ACA2013Thanyaburi
Bloomming Color for Life

The 1st Asia Color Association Conference
11-14 December 2013

Facuty of Mass communication Technology
Rajamangala University of Technology Thanyaburi
Thailand

Proceedings Book

BOOK OF ABSTRACTS

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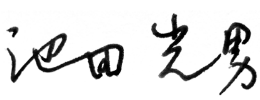
content

Message from the coordinator of the Asia Color Association ACA

It has been frequently pointed that it is not easy for young people in Asia to attend often at the International Color Association AIC meetings because the registration fee is high and the transportation fare is expensive as the conference is often held at places far from Asia, and we need another color association which will meet the need of young color scientists in Asia. In May 2012 leaders in the field of color science and design gathered at Kyoto University from China, Japan, Korea, Taiwan, and Thailand and decided to establish the Asia Color Association with motto "Economical conference". At the same time the Color Group of Thailand and Rajamangala University of Technology Thanyaburi invited the 1st ACA to be held at RMUTT in 2013 and the invitation was accepted by all the attendants.

Now we see the 1st ACA conference has been prepared very nicely meeting the motto of the ACA and many young people showed their attendance to the conference. I can surely say that the conference is successful. I thank the Color Group of Thailand and particularly Rajamangala University of Technology Thanyaburi for inviting us and for organizing the conference. I am sure everybody will enjoy the conference staying at RMUTT campus full of lotus and water lilies. The ACA conference is not held in the year when the AIC takes place in Asia such as the AIC midterm conference in Tokyo in 2015 and the AIC congress in Korea in 2017. In other words the ACA was not established to compete with the AIC but to supplement with each other. I suppose that in the future the ACA conference will be held not only in the countries mentioned above but also in other countries of Asia where no national color societies exist yet. In this way I believe that color science, engineering, design, and industries related to color will become active in those countries as well.



Mitsuo Ikeda, Ph. D.
Coordinator of Asia Color Association ACA
Professor emeritus at Tokyo Institute of Technology
Professor at Rajamangala University of Technology Thanyaburi
Former president of International Color Association AIC
The president of the Color Science Association of Japan

ACA 2013 Chair’ s Preface

Greeting from RMUTT

I, as a representative of Rajamangala University of Technology Thanyaburi, am truly glad and am honored from the ACA Organizing Committee to be the host of The 1st Asia Color Association Conference (ACA2013 Thanyaburi: Blooming Color for Life). This conference aims to encourage knowledge exchanging and create research network related to color among color specialists from various countries in Asia. I am delighted to welcome all of you to the great city of Pathumthani and hope that this conference will meet our expected objectives. Last, but not least, I would like to thank our conference organizers, sponsors and all guest speakers who have helped and shared their valuable experiences. Importantly, I greatly appreciate the assistance of Professor Mitsuo Ikeda, the conference's advisor, who gave the best suggestions and are the inspiring leader of this conference.

Assoc. Prof. Prasert Pinpathomrat, Ph.D.
President of Rajamangala University of Technology Thanyaburi

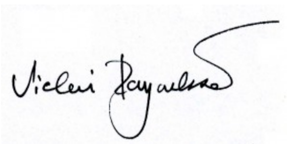
ACA2013 Chair's Message

I am honored to hold the 1st conference of the Asia Color Association at Rajamangala University of Technology Thanyaburi, Pathumthani, Thailand that will take place on 11 through 14 December, 2013.

It was pointed out sometime that beside the International Color Association AIC we need a regional international conference on color where young scientists and students can easily attend economically and the Asia Color Association ACA was established last year. The board of the ACA accepted our invitation to Thanyaburi and we decided to do our best to lead the 1st conference to a success. To meet the motto "Young scientists to ACA" we will open an economical hotel and a dormitory on campus for them and will set the registration fee as low as possible. There are many resort hotels nearby the campus. Attendants who like to enjoy a bit luxury but not expensive room can stay there.

The province where Thanyaburi locates is called Pathumthani, which means the lotus city. Indeed our campus is full of lotus everywhere and you can enjoy the flowers while you are walking around. The slogan of the conference is "Blooming color for our life". We hope the discussion made in the conference will result with glittering results for the color science, technology, applications, and design like blooming lotus.

Thanyaburi locates about 40 km north from Bangkokon the way to the famous world heritage Ayuthaya. It is a country side compared toBangkokbut it can offer a quiet and no-smog atmosphere and no traffic jam with a little more ultra violet than the big city. You can reach here directly from the international airport Suwanabumi without driving through busy Bangkok. I hope and am sure that you can enjoy the conference in forest and wish many of you will come and create good friendship with scientists and color specialists from other countries in Asia.



