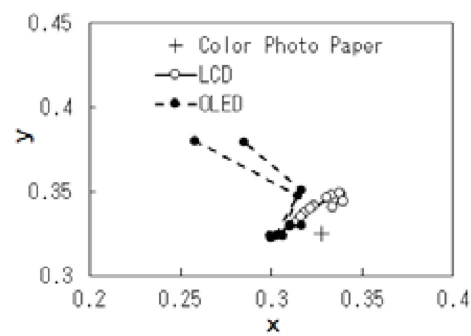

Figure 6. Change in the chromaticity coordinates of white points against measurement angles.

DISCUSSION

As can be seen from Figure 3, in the case of low illuminance of about 34 lx, the reflection luminance of the photographic paper is about 5–7 cd / m^2 except for in the specular reflection direction, and from the luminance characteristics of the display shown in Figure 4, the luminance of the photographic paper can be sufficiently reproduced within the range of -60° to 60° from the front. That is, the luminance of the photographic print image viewed from the oblique direction can be reproduced in the same angle from the display. In reality, because illumination is not applied from the front, it is considered sufficient to reproduce the luminance distribution for the light from the oblique direction.

In Figure 5, the comparison result of the color gamut is shown, but because the color gamut is inherently three-dimensional, a three-dimensional comparison will be necessary. The liquid-crystal display used in this study employs an in-plane switching (IPS) panel, and it is confirmed in Figure 6 that when the viewing angle is wide, the change in luminance and chromaticity due to the observation angle is small. Moreover, because this display is for graphic arts, the color-reproduction accuracy is high. If sufficient color management is also applied to an organic-EL display, the color-reproduction accuracy may be improved.

From the above results, it seems that the liquid-crystal display used in this study is suitable for digital exhibitions at this time, except that the luminance of black is somewhat higher than desired

CONCLUSIONS

As a basic study to reproduce the texture of photographic prints on displays, the luminance and color-reproduction characteristics of photographic prints, liquid-crystal displays, and organic-EL displays were measured. In addition, the angular dependence of the luminance and chromaticity of white were investigated. As a result, it is considered that the liquid-crystal display is more suitable at present than the organic-EL display in that the color reproducibility is excellent, although the luminance of black is somewhat higher than that of organic-EL displays.

ACKNOWLEDGEMENT

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POSTER SESSION

POSTER SESSION

STUDYING LANDSCAPE PHOTOGRAPHY USING THE TONE CONTROL WITH ZONE SYSTEM

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Keywords: Tone, Zone System, Landscape Photography, Dynamic range

ABSTRACT

High resolution, having a color harmony, a sharp focus, and good background which is a good pattern and meaning are able to make an object to be outstanding. In a black and white image, there is no chromaticity in the image at all. There were two things that control an impact of the image which are lightness scale (light tone) and composition. Zone system is a lightness scale technique using controlling an image especially black and white image. In this experiment, we took images with two conditions. Both conditions were color images transformed to black and white image. The first condition was an image with zone system control, and the other was without it. Two images were judged by subjects. The result showed that 83% of subjects preferred the first condition to the latter.

INTRODUCTION

Black-and-white photography has a long and important tradition because it's where photography began—there was no other option. Black-and-white images were the "standard," something everyone shot. When color appeared, the black-and-white medium became the "special" way of shooting and gradually became the poor relation to color. Today, color is the standard and usual way of shooting, and black-and-white photos are special. Black-and-white photography has experienced a resurgence as an elegant and rich way of interpreting a subject, and that's especially true for landscape photography. But it isn't simply about removing color. In fact, just removing color can give you a blah, unappealing black-and-white landscape.[1]

To study and take a black and white landscape, I used a zone system developed by Ansel Adam, the famous black and white and dark room photographer to take 8 photos and developed it by a software before giving subjects to judge and analysis by a contrast relationship.

METHODOLOGY

Apparatus

To get an idealism of a beautiful photograph, I studied about a basic of photography including a good composition, what is a zone system, how to control a camera to get a good black and white image after taking a color photograph. The main factors of a good photograph are time and location. I studied about which place I should select as a scene for my experiment and decided what is a good time to take it.

In taking a photograph process, I controlled a composition of the image frame as a composition rule and to suite a black and white landscape photography. In this process, location was the most important part. I preferred a place which has a depth in a vision field. I took a raw image file to get a maximum dynamic range which limited in a camera. ISO was set to have the lowest value to get a maximum detail. Aperture was controlled following the hyperfocal distance technique to have a maximum focus range of an image. Speed shutter was set free and automatically controlled by a camera itself as a camera's white balance potential. In the image, there was a color checker to be a reference. The image was graded by Photoshop's plug in called Silver Efex Pro to control all lightness scale to stay within 11 zones by using dodge and burn technique to brush an area that out of zone.

Procedure

The images in Fig1-3 were judged simultaneously by random subjects composing of a professional photographer and normal person. A subject scaled likeness of each image and answered the idea in each image. By measuring a contrast in each image by color checker, I could compare the different between both of them.

Figure 1. Some picture used in the evaluation

Figure 2. Some picture used in the evaluation

Figure 3. Some picture used in the evaluation

RESULTS AND DISCISSION

83% of all subjects preferred the image with zone system control. The result in Fig4 shows the contrast between image with zone system and without zone system. The image with zone system normally gives high contrast which making an object to pop out and shining. Nevertheless, some of subjects which didn’t like artificial controlled image told me that the image looks terrible and frighten.

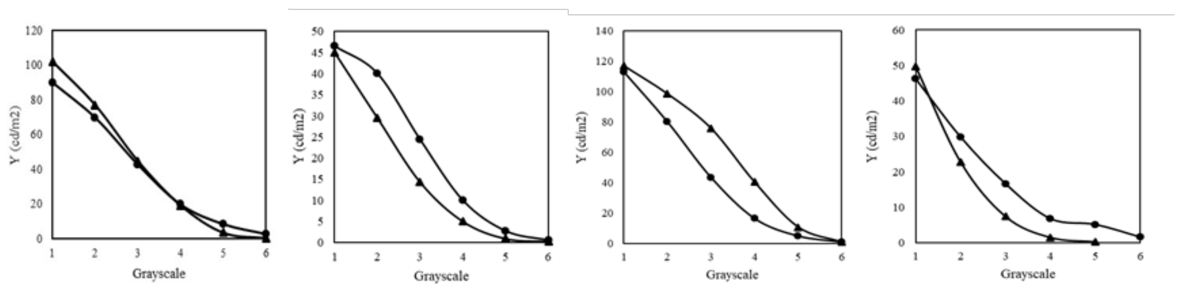

Figure 4. Some graphs show the different brightness levels of the unmodified image (●) and the adjusted image (▲).

So, the result might be changed if a photographer doesn’t have a good skill in a composition technique. With more detail or objects in the image is a more contrast and lack of a sharpen focus area.

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POSTER SESSION

PRODUCT DEVELOPMENT OF TEA DRINK FROM *TELANG* (*Clitoria ternatea)* FLOWER BY USING VALUE ENGINEERING

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Keywords: Product development, tea drink, dried flower, blue, Value Engineering

ABSTRACT

Telang flower (*Clitoria ternatae*) is one of indigenous Indonesian flowers, which could be found in other ASEAN countries too. The usage of these flowers is popular in giving blue colour in drink and foods. Actually these flowers have potential ingredients which are related to healthy food and drink, so some small medium enterprises want to develop healthy tea drink with this flower as raw material. The problem is how to find optimum condition for preparing flower as healthy drink that produces blue colour and fulfils consumer expectation. Objectives of this on-going research are; a. to find parameters for preparing dried *telang* flower based on consumer preferences; b. to optimize these parameters for producing dried *telang* flower. The method for conducting this research is Value Engineering, in which the consumer preference is used for developing healthy drink. After collecting data from consumers, the data is analysed then prioritized. The concept of the healthy drink is drawn through function analysis system technique (FAST) Diagram, then some concepts are developed and analysed for gaining the best concept of drink. Some chemical and physical parameters of dried flower are measured. Furthermore process parameters such drying temperature and time, colour intensity, and others are also determined.

INTRODUCTION

At recent time society usually uses *telang* flower as food colorants and eye drop, because they believe that stew *telang* flower could enlighten sight. These lead to explore potencies of the flowers, which contains phenol, alkaloid, flavonoid, Sulphur, calcium oxalate and others. One of weaknesses at moment is that only few product variations. This challenge is important to promote the functional properties of this flower to society, so they have more choices in using it as nature food colorant for foods and drinks.

This research was aimed to optimize the process combination for producing tea drink with telang flower by using Value Engineering. This method could give important information from consumers, what they really need for consuming tea drink from *telang* flowers. Based on voice of customers, some product specifications could be developed and used as reference for producing tea drink that has high value and attract consumers.

The research was aimed to determine and prioritize product attributes based on consumer need; to determine tea drinks based on *telang* flower that fulfills consumer needs and has high value.

METHODOLOGY

The research was conducted at Laboratory of Product Engineering and Waste Management – Department of Agroindustrial Technology – Faculty of Agricultural Technology – Universitas Gadjah Mada. Sampel of telang flowers was provided by farmers from Sleman District – Yogyakarta. They planted because some restaurants need it. For gaining voice of consumers the questionnaire was used to make the consumers easier in answering list of questions. The target group is people who have tasted and consumed this drink, then the sum of people as respondents was 100 persons. The Value Engineering Method was used for implementing this research, which consists of following phases; a. Information Step; b. Creativity Step; c. Development Step; d. Recommendation Step.

RESULTS AND DISCUSSION

The results were depicted in sequence of Value Engineering steps as mentioned in methodology as follow:

1. Information phase.

Based on consumer responses, primary attributes of the drink were categorized into six items namely; taste, color, flavor, packaging, price and function. The primary attributes were divided into some secondary attributes that supported basic function of products. Both attributes were compiled and constructed into questionnaire that was spread to 100 respondents with purposive sampling technique. The data analysis was based on confidential level 95%, validity and reliability tests were conducted and then comparing between $R_{calculation}$ and $R_{table.}$ The realibility test was done and comparing with Cronbach Alpha value > 0.600 meant reliable (Sugiyono 2012).