Vichai Payackso, Ph. D.

Chairperson of Organizing Committee of ACA2013Thanyaburi

Vice President of Rajamangala Universityof Technology Thanyaburi

Pathumthani,Thailand

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Conference Programme Overview

	December 11, 2013	December 12, 2013	
		MCT Theater	MCT 1219
8.30		Registration	
8.45 – 9.15		**Chair: N. Kuptasthien** **Open ceremony**	
9.30 – 9.45		**Chair: N. Kuptasthien** **Invited Lecture** Blooming colors of lotus, how do we develop? P. Akarakunthron	
10.00 – 10.15		**Chair: V. Payackso** **Invited Lecture** Vision, Light, and Color –mechanism of seeing and techniques for displaying– H. Shinoda	
10.30		Break	
10.45		**Chair: P. Pungrassamee** **OA11** Colour: Constancy and Inconstancy V. Cheung	**Chair: T. Horiuchi** **OB 11** Pictorial Expression Techniques Used in the Wall Painting of Each Thai Dynasty Period K. Ruxpaitoon, N. Aoki and H. Kobayashi
11.00		**OA12** Effect of initial visual information on construction of a space perception and on the color constancy C. Phuangsuwan and M. Ikeda	**OB12** The Tropic of Cancer in Taiwan: Preliminary Approaches to Regional Colors and Chromatogram M. C. Kuo
11.15		**OA13** Meaningful Position of an Object in a Space to Construct a Recognized Visual Space of Illumination RVSI M. Ikeda and C. Phuangsuwan	**OB13** A Method for HDR Image Rendering Based on iCAM Framework J. Fang and H. Xu
11.30		**OA14** Images of Colors with Different Shapes and in Different Motions M. Mitsuboshi	**OB14** Using Color Shading for Pineapple Ripeness Classification C. Suppitaksakul, M. Rattanakron, W. Charoensuk and S. Dangeam
11.45		**OA15** Evaluation of Color Discrimination under LED Lighting by two Types of 100 Hue-Tests D. Tagawa, H. Komatsubara, S. Kobayashi, N. Nasuno, Y. Mizokami and H. Yaguchi	**OB15** Multicolor LED Lighting Apparatus Fabricated to Demonstrate Metamerism T. Nakagawa
12.00		Lunch	

	December 11, 2013	December 12, 2013	
		MCT Theater	MCT 1219
13.00	Registration	**Chair: M. Ikeda** **Invited Lecture** The color we used in our daily life T.R. Lee	
13.15			
13.30		**Chair: T. Ishida** **OA21** The Influence of Public Facilities Color on Landscape Preference:A Case Study of Telecommunication Boxes in Taipei city H. Hsieh and M. Kuo	**Chair: M. Kuo** **OB22** An Analysis on Japanese Package Designs from the Point of a Chinese Designer H. Bian
13.45		**OA22** A Comparison Between Taiwanese and Japanese Categorical Colors I. P. Chen and T. J. Hsieh	**OB23** The Color Design of the Book Waist and the Consumer's Purchasing Behavior Y. Li
14.00		**OA23** Consumer Colour Preferences for Home Textile Products made from Silk Fabrics P. Jingjit and S. Juynoy	**OB24** Effects of Color Decoration on Users' Feeling and Operational Performance on Touch Panel Device P. Patitad, H. Suto, S. Hanita and M. Sakamoto
14.15		**OA24** Study of Chinese Traditional Color Names M. Yu and S. Ruoduan	
14.30	**Chair: U. Tangkijviwat** **Pre-event Workshop** "What Color of Cloth Does Fit to Your Face and Hair?" Y. I. Kim (MCT Theater, 14:30-16:30)	Break	
14.45		Poster Session	
15.00			
15.15			
15.30			
15.45			
18.00	**Welcome Party**	**Conference Banquet**	