Table 1. Primary and secondary attribute

Primary attributes	Secondary attributes	R_{hasil}	R_{tabel}	Explanation
Function	Functional value of *telang* flowers drink	0,258	0,195	Valid
Taste	Plain taste	0,254	0,195	Valid
	Sweet taste	0,441	0,195	Valid
	Taste variations of drinks	0,501	0,195	Valid
Color	Natural color (bright blue)	0,207	0,195	Valid
	Color variations of drinks	0,441	0,195	Valid
Flavor	Natural flavor	0,370	0,195	Valid
	Flavor variation	0,539	0,195	Valid
Packaging	Sum of flavors in pack	0,479	0,195	Valid
	Serving form	0,481	0,195	Valid
	Packaging materials	0,374	0,195	Valid
Price	Price as consideration factor	0,415	0,195	Valid

All aspects in primary and secondary attributes were valid based on the test, then they should be ranked for determining the priorities for developing the drinks. The rank of the attributes were at table 2.

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Table 2. Priority Level of Primary Attributes

No.	Attributes	Score	Rank
1	Function	2.16	1
2	Taste	2.77	2
3	Color	3.89	3
4	Flavor	3.94	4
5	Price	3.95	5
6	Packaging	4.29	6

The price was not able to be developed because it was quality attribute that came from outside of products. It was depended on the intrinsic product attributes (Juda, 2016).

2. Creativity phase

Based on the results of consumer perception, some interesting findings could be used as reference for developing this products. These points were as follow; function of the flower because of antioxidant component, plain drink with original color, taste and flavor. Furthermore the consumers wanted the packaging of the flower in tea-bag, kraft-paper as secondary packaging, net weight per packaging 10-20 gram. But some consumers still wanted to drink this tea with sugar cub and some other flavor like from rosella and lemon grass.

3. Development Phase

Based on identification of consumer needs, some specification of *telang* flower drink could be pointed out in alternative concept which was shown in Figure 1.

Attribute	Raw materials	Sweeteners	Flavor enhancers	Concept
Concept	Dried *telang* flower	Plain	Rosella	**A**
			Lemon grass	**B**
		Sugar cub	Rosella	**C**
			Lemon grass	**D**

Figure 1. Zero-Level Concept Diagram for Alternative Concept Product

4. Recommendation Phase

In this research this four concept were test by at least 30 panelists, who were not trained panelist. They were normal consumers (Sugiyono, 2012). The sensory test was conducted and evaluated by using Likert scale, in which 5 was like very much and 1 was don't like very much. The test was used for determining and choosing the best concept of tea drink from telang flowers. The resume of sensory evaluation results was depicted in table 3 as follow.

Table 3. Results of sensory evaluation on product concepts

Attributes	Product evaluation					
	A	**B**	**C**	**D**	Sum	Percentage
Color	121	104	71	97	393	33.33
Flavor	92	105	115	105	417	35.37
Taste	62	68	112	127	369	31.30
TOTAL	**275**	**277**	**298**	**329**	**1179**	**100**

The results in table 3 was used for calculating performance value of every concept, which had the best performance for promoting to be best alternative product. The calculation and result were shown in table 4 as follow.

Table 4. Performance value of every concept

Product Concept	Bobot Atribut (%)			Performance Value
	Color	Flavor	Taste	
	0.3333	*0.3537*	*0.313*	
A	121	92	62	92.2757
B	104	105	68	93.0857
C	71	115	112	99.3958
D	**97**	**105**	**127**	**109.2196**

Based on table 4 the concept D had highest performance value (109.2196), it meant this concept could be accepted by the consumers based on three sensory criteria (color, flavor and taste). But it should be considered by other factors such as production cost. It played an important role, since the cost could be as determinant factor whether the production could be proceed or not. In the table 5 the ingredient composition and their price were evaluated

Table 5. Composition and *price* (in rupiah) for producing 2 gram telang-drink in tea-bag.

Concept	*Telang* flower		Rosella		Lemon grass		Tea-bag		Sugar		Sum
A	1 g	*1500*	1 g	*160*			1 pcs	*75*			*1735*
B	1 g	*1500*			1 g	*45*	1 pcs	*75*			*1620*
C	1 g	*1500*	1 g	*160*			1 pcs	*75*	5 g	*120*	*1855*
D	1 g	*1500*			1 g	*45*	1 pcs	*75*	5 g	*120*	***1740***

Further calculation should be performed, so that the final concept can be chosen and used as prototype for producing this drink. The calculation will yield Value that final result from cost divided product performance. The result was shown in table 6.

Tabel 6. Result of Product Value

Produk	Production cost (Rupiah/pcs)	Product Performance	Value
A	1735	92.2757	0.053185
B	1620	93.0857	0.05746
C	1855	99.3958	0.053583
D	**1740**	**109.2196**	**0.06277**

The best concept was determined form highest value that was got by product (Ulrich and Eppinger, 2001). Based on their product performances and production cost, and of course value, the concept D (0.06227) could be chosen as alternative tea-drink produced from *telang* flower.

CONCLUSION

The conclusion were as follow:

a. Important factors affected consumers consideration were; Function, Taste, Color, Flavor, Price and Packaging.
b. The product concept D gained highest value for 0.6227 and consisted of dried telang flower, lemon-grass and sugar cub.

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THE FACTORS FOR DETERMINING THE SHARPNESS OF THE IMAGE OBTAINED FROM PVC MULTI-ROTOR (DRONE)

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Keywords: **Sharpness**, **PVC** (polyvinyl chloride), **Multi-rotor, Drone**

ABSTRACT

Drone or Multi-rotor UAVs is an unmanned aircraft can control the flight by using controls and GPS systems are connecting with mobile phone. It has many forms are depending on each event. In film and television, people like to use is it for using to take a photo and VDO clip presenting new view. However, its structure is expensive and must be imported from abroad. The purpose of this research was studied about structure by using PVC pipes are main material, and studied structure factors are effect to view of image.

In the study, researcher was designed drone's structure by using PVC pipe because it's cheap and light weight but it's strong. It can support the weight of the other tools on drone. In addition, studying vibration of drone on flight, distance, motor, and paddle system that's effect to present clear image.

The result of this study is factors are effect to present image is clear and views of image are: -

1. Strength of material: There are 3 types and it can support for different strengths. A blue PVC pipes can support vibration is moderate, and image is clear. In addition, it's related to altitude and wind strength. A blue PVC pipes can support altitude around 100-200 meters and wind strength
is moderate.

2. Weather in flight testing in open space: Drone's structure can support withstand moderate winds. It makes image is clear, and it can support see things.

3. The performance of the drone's camera: it can support altitude around 100-200 meters. When it's more than 100 meters high, a noise signal of the drone's camera appears on the screen. The video signal is missing at some point.

INTRODUCTION

Drone is a technology driven and aerial photography or unmanned aircraft (Unmanned Aerial Vehicle, UAV control it by remote control. The form of Dorn is both small to large. It's first start developing abroad in a military mission for a long time and widespread in Thailand a few years ago. Nowadays drone is use for taking photo in high angle such as sports event, the weather forecast on television program, traffic conditions, disaster relief and entertainment. In the part of entertainment use it in recording both slide and VDO clip for getting a picture with a new perspective.

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Drone has many shapes, and it is the most popular for using is MultiRotor or Multicopter. The type of MultiRotor is A four-blade propeller, one motor, and its shape is similar to a helicopter. The advantage is that it can climb up vertically, and it is suitable for recording. The disadvantage is that imported components are expensive. In addition, Other components are compared with the Drone also has a high price is depending on user such as Automatic Return-to-Home, barometer, Battery voltage and controlling of user.

Figure 1. Example of MultiRotor or MultiCopter

(http://www.dstd.mi.th/board/index.php?topic=2406.0, 25 September 2018)

From this problem, researcher would like to study about designing and select materials for the construction of Drone by using PVC pipes for reducing costs, and take it to create image in new perspective. The aim of this research is develop about Aerial photography such as Image integrity, Detail of the image while flying, and maximum level of image quality that can support image clarity.

The aim of study

To study the clarity of the image, ability to capture image details, and height level of recording that can support image clarity.

Scope of study

A study of the sharpness image using Drone fabricated from PVC pipe.

Methodology

This research was conducted in 2 steps as follows:

Part 1: Drainage from PVC pipe is divided into 3 stages.

1. Pre-production

1. Collecting information about PVC pipe in each form and size of pipe. The strength and flexibility of the pipe is tested.

Figure 2. Testing of PVC pipe in various forms

2. Studying the structure in each form of the drone for creating and designing structure by using PVC pipe.

3. Preparering the tools used in the invention. And it has already been drafted.

2. Production

Fabricate the drones to the shape they have designed.

Figure 3. The process of creating Dorn

3. Post-production

Testing of Drone's work such as structural strength tests on aviation or the flight recording was checking by three flight specialists about Drone.

Part 2: Testing and in-depth interview

Researcher had testing drone by using PVC pipe around 3 things are strength of drone, the weather while flying, and height level of drone is effect to clearly image, and in-depth interview with 3 specialists.

Conclusion

From in-depth interview of 3 specialists are specialist of invention, specialist of flying, and specialist of controlling techniques can be summarized as follows.

Table 1: Effective of Dorn while flying

No. of Specialist	Structure of Dorn	The relationship between weather and height level while flying	The relationship between Clarity of image and height level while flying
Specialist 1	The shape is stable and it can resistance the wind that hit. However, it may not be convenient for working. The structure should be smaller.	Flying is stable with wind resistance. The use is quite simple, but weight cannot fly very long time. The distance cannot exceed 150 meters.	More than 200 meters will be unclear. And cannot keep details. The camera attached to the structure is also effective.
Specialist 2	The structure is well proportioned and suitable according to the shape of the rotor motor size. However, the Installed equipment should be constructed to prevent moisture from the weather.	I'm not good with wind. The balance of the structure should be adjusted and weight which will affect the duration of flight. The distance of 150-200 meters, suitable for general use.	The height of 150-200 meters will be sharp image and detail of the image. If the height level is more than 200 meters, the image will be unclear.
Specialist 3	Suitable for general use. When installing the engine, it may affect the weight of the structure.	Balance of Dorn is not good. Can fly higher than 200 meters.	More than 200 meters will be unclear, and it could not capture image details. The performance of the camera installed also affects the video transmission.