	December 13, 2013		December 14, 2013
	MCT Theater	**MCT 1219**	
8.30			**Laboratory Visit and Excursion to Ayutthaya**
8.45			
9.00	**Chair: Y. I. Kim** **Invited Lecture** A comparative study in Asian countries on color preference for factory products M. Kawasumi		
9.15			
9.30	**Chair:B.Waleetorncheepsawat** **Symposium** **"Use of Color in My Country"** **Thailand** **Hong Kong** **Indonesia** **Cambodia**		
9.45			
10.00			
10.15			
10.30	Break		
10.45	**Chair: Y. Mizokami** **OA31** Evaluation of Discomfort Glare from Color LEDS under Different Illuminance P. Charoensarp, P. Panadist and P. Pungrassamee	**Chair: H. Sakai** **OB31** The Correspondence Between Macroscopic Appearance and Microscopic Colors Investigated by Light and Electron Microscopy M. Roesler, S. Goetze and N.Mezger	
11.00	**OA32** Distinguished Color Traffic Sign for the Elderly under Different Illuminance Levels N. Sungvorawongphana, P. Pungrassamee, R. Subgranon and T. Obama	**OB32** Effect of Polarization to Directional Surface Color Measurement R. Sun and Y. Ma	
11.15	**OA33** Elderly Vision on legibility of Thai Letters presented on led panel K. Rattanakasamsuk	**OB33** Research on the Imapact of Light Source Spectrum on Color Vision W. Ye and T. Rou	
11.30	**OA34** Proper-Sized Thai Letters on Different Background Contrasts and Illumination Environment Suitable for Elderlies B.Waleetorncheepsawat, P.Pungrassamee, M. Ikeda, and T. Obama	**OB34** Relationship Between Color Appearance Mode and Color Appearance Shift P. Chootragoon, P. Katemake and M. Ikeda	
11.45	**OA35** Color Conspicuity for Single Color Affected by Color Attributes U. Tangkijviwat	**OB35** Working Memory in Color: An fMRI Study N. Osakar, T. Ikeda and M. Osaka	
12.00	Lunch ACA Board Meeting		

	December 13, 2013		December 14, 2013
	MCT Theater	**MCT 1219**	
13.00	**Chair: H. Yaguchi** **Invited Lecture** Color difference evaluation for digital images" H. Xu		Return to RMUTT
13.15			
13.30	**Chair: C. Koopipat** **OA42** The Human Skin Colorimetric and Evaluation Way Applied Spectral Imaging with 3-Dimensional Scanning and Laplacian Filter Image Processing M. Osumi	**Chair: W. Ye** **OB42** Color and luminance Affect Perceptual Transparency of Human Skin D. Nishimuta, K. Okajima and T. Igarashi	
13.45	**OA43** Perceived Quality of Wood Images Influenced by the Ratio Skewness and Kurtosis of Image Histogram S. Katsura, Y. Mizokami, and H. Yaguchi	**OB43** Evaluation of the Effect Daylight on Space Brightness R. Tanaka	
14.00	**OA44** Modeling Image Quality Attributes Based on Image Parameters for Mobile Displays R. Gong and H. Xu	**OB 44** Blackness Judgement of Lacquer Ware by Expert and Naïve Groups Y. Sakaue	
14.15			
14.30	Break		
14.45	**Chair: Y. Ma** **OA51** Do the zebra patterns interface the recognition of targets ? S. Hatano	**Chair: I. P. Chen** **OB51** Pioneer Course in Colour Study and Design at the Faculty of Architecture, Chulalongkorn University P. Prasarnrajkit	
15.00	**OA 52** Correlated Preferences for Color Combination and Shape N. Chen, K. Tanaka, D. Matsuyoshi and K. Watanabe	**OB 53** The Color Identity in Traditional Thai Bhuddist Temple V. Songcharoen	
15.15		**OB 53** Color Semiotic in Short Film Eclipse N. Amorntut, J. Kirdsuk and P. Tangpondpasert	
15.30	**Chair: K. Rattanakasamsuk** **Invitation to ACA 2014**		
15.45			
18.00			

Invited Lectures,
Oral paper

in order of presentation

VISION, LIGHT, AND COLOR
–MECHANISM OF SEEING AND TECHNIQUES FOR DISPLAYING–

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Keywords: Lighting, Brightness Perception, Color Management, Elderly Vision, Color-Vision Deficiency

ABSTRACT

Having a good knowledge of physics of light and mechanism of visual perception is necessary, when one controls colors as one likes and creates comfortable and efficient environments. Here several topics are introduced on color perception and its applications, such as perceived brightness and its metric, elderly color vision and a color recovery lighting system, color vision deficiency and a color-barrier-free lighting, and color adaptation and a color management for displays.

INTRODUCTION

No visual experience is possible without light. Light conveys the information of the outside world into our eyes. In particular, color perception reflects spectral properties of lights and objects. Illumination affects our color perception in two ways [1][2]. In one way, the spectral composition of reflected light, the product of the spectral power of a light source and the spectral reflectance of a surface, directly determines color sensation (solid lines in Figure 1). In the other way, the state of the visual system is automatically adjusted by adaptation to illuminant and indirectly affects color perception (a dotted line in Figure 1).

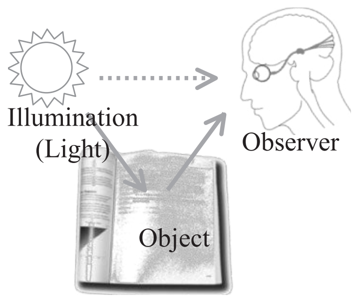

Figure 1. Three elements in color production

In Chapter 2, a new color management [3] is introduced, which achieves constant color appearance on self-luminous displays. Then observer's variability is considered in the following chapters. The concept and the derivation of suitable spectra for color-barrier-free lighting [4] are described in Chapter 3. A lighting system for cataractous elderly [5] is introduced in Chapter 4, which prevents desaturated color appearance. In Chapter 5, a brightness perception for lighting environments is discussed.

COLOR MANAGEMENT SYSTEM

The color management system (CMS) is to ensure color fidelity across different color devices. Since each device has its own color space, the goal of CMS is conversions of color representations from one to others. In many CMSs, the conversion is done through device-independent color spaces such as CIE XYZ or LAB (Figure 2). In other words, CMSs are designed to achieve colorimetrical equality. In metameric color match, however, equal colorimetric values assure equal appearance only to the standard observer but not to individual observers. Another and more serious problem of the CMS is the color adaptation to illuminants. Even though the spectral composition of a display is held constant, the color adaptation to an illuminant changes the appearance. To achieve the equal appearance, appropriate color conversion is necessary (Figure 3).

To solve the problem, we have developed a new CMS based on the color constancy on reflecting surfaces [3]. Color matching with color chips should assure equal appearance on the displays across different illuminants. The objective of the CMS is to derive a conversion matrix from one to another environment through a visual color match of display with the same set of color chips under each illuminant (Figure 4). Then the obtained conversion matrix m_{NA} is applied to (R_N, G_N, B_N) to get (R_A, G_A, B_A) which achieve the same appearance in condition A as in condition N (Eq. 1). Thus another advantage of the CMS is a procedure where no colorimetric measurement is requited.

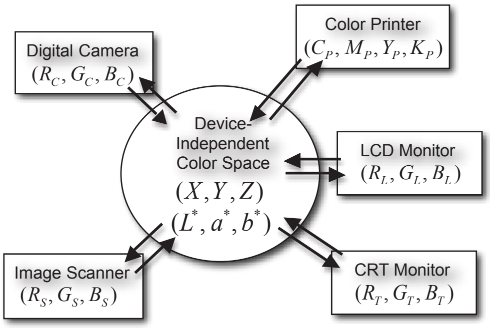

Figure 2. The CMS by way of device-independent color spaces

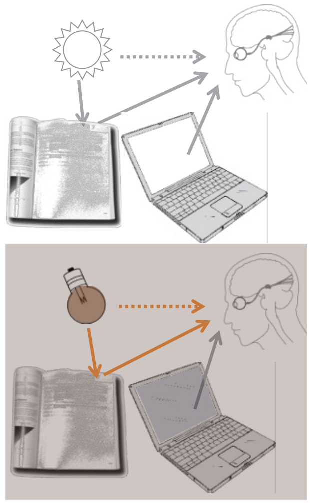

Figure 3. Color constancy on a reflecting surface and color constancy failure on a self-luminous display

$$\begin{pmatrix} R_A \\ G_A \\ B_A \end{pmatrix} = m_{NA} \begin{pmatrix} R_N \\ G_N \\ B_N \end{pmatrix} = \begin{pmatrix} a_0 & a_1 & a_2 \\ a_3 & a_4 & a_5 \\ a_6 & a_7 & a_8 \end{pmatrix} \begin{pmatrix} R_N \\ G_N \\ B_N \end{pmatrix} \qquad (1)$$

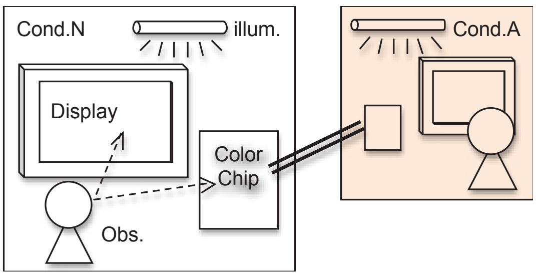

Figure 4. The idea of a new CMS

Here color matchings between mobile phone displays and color chips (5R 6/6, 5Y 6/6, 5G 6/6, 5B 6/6, 5P 6/6, N6) are shown as examples. Two observers carried out subjective matchings under illuminants D65 and A. Results are shown in Figure 5 of the (r, g) chromaticity calculated by Eq. (2). Values of RGB matched by two observers show large individual differences, suggesting the same colorimetric values does not assure the same color appearance. Notice that all the chromaticities shift toward reddish yellow direction when the illuminant changes from D65 to A. This indicates that (R, G, B) must be converted to those of reddish yellow so as to achieve the same extent of color constancy as on reflecting surfaces, Munsell color chips in this situation.