The result of this study is factors are effect to present image is clear and views of image are: -

1. Strength of material: There are 3 types and it can support for different strengths. A blue PVC pipes can support vibration is moderate, and image is clear. In addition, it's related to altitude and wind strength. A blue PVC pipes can support altitude around 100-200 meters and wind strength is moderate.

2. Weather in flight testing in open space: Drone's structure can support withstand moderate winds. It makes image is clear, and it can support see things.

3. The performance of the drone's camera: it can support altitude around 100-200 meters. When it's more than 100 meters high, a noise signal of the drone's camera appears on the screen. The video signal is missing at some point.

Discussion

The results of the study can be described as follows:

1. Strength of material that is effect on flight efficiency. The structure should be of proper size, and the strength of the drones to flying. In addition, the installation of the other engines on the drone can affect the weight on the fly as well. From the study of Pattama Choorin. (2014:84) said Battery is important to pay attention. User to know the extent of battery, limited of battery for flying, and the weight of battery while flying. The pressure gauge should be mounted on the battery while flying for helping to alert. In the structure part and iinstall of equipment should not overload the device, but it should be able to easy separation of aircraft.

A blue PVC pipes can support vibration is moderate, and image is clear. In addition, it's related to altitude and wind strength. A blue PVC pipes can support altitude around 100-200 meters and wind strength is moderate. This is consistent with article is What is the blue PVC pipe. (2018) said PVC blue pipe are Many good features, for example, properties that are tough, flexible, good. resistant to water pressure, resistant to corrosion, and it is non-combustible material. It is lightweight and also cheap, and taking it to use about plumbing and electrical systems.

2. Weather in flight testing in open space. Drone's structure can support withstand moderate winds. It makes image is clear, and it can support see things. DJI13STORE (2018) said If you take drone on a flight at any time. You should check weather to be sure that you can take Drone to fly. If you do not check the weather before you take drone to fly, there is a risk that your drone will be hit by rain or hit the sky. In addition, if drone is effect with windy or storm, it can make drone is broken, and including image of drone is not clearly.

Figure 4. Flight test in open space

3. The performance of the drone's camera: it can support altitude around 100-200 meters. When it's more than 100 meters high, a noise signal of the drone's camera appears on the screen. The video signal is missing at some point. It complies with article of Thai Air Force said user should force or release drone must be able to see it at the time of flight. If drones approach the clouds or fly at night. It makes the vision less visible, and it has opportunity to cause harm to people, dormitories and houses of their own including themselves. Including Drones flying over the law, the 90-meter (300 ft.) limit may collide with the aircraft and cause a fatal accident. In the normal flight. As a rule of flight, aircraft will not fly below a height of 500 feet.

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Figure 4. **Flight test and The performance of the camera in the transmitter.**

Figure 5. **Bad weather affects signal transmission.**

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SOCIAL MEDIA USING BEHAVIOR AND MEDIA LITERACY, AND RISK PREVENTION BEHAVIOR OF UNDERGRADUATES OF RAJAMANGALA UNIVERSITY OF TECHNOLOGY THUNYABURI

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Keywords: Social Media, Behavior, Media Literacy, Media Risk Prevention

ABSTRACT

The objective of this study is to study behavior in using social media and media literacy, and risk prevention behavior and study the relationship between behavior and social media literacy of undergraduates of Rajamangala University of Technology Thanyaburi. The samples are male for 205 persons or 46.6% and female for 235 persons or 53.4%. The instruments used in research are questionnaire and in-depth interview form relating to behavior in using social media, media literacy and social media risk prevention behavior. The findings of the research results indicated that most of samples was literate with social media in the matter of exaggerate or deceptive propaganda about cosmetic products for 348 persons or 79.1%. 261 persons or 59.3% of samples tended not to be literate with social media about persuasion to participate in activities via social media through advertising media with discount, exchange, distribution and giving away of goods and 254 persons or 57.7% of samples tended not to be literate with social media about request for assistance or donation of properties in social media. 256 persons or 41.8% of samples had proper knowledge relating to social media risk prevention behavior and 184 persons or 41.8% of samples had none of knowledge relating to social media risk prevention behavior. 357 persons or 81.1% of the sample believe in color ads more than plain old black and white ads. In this research, the finding of the hypothesis testing result indicated that behavior in using social media was related to social media literacy at .05 of statistical significance level. It was to say that behavior in using social media, such as frequency of access to use social media and duration of access to use social media in each time, was related to social media literacy.

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INTRODUCTION

The growing popularity of social media networks has had many positive and negative implications for society. It seems like the Social media just came out of nowhere and changed everything, including Teenage. Social media plays a very important role in the daily lives of people in society. We are using it to keep in touch with our friends and make some new friends. Besides that we want to show the world what we are doing by means of posting pictures or videos. Social media is a vital aspect of teenagers' social and creative lives. They use social media to have fun, make and maintain friendships, share interests, explore identities and develop relationships with family. It's an extension of their offline and face-to-face interactions. The explosive growth of social media applications has revolutionized the way they interact with one another. However, the emergence and use of this online environment has also created new opportunities for deception [1].Teenagers who are media literate and have risk prevention behavior are more aware of the way media content is made, where it comes from and what its purpose is. They're more confident about voicing their opinions about media. They're also safer online and less likely to be manipulated by the media.

MEDIA LITERACY

Media Literacy is a 21st century approach to education. It provides a framework to access, analyze, evaluate and create messages in a variety of forms - from print to video to the Internet. Media literacy builds an understanding of the role of media in society as well as essential skills of inquiry and self-expression necessary for citizens of a democracy [2].Media literacy can be considered as the process of accessing, critically analyzing media messages, and creating messages using media tools. A lot of people view that media literacy facilitates understanding of communication technology, the message code, message generated, message selection, interpretation, and impact of the message on the receiver. Furthermore, media literacy can become very important, as by it is a set of perspectives to interpret the meaning of the mediated messages so that it can provide clues about how to treat the media – in the context of this paper, this refers to the online social media. The freedom of delivering messages on social media should be appropriately filtered to preserve the societal norms and values, especially so for teenagers who are still in search of identity and therefore a prime target for terrorist groups' recruitment via the social media. Media literacy will potentially help young social media users better interpret the messages.Theoretically, there are two main things that can be done to develop social media literacy. First, consciously manage the flow of information. It is clear that no one is able to withstand the flow of information in this Internet era. One of the characteristics distinguishing social media from media is consumers' freedom of access to information, in this case social media users choose what they want. In contrast to conventional media, such as news on television, for example, society must receive the news aired by a television news network. Meanwhile, in social media, the account owner can choose to read the information he wants, and he can choose which information he will share. However, it is not easy, because it relates to the personal awareness of each social media user. Second, actively participate in determining the regulations in the use of communication technology to minimize the abuse of human rights and protect freedom of speech.

OBJECTIVE

The objective of this study is to study behavior in using social media and media literacy, and risk prevention behavior of undergraduates of Rajamangala University of Technology Thanyaburi,and study the relationship between behavior in using social media and social media literacy of undergraduates of Rajamangala University of Technology Thanyaburi.

METHODS

The samples used in this research are 440 undergraduates of Rajamangala University of Technology Thanyaburi under classification into 10 faculties per 1 College, using the faculty samples/college for 40 persons. Using the faculty samples/college for 40 persons. The samples are male for 205 persons or 46.6% and female for 235 persons or 53.4%. The instruments used in research are questionnaire of behavior in using social media, media literacy and social media risk prevention behavior of the undergraduates of Rajamangala University of Technology Thanyaburi, and in-depth interview form relating to behavior in using social media, media literacy and social media risk prevention behavior. The process of creating the instruments used in research, Firstly, Researcher collected and analyzed data related to social media usage behavior, media literacy and social media risk prevention behavior from books, websites and interview with experienced and qualified experts. Socondly, researcher analyze the content to prepare a questionnaire. Thirdly, determine the appropriate form of the questionnaire. The questionnaire of behavior in using social media, media literacy and social media risk prevention behavior of the undergraduates of Rajamangala University of Technology Thanyaburi contains 4 parts:

Part I: Demographic questionnaire of respondents (Age, Gender, Faculty, Year of study)
Part II: The social media usage behavior of the respondents
Part III: Media literacy behavior of the respondents
Part IV: Social media risk prevention behavior of the respondents

Fourthly, take the questionnaire to check the quality of the content validity. Finally, the researcher used a questionnaire with 40 sample to determine the discrimination power.

An in-depth interview form relating to behavior in using social media, media literacy and social media risk prevention behavior contains 3 parts:

Part I: Demographic questionnaire of interviewer (Age, Gender, Faculty, Year of study, Hometown, Expenses in daily life)
Part II: Social media usage behaviors of individuals
Part III: Media literacy behaviors of individuals
Part IV: Social media risk prevention behaviors of individuals

The questionnaire was used to collect field data. The samples used in this research are 440 undergraduates of Rajamangala University of Technology Thanyaburi under classification into 10 faculties per 1 College. (Students in faculty of Mass Communication Technology 40 persons, Faculty of Science and Technology 40 persons, faculty of Business Administration 40 persons, Faculty of Fine and Applied Arts 40 persons, faculty of Liberal Arts 40 persons, Faculty of Techical Education 40 persons, Faculty of Engineering 40 persons, Faculty of Architecture 40 persons, Faculty of Home Economics 40 persons, Faculty of Agricultural Technology 40 persons and Thai Traditional Medicine College 40 persons.) .One sample of each group was interviewed and using an in-depth interview.

RESULTS

The samples are 205 males (46.6%) and 235 females (53.4%). The sample consisted of 107 first-year students (24.3%),118 second-year students (26.8%), 112 third-year students(25.5%) and 103 fourth-year students (23.4%).The samples were in Bangkok Metropolitan Region 220 persons(50.0%). Next, the samples were in central region 134 persons (30.5%). Sample received average daily living expenses are about 5,331 baht per month. The sample live at dormitory / rental homes are 267 persons (60.7%). Next, the samples live at their parent's home 140 persons (31.8%)

The findings of the research results indicated that most of samples used social media for more than 10 times per day for 284 persons or 64.5%. Average duration of which most of samples used social media in each time was lesser than 30minutes for 141 persons or 32.0%. Equipment maximally used by samples in access to social media was mobile phone and the secondary was desktop computer, portable computer, tablet and clock, respectively. They believe social media has a positive effect on their lives, helping them feel more confident and less lonely.

According to the evaluation of samples in the matter of media literacy, the finding indicated that most of samples was literate with social media in the matter of exaggerate or deceptive propaganda about cosmetic products for 348 persons or 79.1%. However, 261 persons or 59.3% of samples tended not to be literate with social media about persuasion to participate in activities via social media through advertising media with discount, exchange, distribution and giving away of goods and 254 persons or 57.7% of samples tended not to be literate with social media about request for assistance or donation of properties in social media. 256 persons or 58.1% of samples had proper knowledge relating to social media risk prevention behavior and 184 persons or 41.8% of samples had none of knowledge relating to social media risk prevention behavior. 357 persons or 81.1% of the sample believe in color ads more than plain old black and white ads.

In this research, the researcher assumed the research hypothesis that behavior in using social media, such as frequency of access to use social media and duration of access to use social media in each time, is related to social media literacy. The finding of the hypothesis testing result indicated that behavior in using social media was related to social media literacy at .05 of statistical significance level. It was to say that behavior in using social media, such as frequency of access to use social media and duration of access to use social media in each time, was related to social media literacy.

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POSTER SESSION

Development of Online Interactive Infographics for Digital Communication

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Keywords: Interactive, Infographic, Online Media, Digital Communication

ABSTRACT

This research aimed to (1) develop and quality evaluation of online interactive infographics for digital communication (2) study the satisfaction of sample group and (3) study the correlation of quality and satisfaction. The research using the ADDIE method. The sample group is the 30 first year students in Mass Communication Technology of RMUTT by Simply Random Sampling. The statistics used in this research are mean, standard deviation and bivariate correlation. The result showed that online interactive infographics for digital communication was at high level (Mean = 4.24, S.D. = 0.48), the satisfaction was at high level (Mean = 4.27, S.D. = 0.60) and bivariate correlation is significant at 0.05 level. Therefore, increased quality correlate with increased sample satisfaction.

INTRODUCTION

In Thailand 4.0, information and communication technology have many roles relate with daily life in 21st century. They lead to have vast data (Big Data) and are presented by various type; printing and digital media. The sender will send the messages through the platform by using intranet to spread the data through the social network, Website, Facebook and Line, to the receiver. Thus, the receiver will meet the vast data immediately at the same time [1]. The data that made in times in daily basis contained texts, numbers, sounds and videos, which aren't inappropriate form to use. They must have transformed to information through data processing before using more [2].

The infographic is a process to change the data into the picture for the receiver to understand more easily and communicate with each other by touchable objects. [3]. Infographic is comprised by information and graphic that made from turning data into information whether it be knowledge, statistic, or situation into the systematical picture included texts, graphics, icons, cartoons and diagrams. The notabilities of infographic communication are easy to understand, attractive, timesaving and professional. [4] and [5]. Consequently, infographic is a popular tool to use for data presentation. Furthermore, using effective infographic must consider the color theory (mono, complement and triad) to choose the color modes correctly, the types of works that are screen or printing for choosing the RGB or CYMK mode respectively and the color emotions and tone backgrounds, and that the characters must complement the background to read easily and don't use color in the infographic project [4].

The interactive media is digital media that is popular because it can stimulate the attraction and response to the need between media and user. It can be display in any gadgets whether it be laptop, tablet and smartphone [6] and also can be export into HTML5. Now, the new infographic is developed from the original that are just screenshot pictures for more interaction, more interest in receivers and publishing on websites and social networks easily. The online interactive infographic is developed by using the ADDIE method that comprises with analysis, design, development, implementation and evaluation. [7]

Thus, the researcher aims to develop the online interactive infographic for digital communication in order to construct the interactive knowledge media by using ideas, infographic design principle and online publishing (e.g. websites and social networks) to enhance the attraction, reach to the receivers easily and save the time in studying the data for remembering, more professional and reliable.

OBJECTIVES

1. To develop and evaluate the quality of online interactive infographic media for digital communication.
2. To study the satisfaction of sampling to online interactive infographic media for digital communication.
3. To study the relation of media's quality level and satisfaction of sampling to online interactive infographic media for digital communication

RESEARCH LIMITATIONS

Expert

The samples wrer 5 experts who graduated above master degree in Mass Communication Technology, Journalism, Education Technology, or related field or have experience in the field of multimedia for more than 3 by purposive method.

Population and Sampling

Population were students in the department of Mass Communication Technology, Rajamangala University of Technology Thanyaburi by Simply Random Sampling.

Variable

1. Independent variable was online interactive infographic media for digital communication
2. Dependent variables were media quality level and satisfaction of sampling to online interactive infographic for digital communication

METHIDOLOGY

The methodology was divided into 5 phases following ADDIE Branch, R. M. (2009: 2-3)

1. Analysis phase was to study documents and literature reviews on related theory in infographic design and the interaction on media. In addition, to analyze the contents of online infographic media.

2. Design phase was planning on online infographic media project.
3. Development process was to follow the plan in order to develop the interactive infographic and construct the interaction using the computer programmed. Then, studying the different qualities between the original infographic media and interactive infographic media that were evaluated and analyzed by multimedia expert.
4. Implement phase was to publish interactive infographic media on websites, TouchPoint facebook page and to study the impression of 30 samples.
5. Evaluation was to analyze the data that gathered from samples.

RESULTS

The results of quality evaluations

The interactive infographic media for digital communication is evaluate by using mean and standard deviation [8], as showed in Table 1.

Table 1 The results of quality evaluations of interactive infographic media for digital communication.

Evaluation	Quality levels		
	Mean	S.D.	Meaning
1. The interactive infographic media can be understood easily.	4.40	0.55	Good
2. The interactive infographic media can be used easily.	4.20	0.45	Good
3. The buttons were aligned appropriately	4.00	0.71	Good
4. The linkage to each content was correct.	4.60	0.55	Very good
5. The background melody was appropriate.	4.20	0.45	Good
6. The volume levels was appropriate.	4.20	0.45	Good
7. The composition comprises were beautiful.	4.60	0.55	Very good
8. The colors using were beautiful.	4.40	0.55	Good
9. The characters were appropriate.	3.80	0.45	Good
10. The size of characters was appropriate.	4.20	0.83	Good
11. The color of characters was appropriate.	4.00	0.00	Good
12. The text arrangements were appropriate.	4.00	0.71	Good
13. The pictures in each contents were clear.	4.00	0.00	Good
14. The graphic and content were relerant and appropriate.	4.80	0.45	Very good
Total average	4.24	0.48	Good

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The results of Satisfaction

The interactive infographic media for digital communication is evaluate by statistic methods, e.g. mean and standard deviation [8], Following Table 2.

Table 2 The results of satisfaction evaluations of interactive infographic media for digital communication.

Evaluation	Quality levels		
	Mean	**S.D.**	**Meaning**
1. The interactive infographic media can be understood easily.	4.63	0.56	Very good
2. The interactive infographic media can be used easily.	4.33	0.61	Good
3. The buttons were aligned appropriately	4.16	0.64	Good
4. The linkage to each content was correct.	4.53	0.51	Very good
5. The background melody was appropriate.	4.00	0.69	Good
6. The volume levels was appropriate.	3.93	0.69	Good
7. The composition comprises were beautiful.	4.30	0.60	Good
8. The colors using were beautiful.	4.57	0.50	Very good
9. The characters were appropriate.	4.27	0.58	Good
10. The size of characters was appropriate.	4.00	0.64	Good
11. The color of characters was appropriate.	4.20	0.71	Good
12. The text arrangements were appropriate.	4.1	0.55	Good
13. The pictures in each contents were clear.	4.27	0.58	Good
14. The graphic and content were relerant and appropriate.	4.53	0.51	Very good
Total average	4.27	0.60	Good

The Relation between quality evaluations and satisfaction

A study of the relation between quality evaluations and satisfaction for Online Interactive Infographics for Digital Communication is evaluate by correlation analysis statistic methods, as shows in Table 3.

Table 3 A Study of the Relation between quality evaluations and satisfaction

		The Quality	The Satisfaction
The Quality	Pearson Correlation	1	.563**
	Sig. (2-tailed)		.036
	N	14	14
The Satisfaction	Pearson Correlation	.563**	1
	Sig. (2-tailed)	.036	
	N	14	14

The significant at the 0.05 level. (2-tailed)

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From table 3, The level of relation between quality evaluations and satisfaction from sample is very high and positive. Therefore, the increased quality is related to the satisfaction of the sample. The relation was statistically significant at the 0.05 level.

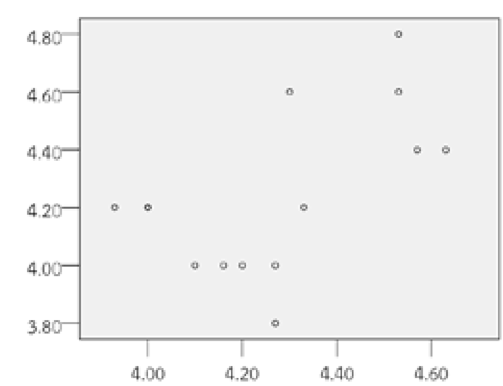

Figure 1. The Relation between quality evaluations and satisfaction

CONCLUSION AND DISSCUSSION

The development of interactive infographic media for digital communication was to take the original infographic that is popular in present and modifies for enhancing the interests of people. This research studied the relation of media's qualities level and satisfaction of sampling to online interactive infographic media for digital communication and found the relationship was statistically significant at 0.05 level. It indicated that the increasing qualities related to the increasing impression of sampling. According to Angela Locoro and et al. that studied the value of using constant infographic and interactive infographic in daily life and found that the interactive infographic had more complex processes in production than the constant infographic, but the interactive infographic had more positive interaction to people than the constant infographic.

Figure 2. Online Interactive Infographics

SUGGESSTION

The researcher suggested it to use in the interactive infographic in other fields and suggested to apply this knowledge to be more advance that can lead to interactive motion graphic media.