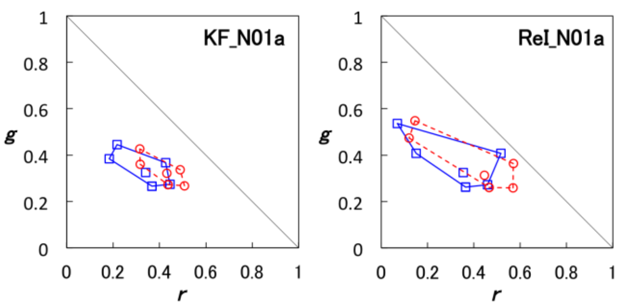

Figure 5. Subjective color matching between a mobile phone display and Munsell color chips.

$$r = \frac{R}{R+G+B}, \quad g = \frac{G}{R+G+B} \qquad (2)$$

COLOR-BARRIER-FREE LIGHTING

Color sensation is initiated by the stimulation to the three types of photoreceptors (S, M, L cones). Therefore people with normal color vision are called normal trichromats. Color-vision-deficiency arises from the dysfunction of one of cone types or two. Dichromats are people who have only two types of cone. Anomalous trichromats posses all three types of cone but one of them has somewhat different spectral sensitivity from normal cones. Certain group of colors cannot be discriminated by color deficients. In a color space this set of colors composes a line called color confusion line. A set of the confusion lines for protan (absence of L cone) are drawn in the *xy* chromaticity diagram as an example (Figure 6).

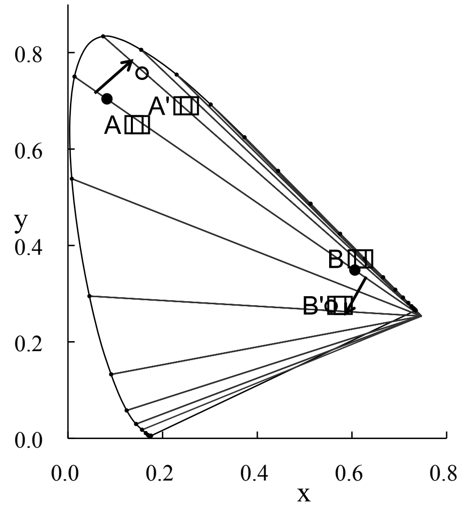

Figure 6. Color confusion lines for protan.

The idea of color-barrier-free lighting is to make confusing colors on objects discriminable to color deficient observers by modifying the spectrum of illuminant. For instance, although colors A (green) and B (red) in Figure 6 look very different to normal trichromats, they lie on the same confusion line and look the same to protan observers. If colors A and B are moved to A' and B' by the change of illuminant's spectrum, then they would be discriminable to protan observers.

To evaluate the performance of color-barrier-free illuminant, a measure, the color discriminability index i_{CD}, has been defined using Ishihara pseudoisochromatic plates. In the typical Ishihara plates two groups of colored dots form a figure, normally letters, and a background. Since the colors of the letter-dots and background-dots lie on a single confusion line, color deficient observers cannot segregate the letters from the background whereas normal trichromats can. The index i_{CD} is defined as the minimum color difference between figure and ground on the Ishihara plate under each illuminant. Color difference is calculated in the normalized LMS cone excitation space with remaining two variables of LMS.

First, the index i_{CD} was calculated for various virtual spectra [4]. The result showed that the spectrum of the largest i_{CD} should be composed of two monochromatic lights at 380nm and 660nm. Then, several psychophysical experiments were conducted with color deficient observers under various illuminants in the wide range of i_{CD}. All the results showed the good correlation between i_{CD} and the discriminability of color deficient observers, suggesting i_{CD} is practically effective as a measure for color-barrier-free lighting.

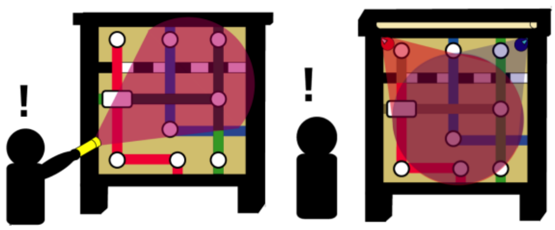

Figure 7. Color-barrier-free lighting

Note that the color-barrier-free lighting can make some confusing color pairs discernible but, at the same time, it may make some other new color pairs indiscernible. Therefore the color-barrier-free lighting should be used as an extra or a supplementary lighting together with the normal white illuminant (Figure 7). The illuminant for color-barrier-free lighting may be a good application target of newly developed types of solid state lighting such as LED and OLED because of the higher flexibility in spectral composition.