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THE RESULT OF COMPOSITE GRAPHIC PRODUCTION IN ADDING COMPLETE PICTURES TO AUDIENCE'S VIEW

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Keywords: Composite Graphic, historical documentary, television program

ABSTRACT

Composite Graphic is a technology to create graphics from computer programs, and it looks like realistic. It makes to create new views for the audience on television. It is an important element in helping to explain the content of information is quite complex and difficult to picture that makes the audience to understand easily.

In this research, researcher designed Composite Graphic to help explain and create interesting about historical documentary television program. The purpose is to help explain the background of the missing part is complete and attraction. The scope of the study is to create a missing piece within Wat Phra Sri Sanphet and Wat Mahathat at Phranakhon Si Ayutthaya province. It is a popular tourist destination both Thai and foreigners. The length of clip VDO is about 10 minute. First step is pre-production, we're surveyed and interview to collect information about the place, script writing, and exploring places for drawing graphic at each point to determine where to create composite graphics. Second step is production, shooting pictures at each designated point, and creating graphic. Last steps in post-production are video editing by using composite graphics and video images are mixed together.

In the study, we're interviewed professional around 3 persons are television production, editing and graphic computer. The sample groups are elementary primary students around 33 persons by watching video clips and do questionnaire.

The results showed that content and composite graphics is suitable, and colorful and attractive. It makes them to understand about these places, and background of the elements of places. Audience can recognize the form and structure of these places in the past, and visualize the structure more clearly than imagined or viewed from a photo. The suggestion from the sample group is adding color that is similar to real things. It helps to feel realistic.

INTRODUCTION

Television is one media that influences the population in society around the world. The presentation of information on television programs has a great influence on behavior, idea, and lifestyle. The main function of the television program is presenting of information, knowledge or entertainment in various forms to audience. Therefore, television is an important tool in social and country development.

Historical documentary television program is one television program that are popular to audience. The type of this television program is presenting information and travel map both inside and outside of the country. At the same time, this one is adding knowledge of religion, art, and culture, and it has various television program such as ecotourism Cultural tours, or historical tours. In the past, the content of television program was presented by using visualization of the place and lecturer by speaker.

In past, touring feature television program was being presented by using image from real location for presenting and using music is background music. This one make it look simple and it's not interesting. From this problem, Television producers have to adapt themselves in terms of presentation content. The form of television program is unique, remarkable, and motivating their interesting. In addition, graphics are one of the elements that television producer take it to present information to audience.

Figure 1. Graphic on news television program's Thairat TV
(https://pantip.com/topic/33863714, 28 September 2561)

Most of the graphics in the travel television program will focus on presenting the information with the location or map maps for trips to places. Graphics for touring feature television program was being presenting motion picture for telling story or animations designing that is cute. It makes audience to feel interesting and realistically that's motivate interesting's children. Sudarat Wongkampa (2011) said children and youth like to watch motion graphic on television because it can make them to understand information immediately by using picture for explaining. Picture can make them to remember info more than oral presenting.

Figure 2. Graphic on weather television program's 7 Channel (CH7 HD)
(https://pantip.com/topic/33417482, 28 September 2561)

For that reason, researcher was studied using composite graphic for explaining and creating it interesting on historical documentary television program. The purpose is to help explain the background of the missing part is complete and attraction. The scope of the study is to create a missing piece within Wat Phra Sri Sanphet and Wat Mahathat at Phranakhon Si Ayutthaya province. It is a popular tourist destination both Thai and foreigners. The sample groups are elementary primary students. To study the effectiveness of graphic on the television program can increase the knowledge and understanding of history to children.

Hypotheses

Virtualization of composite graphic can stimulate interesting and help to explain the history of the place to children more than oral presenting.

Methods

The study was divided into two parts.

Part 1 is the production. The steps are as follows.

Pre-production :

1. The sample was elementary school's children and youth.
2. Length of VDO clip is about 10 minute.
3. Searching the location for filming.
3. we're surveyed and interview person to collect information about the place, script writing, and exploring places and surrounding areas for drawing graphic at each point to determine where to create composite graphics.

Production :

1. Shooting pictures on real location.
2. Designated point, and creating graphic on location is Wat Phra Sri Sanphet and Wat Mahathat at Phranakhon Si Ayutthaya province.

Post-production :

1. Creating temple model by using Google Sketch up 2017 program and creating animation model by using Maya 2017 program.
2. Taking composite graphic, animation model and Wat Phra Sri Sanphet and Wat Mahathat at Phranakhon Si's images are mixed together by using Adobe Premiere Pro CC program for VDO editing.

Part 2 is a surveying. The steps are as follows.

1. we're interviewed professional around 3 persons are television production, editing and graphic computer.
2. The sample groups are elementary primary students around 33 persons by watching video clips and do questionnaire.

After that, take it to sum this information.

Results

The results can be summarized as follows:

From depth-interview with specialist can be summarized as follows

1. Motion graphic are design is similar to the real place. It can present information these temples to children. However, models should be colorful to stimulate the interests of children and youth. Colors will help children get interested, learn and memorize.

Figure 3. Model image of Phra Sri Sanphet Temple

2. Image and camera angles are appropriate and can be attributed to graphics. However, some scenarios have colors that are not as close to the actual location.

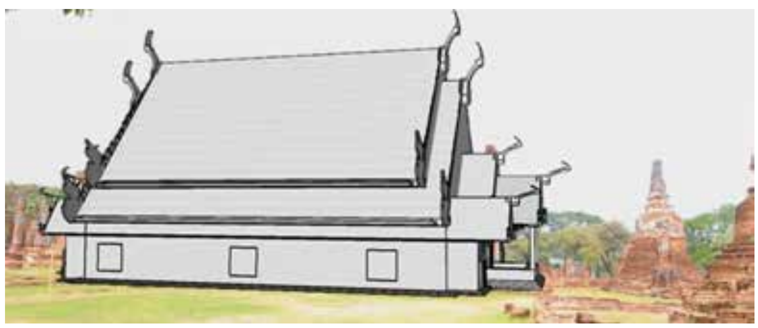

Figure 4. some model image of Phra Sri Sanphet Temple is not as close to the actual location

3. Character design is appropriate for a good historical documentary television program. The character of the student model is well suited for providing good historical knowledge. However, character model should be added color to make the images that is more eye-catching to children.

Figure 5. The character of the student model

The sample of 33 elementary school students was able to summarize the results as follows.

1. Model are virtual, and it can make them to understand the style of the temple in perspective never seen before. However, model should be added colorful as the real picture.

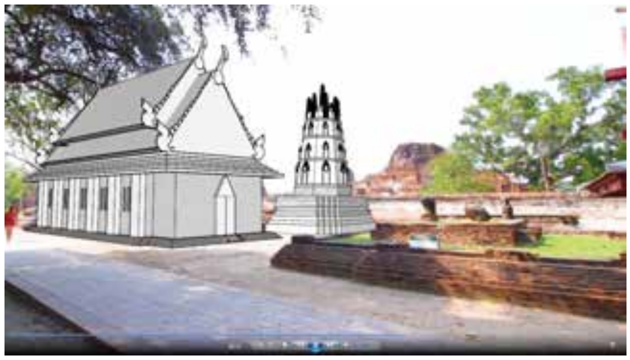

Figure 7. Model inside Wat Mahathat

2. The Character Model is quite nice for presenting, but the body of model has a little color and the color is light color. It should be added color for attracting.

Figure 8. The Character Model inside Wat Mahathat

3. The map model inside the temple is bright, interesting and beautiful. It can make them to understand everything inside this temple. In addition, beautiful colors in the map make children to most interested history.

Figure 9. Model's map inside Wat Phra Sri Sanphet

Figure 10. Model's map inside Wat Mahathat

Discussion

From the assumptions about virtual of composite graphic can help stimulate interest and help explain the history of the place, bringing more attention and knowledge to children and youth can be discussed as follow:

1. Model are presented in vibrant colors and virtual reality. It makes children to understand the style of the temple in perspective never seen before and understand the composition of the two measurements. Model can recognize the complete form of the temple in the past. It consistent with the concept of Weeratapwutti (2017) said technology can create the desired graphics from the computer. The image is realistic both 2D and 3D can make things disappear to complete image.

2. Animation model's colors are bright and interesting to children. It can motivate them to interest and watch the historical documentary television program. It consistent with the concept of Taweesak Kanchanaswan (2012: 222) said animation means creating graphics are moving structure that they want. The slide show is sequenced and displayed continuously until it became persistence of vision. In addition, animation graphic can help people to understand detail something that creator want to present especially audience are children are less interest history than adult. From this research, children are attentive composite graphic and animation graphic. It makes them to know components of the temple are missing to complete components. It consistent with the concept of Anucha Serisuchat (2005:1) said graphics and animations are easy understanding, and it is cross cultural media can communicate to foreigners have a common understanding. Graphic is present can support imagination and interpretation of audience.

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POSTER SESSION

THE COMPARISON OF TEA COLOR BETWEEN MULBERRY PULP TEA BAG PAPER AND COMMERCIAL TEA BAG PAPERS

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Keywords: Teabag Paper, Mulberry Pulp, Commercial Teabag Paper

ABSTRACT

This research aims to compare the difference of tea color between mulberry pulp tea bag paper and commercial tea bag paper no. 1 and 2 using a LAB color measurement by soaking tea bags in 80 degree Celsius water for 3 minutes. It was found that the L* values of tea from commercial tea bag paper and from mulberry pulp tea bag paper are higher than the tea color from commercial tea bag paper no. 1. Additionally, the a* values of three types of tea bag paper had been measured, it showed that the a* values of tea from commercial tea bag paper no.1 and tea color from mulberry pulp tea bag paper are in the highest level which are equivalent to 0.986 ± 40.79 and 40.69 ± 0.986 respectively. The a* values of tea from commercial tea bag paper no.1 and mulberry pulp tea bag paper are different from commercial tea bag paper in accordance with a statistical significance. For the b* values, the maximum average of tea from mulberry tea bag paper is 57.80 ± 2.822. In terms of LSD pair-comparison of means, tea color from mulberry tea bag paper, commercial tea bag paper no.1 and no.2 are different according to the statistical significance. The red color of commercial tea bag paper no.2 is lighter and more yellow than paper no.1. Whereas the red color from mulberry pulp tea bag paper is particularly similar to the color from commercial tea bag paper no.1 and the difference in yellow color can be clearly seen.