LIGHTING FOR CATARACTOUS ELDERLY

Cataract is one of the most typical age-related eye diseases. The hazy crystalline lens scatteres light which overlaps the color images on the retina and causes loss of colorfulness as shown in Figure 8.

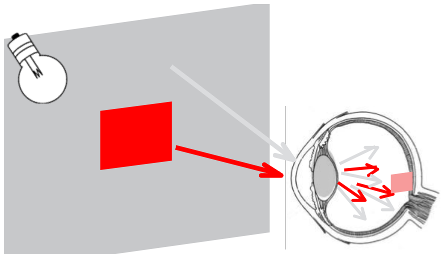

Figure 8. Color desaturation by light scattering from a hazy lens

In a new lighting system, two sets of illumination for an object and an environment are independently operated. To reduce color desaturation by the scattering light the intensity of the ambient illumination is reduced while that of illumination for an object is increased. The lighting system was implemented to a fitting room as Color-Recovery-System, CRS. The performance of the lighting system was evaluated by colorimetric measurements, psychophysical experiments (categorical and elementary color naming), and a questionnaire by customers [5].

Figure 9, as an example, shows chromaticities for Munsel color chips, 5R4/12, 5YR7/14, 5Y8/12, 5GY7/10, 2.5G5/10, 5BG6/8, 10B3/10, 2.5P5/10, measured with Minolta CS-100. Chromaticities measured through the goggle (circles) locate inside of those measured without the goggle (diamonds), showing the color desaturation in simulated elderly under the normal lighting. On the other hand, under the color-recovery lighting even through the goggle, chromaticities (triangles) returned toward the original locations (diamonds), showing increases in saturation.

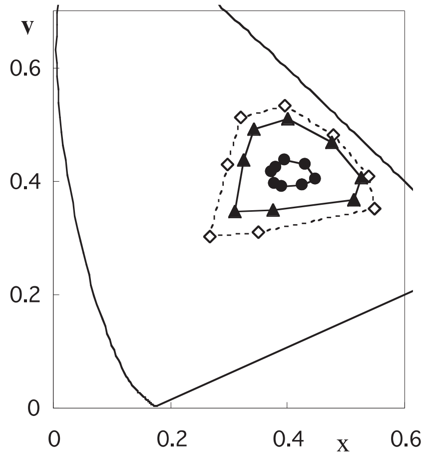

Figure 9. Colorimetric measurements

The color-recovery effect was confirmed by the questionnaire conducted on actual customers too. For instance, to the questions of how the clothes looked in the fitting room with CRS, the positive answer, such as “they looked clearer or more distinct than usual,” increased with customer’s age.

PERCEIVED BRIGHTNESS FOR LIGHTING ENVISONMENTS

In designing lighting environments, horizontal illuminance is generally used as a measure of brightness for a room. However illuminance and perceived brightness disagree in many circumstances. For evaluation of brightness for space, we have proposed a subjective measurement of a border luminance between object color mode and light-source color mode [6]. Then, as an approximation of the border luminance, a new metric for space brightness has been developed and named “Feu” which stands for “flame” and “fire” in French [7]. Using Eq. (3), Feu is calculated as a geometrical average of the luminance distribution $L(\theta,\phi)$ over the visual field of 100 deg. wide and 85 deg. tall.

$$Feu = 1.5 \times \left(\sqrt[N]{\prod_{\theta=-50^\circ}^{35^\circ} \prod_{\phi=-50^\circ}^{50^\circ} L(\theta,\phi)} \right)^{0.7} \qquad (3)$$

Characterizing or evaluating a lighting environment in perceptual and physical dimensions of light increases the variety in lighting plan (Figure 10). Particularly its potency has been proved in energy-saving lighting using LED characterized by the 2nd quadrant of the diagram [8].

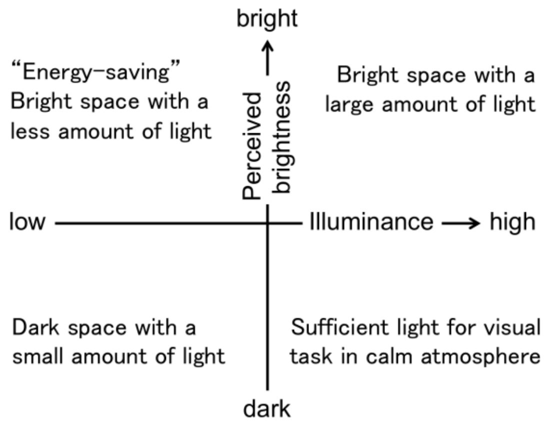

Figure 10. Characterization of environments with physical-perceptual dimensions of light

Thus a metric of perceived brightness has been used in many practical situations and rewarded with good results. However Feu is not perfect or completed yet but rather under development [9]. Insensitivity to color is one of the defects of Feu, which is calculated from luminance distribution. It has been reported that a room furnished with colored objects is perceived brighter than one with achromatic objects [10][11][12].

It has been recognized as another defect that Feu is incapable of assessing the brightness of a room with windows. To investigate the window effect, perceived brightness was evaluated by magnitude estimation on juxtaposed 1/8 scale models shown at the top of Figure 11 [13]. One of them, a reference, was a windowless room with a fixed illuminance, 100 lx in this example. The other was a test room to which an observer was asked to assign integer according to the perceived brightness by comparing with the reference room assigned 100.

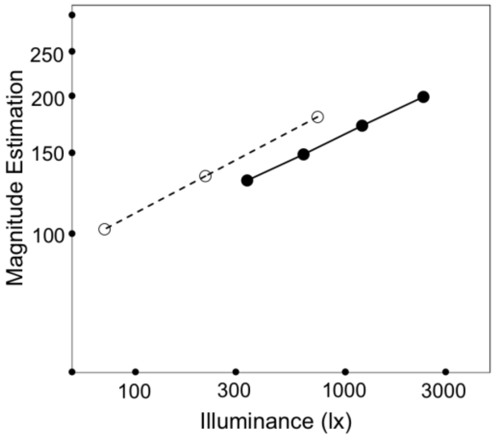

Figure 11. Experiment for window effect

The magnitude of perceived brightness increased with illuminance when the test was a windowless room whose illuminance was modulated by ceiling lamps (dashed lines with open symbols in Figure 11). When the test room had a window of several luminance levels which modulated the room illuminance, the brightness increased with illuminance but significantly below that for a windowless room (solid lines and symbols in Figure 11).

The chart indicates that the room appears darker with a bright window than a windowless room even though it provides an equal illuminance. This brightness reduction by window occurred when the intensity of ceiling lamps was relatively low. On the other hand, the brightness enhancement by window occurred with high intensity of ceiling lamps. Recently the energy-saving lighting is becoming popular where artificial light is reduced by a substitution of daylight. However, the window effects of brightness reduction/enhancement suggest that artificial light should be controlled in terms of perceived brightness not illuminance.

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"THE COLOR WE USE IN OUR DAILY LIFE - COMMUNICATING WITH COLOR".

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Keywords: Color, color experience, visual path, color communication, color needs

ABSTRACT

Human vision enables us to see color every day and everywhere whenever we open our eyes. Perceiving color in our environment is a matter of both conscious and unconscious visual pathways, some of which have been explored well and others have not. What are the physical processes of seeing color, what influences the understanding of color, and what are the ways of communicating through color? By applying different models of color experience, this study aims to explore the processes involved in color perception and color communication. Starting with an introduction of the complex path of seeing color, physiological and psychological factors are explained, followed by an understanding of general color functions, and an interpretation of the origins and evolution of human color needs.

INTRODUCTION

As an infinite number of colors surround us in our everyday lives, we take it pretty much for granted, not recognizing its many roles in our daily lives. The color of a product may attract or disgust us, we can read emotions from the color of a face, and we decide rather intuitively on buying colorful packaged gifts. However, our knowledge of color and its ways of communication is still insufficient, giving way to further studies on product color, packaging, publishing, fashion, healthy foods, and much more. By introducing the paths of visual perception and color communication models, this study explores the scope and limitations of modern color research approaches. Color as a means of information and communication serves for interpreting and understanding our living environment: Colors have been used in cultural traditions since the early ages of mankind. There are four Principles of Color Selection in folklore: by the contrast displayed, as a transfer from the perceived or actual usefulness of the color, by association, and by availability (Hutchings, 2004). In Thai tradition, a specific color is assigned for each day of the week, related to the God who protects that day. On Sunday, red is the color of the day, the unfortunate color is blue, the celestial body is the sun, and Surya the God of the day. On Monday, yellow is the color of the day, the unfortunate color is red, the celestial body is the moon, and Chandra the God of the day, and so on. In India, the colored chakras are used in traditional healing techniques. In Chinese philosophy, the five basic needs of human beings are listed as food (shi), clothing (Yi), dwelling (Zhu), moving (Xing), entertainment (Le), and education (Yu), and relate to the daily practice of applying the Five-Elements-Theory, which is a practical tool to achieve a life in balance and harmony, based on five basic colors (Lee, 2012). In Traditional Chinese Medicine, medical treatments are based on colored food, i.e. as Green is the color related to the liver, green food (such as green beans) is helpful in strengthening this organ. Yellow resembling the center of the cardinal directions is also the imperial color, so the roofs of the emperor's palaces are covered with yellow glazed tiles. On joyful occasions, like Chinese New Year, weddings, and child birth, the color red expresses the vibrant energy of life and happiness. These culture-specific examples reflecting traditional color applications, though of great value to the local people, remain largely unknown to the foreigner, and there is certainly a need for further empirical study.