Furthermore, the photos of enlarged surface of mulberry pulp tea bag paper from scanning electron microscope prove that the fiber is rough. Because of the roughness, it is able to absorb more water in the fiber. On the contrary, the drying process of the commercial tea bag paper no.2 has been done by machines, so the fiber is flat. It can absorb less water. For this reason, less tea permeates from fiber and the color is lighter. After sensory testing by 24 people in order to differentiate the tea in mulberry pulp tea bag paper and both commercial tea bag papers, the result is statistically non-significant.

INTRODUCTION

Tea is consumed worldwide from the past until now because of healthy benefits. Tea leaves consist of versatile substances. Drinking tea helps people from flexible capillaries, cancers, diabetes and anti-aging. [1]

Chiang Rai, a province located in the Northern region of Thailand, is the significant plantation for tea growing especially Assam tea and Chinese tea. Fresh tea leaves are transformed into dried ones on the tea processing and are sold in the country and aboard. [2] It is generally used as the ingredients and beverages. From the survey, it was found that 1.5-2.5 gram tea powder sold in Thailand normally contains in a tea bag. The basis weight of tea bag paper is 16 and 21 g/m^2. However, most tea bag paper is imported from other countries such as China, Japan, Germany and Taiwan. Thailand is not able to produce its own tea bag paper at this moment. Nevertheless, there are many local communities in the Northern part of Thailand making handicrafts from mulberry pulp paper for a long time. Unfortunately, those handicraft products are used or bought in some local festivals in specific period only. This research aims to study the

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process of making tea bag paper from local mulberry pulp paper. The tea bags from mulberry pulp had been tasted to find the structure and functional properties, sensory evaluation and tea color testing comparing to few types of commercial tea bag paper.

Then, tea colors permeating from different materials had been tasted and observed in order to study the structure properties and exact permeation rates. After gathering all relevant data, the findings would be useful for developing the tea bag paper properties from mulberry pulp to have similar functions to general commercial tea bag paper. The comparison of tea color from tea bags was also done in this research.

METHOD

The method started from studying the paper structure and functional properties of imported tea bag paper which were two types of commercial tea bag paper roll imported from Taiwan as a commercial tea bag paper no.2 and Lipton tea bag as a commercial tea bag paper no.1. After the properties of mentioned tea bag paper were analyzed, afterwards mulberry pulp tea bag paper had been developed. It had been also tasted to find some specific properties namely structure, function, sensory evaluation and tea water color.

In order to test the properties of imported tea bag paper, the TAPPT method had been done. The weight is T410, thickness is T411 and level of paper moisture is T412. The design of tea bag and containing amount had also been studied and developed. Additionally, the TAPPT method had been done to find the functional properties. The result showed that strength resistance is T494c, wet strength resistance is T456 and water permeability is T432-cm99. Moreover, some methods such as completely randomized Design (CRD), analysis of variance (ANOVA) and least significant difference (LSD) had been also used to consider the stated properties.

In terms of the taste, 1.5 gram of tea powder containing in tea bags sold in the country, imported tea bag and mulberry tea bag were soaked in 80 ºC water for 3 minutes. Then, the sensory test was done by 24 experts from Sensory Evaluation and Consumer Testing Unit, Faculty of Agro-Industry, Chiang Mai University using Triangle Test by certain programs (Susense, Thailand).

The color measurement of tea color from each tea bag soaking in 80 ºC water for 3 minutes had been conducted by LAB* color Quest XE Hunter Lab, USA with a purpose of comparing the color differences related to paper structure.

In the final step, the Scanning Electron Microscope, SEM (at 500x magnification) was used to scan the paper surface in order to compare the structure properties and fiber diffusion of each tea bag paper.

RESULT

1.1 Paper Properties

According to the structure and functional properties test of the commercial tea bag paper no.2 and mulberry pulp tea bag paper, it showed that basis weights of both types of paper are equal. However, other properties such as thickness, strength resistance, wet strength resistance and water absorption are different. The statistical significance is at 0.05 as shown in Table 1

Table 1: The comparison of paper properties by statistical methods

Type of paper	Basis weight (g/m^2)	Thickness (mm.)	Strength resistance (MPa)	Wet strength resistance (MPa)	water absorption (Sec.)
commercial tea bag paper no. 2	21.381^{bc}	0.072^{a}	12.085^{a}	8.267^{a}	347.849^{a}
mulberry pulp tea bag paper	21.171^{c}	0.093^{e}	8.037^{d}	2.410^{c}	25.809^{b}

The water absorption of commercial tea bag paper no.2 from Table 1 is higher than mulberry pulp tea bag paper. And the absorption length of time takes longer as well.

2. The result of sensory test of tea

The result of tea sensory test from experts among three types of paper as shown in Table 2.

Table 2: The result of sensory test of tea from different tea bags

Type of comparison	number of people (person)		Total (person)
	Choose correctly	Choose wrongly	
mulberry tea bag paper and commercial tea bag paper no. 1	10	14	24
mulberry tea bag paper and commercial tea bag paper no. 2	9	15	24

Reference: Sensory Evaluation and Consumer Testing Unit, Faculty of Agro-Industry, Chiang Mai University

According to the consumer acceptance using Triangle Test of tea containing in mulberry pulp tea bag and commercial tea bag no.1, it indicated that 10 persons chose the tea sample correctly while 14 persons chose wrongly. After Chi-square calculation had been done, Chi-square is at 0.42 which is less than Chi-square from the table which is 3.84 (df =1) and the confidence level is 95%. From the above finding, it can be concluded that the tastes of tea from both mulberry pulp tea bag and commercial tea bag no. 1 have no statistical significance.

After comparing tea containing in mulberry tea bag to commercial tea bag no. 2, it was found that 9 persons took the correct tea samples but 15 persons took the wrong samples. Chi-square is at 0.05 which is less than Chi-square from the table which is 3.84 (df =1) at the confidence level of 95%. It signified that the tea samples containing in mulberry pulp tea bag and commercial tea bag have no statistical significance.

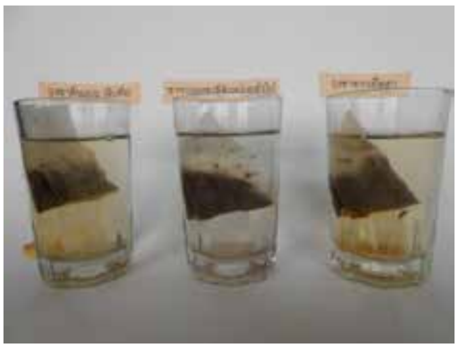
According to the result, there is no relationship between taste of tea and types of tea bag paper.

2.1 The color of tea

The color of tea had been measured by the color meter to find the color average from 3 types of tea bag. Furthermore, tea from commercial tea bag no.1 and commercial tea bag no.2 had been done by soaking tea bags in the 85 ºC water for 5 minutes. From Table 3, the color measuring of L*, a* and b* of each tea bag are different (Figure 1).

Table 3: The comparison of color from tea of three types of tea bags

Types	Color Value		
	L*	a*	b*
commercial tea bag no.1	30.04	40.79	50.92
commercial tea bag no.2	32.04	38.65	53.78
mulberry pulp tea bag	34.31	40.69	57.80



1 minutes

3 minutes

5 minutes

More than 10 minutes

Figure 1. The color of tea soaking in hot water for different lengths of time

The statistical resuilt had been calculated to compare the color, it was found that the tea colors from each tea bag are various as shown in Table 4.

Table 4: The statistical analysis of tea color from different tea bags

Types	Color Value		
	L*	a*	a*
commercial tea bag no.1	$30.04^{c} \pm 0.11$	$40.79^{a} \pm 0.14$	$50.92^{c} \pm 0.23$
commercial tea bag no.2	$32.04^{b} \pm 0.16$	$38.65^{b} \pm 0.19$	$53.78^{b} \pm 0.39$
mulberry pulp tea bag	$34.31^{a} \pm 0.20$	$40.69^{a} \pm 0.08$	$57.80^{a} \pm 0.32$

The statistical analysis of L*, a* and b* of three types of tea, it showed that L* levels of all types of tea bag are different at 0.05 of statistical significance. That is to say, the tea color from mulberry pulp tea bag is in the highest which is 34.31 ±1.744. In terms of LSD pair-comparison of means, the L* of the tea color from commercial tea bag no.1, commercial tea bag and mulberry pulp tea bag are different. The brightness level (L*) of tea color from commercial tea bag no.2 and mulberry pulp tea bag is lighter than tea color from commercial tea bag no.2.

a* value of three types of tea bag are also different. The statistical significance is at .05. The study showed that tea colors from commercial tea bag no.1 and mulberry pulp tea bag are in the highest level which are 40.79 ± 0.986 and 40.69 ± 0.986 respectively. The LSD pair-comparison was done and found that the a* value of tea color from commercial tea bag no.1 and mulberry pulp tea bag showed no difference. However, the a* of commercial tea bag no.2 is different from other tea bags.

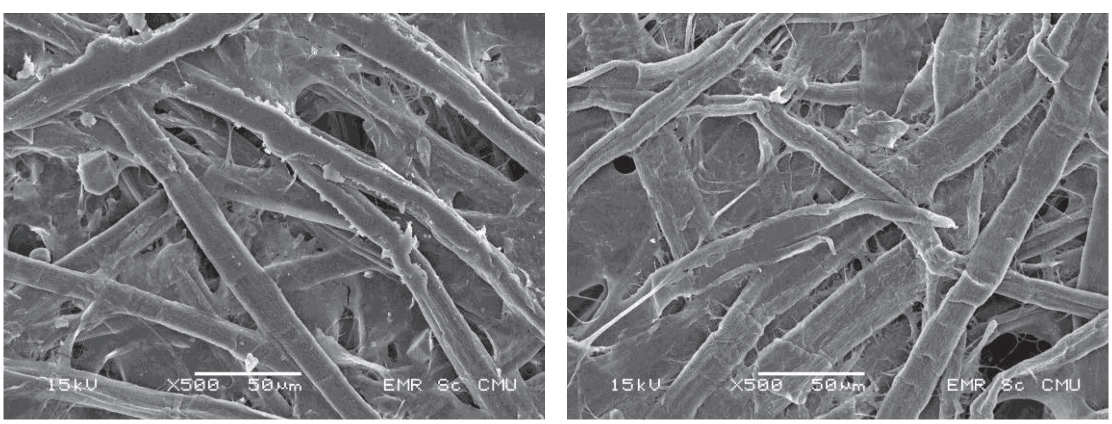
The b* value of three type of tea bag involved with the statistical significance at .50. The tea color from mulberry pulp tea bag is in the highest average at 57.80 ± 2.822. The b* value of the tea color from commercial tea bag no.1, commercial tea bag no.2 and mulberry pulp tea bag are different according to the LSD pair-comparison.

It can be summarized that the tea color from commercial tea bag no.2 is less red and more yellow than commercial tea bag no.1. Meanwhile, the tea color from mulberry tea bag is red which is similar to tea color from commercial tea bag no.1. However, tea color from mulberry tea bag showed some differences in terms of more yellow color.

For the brightness (L*), it was found that tea colors from commercial tea bag no.2 and mulberry tea bag are lighter than commercial tea bag no.1. Delta E of commercial tea bag no.2 and mulberry pulp tea bag related to the total color difference that can be noticed by eyes because the color level more the 2.3 can be seen with naked eyes. [3]

2.2 The photos of surface tea bag by Scanning Electron Microscope (SEM)

Figure 2 is an enlarged paper surface of mulberry tea bag done in laboratory by SEM. It is clearly seen that the shape of fiber is round and there are pore between each fiber. On the contrary, the fiber of commercial tea bags is typically flat with less pore. This is because during the drying process from paper production, the fiber emits most of moisture. [4] The flat fiber absorbs less tea than mulberry tea bag paper which allows more tea to release through the structure of paper and gives darker color.



Mulberry tea bag

Commercial tea bag

Figure 2 The comparison of tea bag paper surface by SEM (at 500x magnification)

DISCUSSION/CONCLUSION

According to the comparison of tea color from mulberry tea bag paper and commercial tea bag paper, it was found that the tea water colors are varied depending on freeness. Apart from that, 2013 structure and the production also relate to the different levels of tea releasing. This finding was discovered after the color measurement was done. This research can identify the paper structure of each type of tea bag influencing tea color. However, the analysis would be fully completed if the porosity and freeness are studied to support more findings about tea a release of tea.

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COLOR MEASUREMENT OF WHITELEG SHRIMP *(LITOPENAEUS VANNAMEI)* COMMODITIES WITH APPLICATION INDUSTRIAL GAS TO INCREASE ADDED VALUE

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ABSTRACT

Whiteleg shrimp *(Litopenaeus vannamei)* that fishery commodity has high economic value in Indonesian, where the export value of shrimp products tends to increase every year. Color is an important attribute in quality product. Industrial gas applications in shrimp to preservation and optimum packaging. This study aims to 1) the color measurements based on the application of industrial gas with oxygen gas (O_2), nitrogen (N_2) and carbon dioxide (CO_2) and mixed gas content 2) analyze color characteristics of shrimp based on organoleptic test and Chroma meter test. The research method used organoleptic tests and using Chroma meter for measurement of shrimp color for 12 days of shelf life. The test results on the level of preference of panelists for the color attributes of Whiteleg shrimp stored in various gas treatments, it was found that significant changes in the level of preference were found with increasing shrimp storage time. It is known that CO_2 and O_2 gas are the fastest decreasing levels of preference. The Chroma meter Test Result of L value is known that in all treatments in the shrimp sample there is a decrease in brightness during the storage period. The CO_2 and Mixed gas treatment gave the highest L value. The shrimp gives the highest b value in the treatment of O_2 gas and the lowest in the N_2 gas treatment. Changes in the value of a shrimp give a positive trend that indicates an increase in the intensity of red in shrimp during storage. Fresh shrimps undergoing red discoloration show a decrease in the quality of shrimp because of the presence of oxidized color pigments producing orange appearance.The color for performance shrimp depend on period shelf life and application industrial gas.

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I. Introduction

Export value of shrimp commodities in Indonesia always increase where in 2015 the free on board value (FOB) reached 1.3 billion USD with an export quantity reaching 145,000 tons of shrimp (BPS, 2018). About 75% of the shrimp is exported to the United States (56.7%) and Japan (18.7%) is frozen, while the rest is exported to several countries in Asia and Europe. This shows that shrimp is a leading export commodity and contributes quite significantly in improving the national fisheries economy. According to FAO (2016), post-harvest handling, processing, preservation, packaging, storage and transportation of fish requires special care to maintain the quality and attributes of fish nutrition, avoiding waste and losses suffered. One important activity that needs to be understood by businesses is the process of preserving and packaging shrimp to reduce the rate of decay that occurs so that it is possible to be distributed and marketed throughout the world. Shrimp is a commodity that has high protein and water content so that this commodity is a perishable food. The process of preservation and packaging is critical point in the process of handling fresh shrimp. One method that can be used to maintain the quality of shrimp is by applying a combination of industrial gases in the preservation process and packaging techniques by combining industrial gases namely oxygen gas (O_2), nitrogen (N_2) and carbon dioxide (CO_2) can be used as an alternative to maintain color and texture and extend the shelf life of shrimp commodities. This study aims to 1) make color measurements based on the application of industrial gas with oxygen gas content, nitrogen and carbon dioxide and mixed gas in vaname shrimp (2) analyze shrimp color characteristics based on organoleptic test results and chromameter test. The application of nitrogen gas in agriculture and food has been very diverse ranging from the application of packaging, freezing, storage to transportation of food products. In addition, the use of mixed gas through the Modified Atmosphere Packaging (MAP) is widely used to maintain the freshness of fresh products, meat and fish by controlling the biochemical metabolism of these commodities. Shrimp products are the focus of this research because the value of shrimp exports is quite high and has high economic value and has the potential to increase the economy of business actors..

II. Method and Material

1.1. Object of Research

The object of the research in this study is shrimp that has high economic value, the type of shrimp is whiteleg shrimp (Litopenaeus vannamei). Determination of area is based on the region with the highest number of shrimp production on Java, especially on the coast of Java. The study was conducted from June 2, 2018 to November 26, 2018.

Figure 1. Whiteleg shrimp *(Litopenaeus vannamei*)

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1.2. Data Collection

Data collection was carried out through testing of the color of shrimp conducted by organoleptic tests with 30 panelists and color tests using Chroma meter in the laboratory Faculty of Agricultural Technology, Universitas Gadjah Mada.

1.3. Research Stage

This study consists of several steps that must be done, namely as follows::

a. Survey
The survey was conducted by observing directly using the visual senses in the field and direct interviews with fishermen, collectors and traders as well as shrimp commodity entrepreneurs to find out the problems that occur in the field and identify the characteristics of the research object.

b. Identification of problem
From the survey, identification of problems can be done in each tier, especially the problems related to how to handle shrimp of high economic value.

c. Formulation of the problem
The formulation of the problem is done to analyze the problems in shrimp commodity business actors. The problem analyzed in this study is the preservation and packaging system in shrimp commodities of high economic value

d. Goal Setting
The purpose is used to find out the results you want to get from the research conducted. The research objective was arranged to measure the color of shrimp after treatment using industrial gas applications.

e. Study of literature
Literature studies are used to support the steps, objectives, and concepts for solving the problems studied.

f. Determination the most optimal color measurement on shrimp
This optimal color determination is done by organoleptic testing by 30 panelists and using a color test with a chromameter tool.

Figure 2. Organoleptic Test

Figure 3. Color Test with Chromameter

g. Conclusion
Conclusions were obtained after the study was completed by answering the research objectives that had been determined.

III. Result

3.1. Organoleptic Test Results for Color Attributes

From the test results on the level of preference of panelists for the color attributes of vaname shrimp stored in various gas treatments, it was found that there was no significant difference between each treatment to the level of color preference, whereas significant changes in the level of preference were found with increasing shrimp storage time. It is known that CO_2 and O_2 gas are the fastest decreasing levels of preference with a score below 5 on the 9th day.

Table 1 : Organoleptic Test Scoring Result Color Attributes

Treatment	Day				
	0	3	6	9	12
Control	7.12	6.79	6.00	5.25	4.50
N_2 Gasses	7.12	5.88	5.90	5.22	4.31
CO_2 Gasses	7.12	5.73	5.19	4.44	4.66
O_2 Gasses	7.12	5.12	5.23	4.41	4.72
Mixed Gasses	7.12	5.67	5.71	5.22	4.41

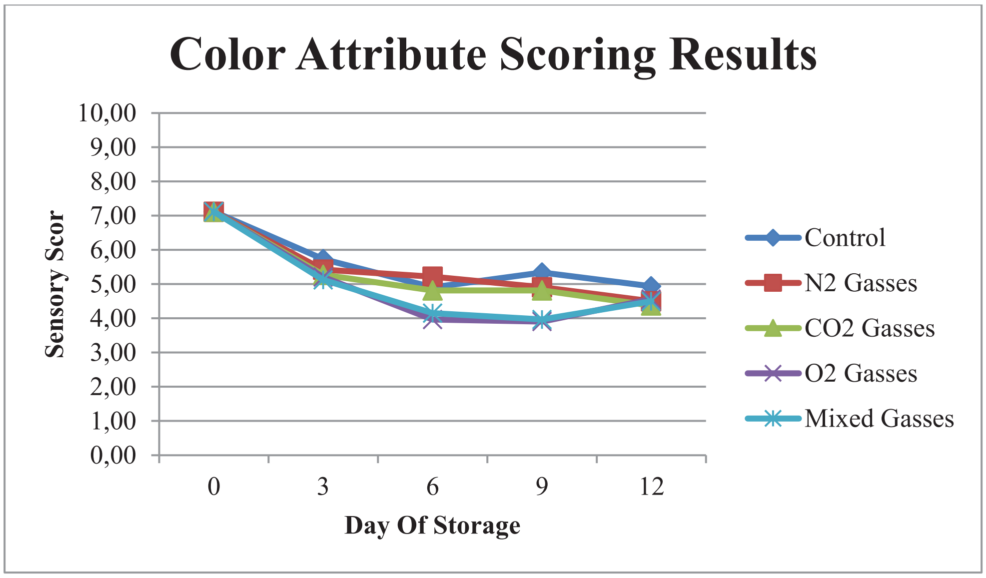

Figure 4. Organoleptic Test Scoring Results for Color Attributes of Shrimp

3.2. Color Test Result on Shrimp with Chromameter

The L value indicates the brightness level of the shrimp color where the higher the value of L, the brighter the color of the shrimp. From the results of the measurement of the L value, it is known that in all treatments the shrimp sample has decreased brightness during the storage period. There is a significant difference between each gas treatment of the L value. The CO_2 and Mix gas treatment gave the highest L value while N_2 gas and control showed the lowest L value..

Table 2 : Tabulation of L value of Vaname Shrimp

Treatment	Day of Storage				
	0	3	6	9	12
Control	35.66	30.50	29.60	26.59	25.48
N_2 Gasses	35.66	31.42	29.87	26.78	25.62
CO_2 Gasses	35.66	34.91	30.83	28.38	27.74
O_2 Gasses	35.66	32.94	30.88	28.17	27.27
Mixed Gasses	35.66	33.58	30.81	28.22	28.82

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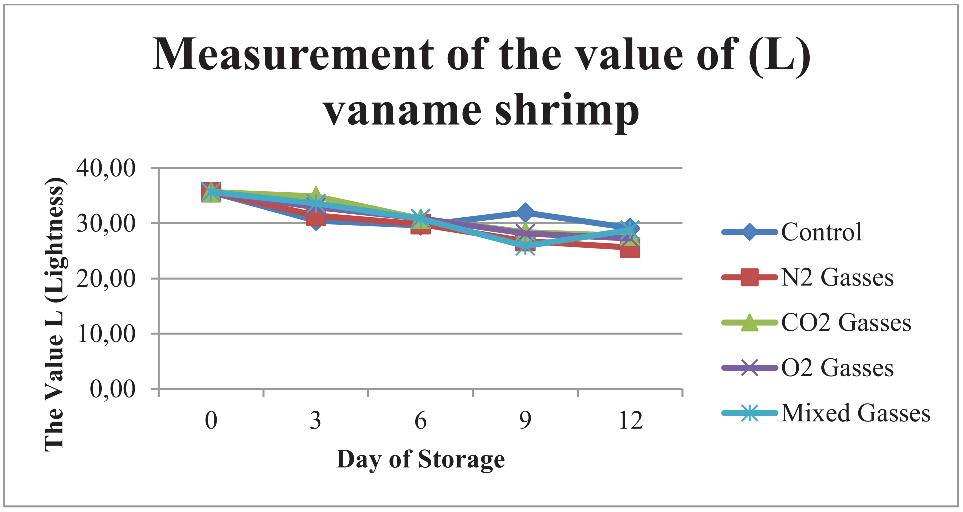

Figure 5. Measurement of The Value of (L) Vaname Shrimp

The positive value of a on chromameter shows that the intensity of red is getting stronger, while the value of a negative indicates that the intensity of green is getting stronger. Changes in the value of a shrimp give a positive trend that indicates an increase in the intensity of red in shrimp during storage. Fresh shrimps undergoing red discoloration show a decrease in the quality of shrimp because of the presence of oxidized color pigments producing orange appearance. From the results it is known that the treatment of O_2 and no gas (control) gas gives the highest value of a to shrimp, and vice versa applies to N_2 and Mix gas treatment. Here is the figure of the value of (a)

Table 3: Tabulation of a value of Vaname Shrimp

Treatment	Day of Storage				
	0	3	6	9	12
Control	1.53	1.58	2.15	4.07	4.64
N_2 Gasses	1.53	1.51	2.12	2.45	3.26
CO_2 Gasses	1.53	1.51	2.27	2.18	3.65
O_2 Gasses	1.53	1.90	2.91	3.86	4.74
Mixed Gasses	1.53	1.45	1.88	2.63	3.01

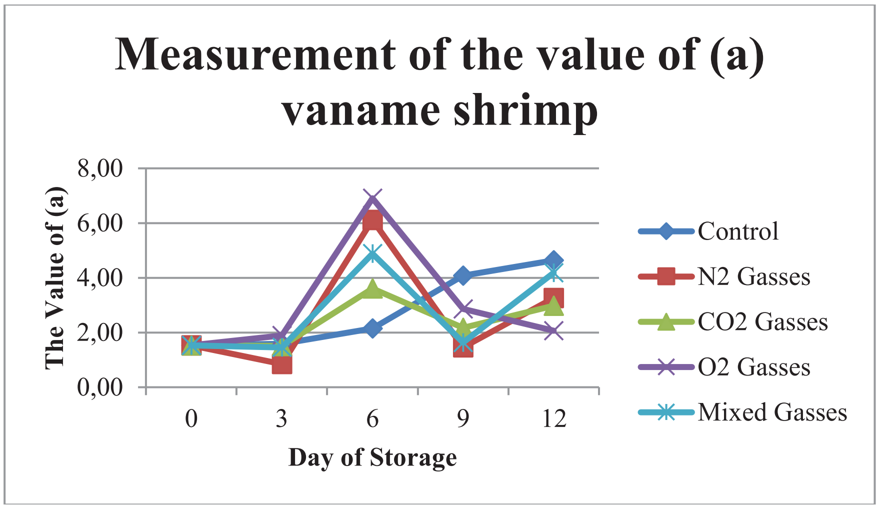

Figure 6. Measurement of The Value of (a) vaname Shrimp

The positive value of b on chromameter shows the intensity of yellow that is getting stronger, while the value of a negative indicates the intensity of blue that is getting stronger. In the initial conditions (days 0 and 3), the value of b in shrimp is still negative (blue is dominant), but on day 6 there is a dramatic increase in the value of b. Increasing the intensity of yellow (value b) can be attributed to the increase in the intensity of red (value a) as well as the change in appearance of the shrimp becomes more orange during the storage period. The vaname shrimp gives the highest b value in the treatment of O_2 gas and the lowest in the N_2 gas treatment.

Table 4: Tabulation of a value of Vaname Shrimp

Treatment	Day of Storage				
	0	3	6	9	12
Control	-1.41	-1.13	1.01	3.75	3.92
N_2 Gasses	-1.41	-1.42	1.76	2.57	2.83
CO_2 Gasses	-1.41	-0.79	3.70	4.19	4.63
O_2 Gasses	-1.41	-0.17	4.44	4.79	6.32
Mixed Gasses	-1.41	-0.50	1.74	4.75	5.18

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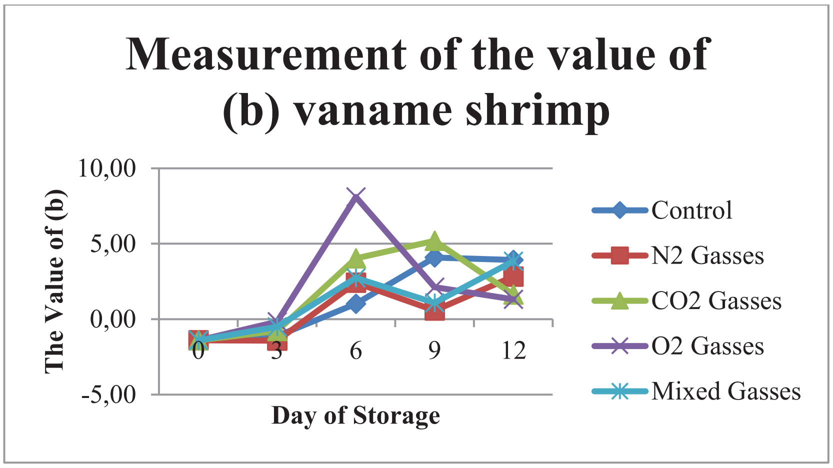

Figure 7. Measurement of The Value of (a) vaname Shrimp

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Fishery products that experience gas application are basically carried out to meet the demands of consumers of exporting countries because the red color of meat greatly affects the purchasing power of consumers (Pivarnik et.al., 2011). The attributes of shrimp quality include freshness of color, size, texture, taste and smell. In the international market, live and fresh shrimp are the most preferred shrimp, followed by frozen shrimp and cooked shrimp (Venugopal, 2006). Agro commodities are commodities that are easily damaged, especially a decrease in quality, so handling agro products is very important to optimize the shelf life. Quality factors that can shorten the shelf life of fresh fruits and vegetables are the presence of dehydration, discoloration, microbial growth and decay, and the appearance of unpleasant odors (Krasnova et al., 2012). Low O_2 levels and high CO_2 are used to reduce the respiration rate of fresh products with the aim of extending shelf life. While very low O_2 levels can produce an increase in the fermentation process (Solomos, 1997; Soliva-Fortuny et al., 2002)

For fish and fishery products, most industrial gas mixtures do not reduce oxygen levels to slow lipid oxidation and the development of rancid odors. For seafood products, the use of nitrogen is used as an alternative to vacuum packaging to replace packaged O_2 which functions to delay oxidative rancidity and inhibit the growth of aerobic microorganisms (DeWitt and Oliveira, 2016).

Based on the results of the research that has been done, giving gas to vaname shrimp increases the lightness of the shrimp and increases the values of a and b so that the gas supply can increase the appearance of fish colors to be more attractive. It can be seen that the result of color measurement with chromameter. The highest lightness value is shrimp treated with CO_2 gas, while the shrimp that has the highest a value are shrimp treated with O_2 gas, and shrimp with the highest b value are shrimp treated with O_2 gas. The color of the shrimp becomes brighter because the carboxymyoglobin that is formed will be more stable than the oxygenated form of myoglobin, namely oxygloboglobin, which can be oxidized to the brown pigment namely metmioglobin. This stable red color can last longer, giving a fresh impression (Eilert, 2005).

CONCLUSION

Based on the results of research that has been done, the addition of oxygen gas to the packaging proved to be able to increase the brightness of shrimp and increase the red color of shrimp so that it looks more attractive and can increase the added value of the perikana products. The thing that needs to be added in the study is the need to calculate the exact gas composition in mixed gas. Because from several treatments for each gas having their respective advantages, such as CO_2 gas can increase brightness, O_2 gas can increase red color and the yellow color of the shrimp.

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