1. THE VISUAL PATH AND COLOR FUNCTIONS

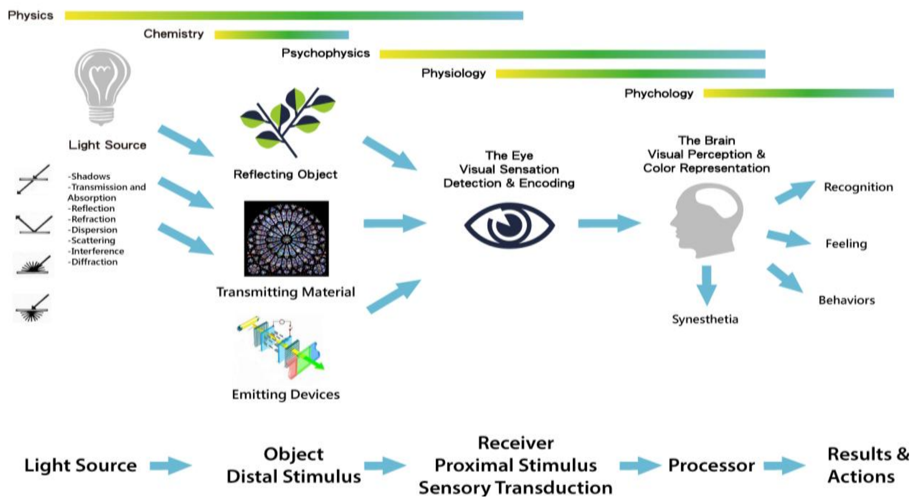

Figure 1: Human path of visual perception (Lee, 2013)

Three major elements define the way we encounter and see color, perceive and experience it: alight source, an object and a recipient (Figure 1). The path of visual perception is a complex process of partly physical, chemical, psychophysical, physiological, and psychological reactions as functions of color. From the light source result physical phenomena, realized as shadows, transmission, absorption, reflections, etc. Light meeting an object or emitted through devices, i.e. LED displays, is influenced by the material. It is therefore defined by reflecting or transmitting chemical processes. This distal stimulus is detected and encoded by the physiological capacity of the human eye, becoming a proximal stimulus of the receiver, and performing a sensory transduction evoking a psychological sensation in the human brain. It is here that people experience the phenomenon of synesthesia. Visual perception and color representation are now being processed and synthesized, and turned into reactions like recognition, feelings, and behavior.

Generally, color research differentiates color by three functional categories of transmitting information: affective, communicative, and diagnostic. Affective color functions cover hedonic sensory pleasure, modulate emotions, possess expressive power and aesthetical value as applied in exploring color preference, or as found in the Fine Arts, design, media, and therapy. Diagnostic functions of color are used in status checking like reality proof and examining conditions, i.e. in medical applications, digital archiving, or quality control. Communicative functions of color mainly involve measurements like indexing and classification found in all kinds of human-product, human-machine, human-computer, and human-environment interfaces.

2. COLOR EXPERIENCE AND COLOR NEEDS

In Mahnke’s pyramid (1990) of color experience, seeing is explained as more than an optical (physical) process, involving individual consciousness: at the ground level, biological reactions are the basic, inescapable response to the colorful environment. Color perception and response develops from an unconscious level towards a conscious one, where associations and symbolisms take place. Here, humans are influenced by culture and mannerisms, and create fashion, trends and styles. At the top, the individual person defines a personal relationship to color. The pyramid resembles Maslow's model of human needs, starting with physical needs like breath, food, water and sleep, followed by safety and security of the body and health, then asking for family ties and

friendship on the level for love and belonging. If all these needs are fulfilled, a person will then strive for esteem, related to confidence and achievements, and finally, for self-actualization.
In pre-historic times, colors were endowed with healing properties because at that time, the sun and rainbows were divine symbols. In the seventeenth century, scientific color theories were mostly influenced by experiences in painting. This was even more noticeable in the search for “primary colors." In the eighteenth century, scientific theories of colors gradually became universal and artists also started to incorporate color-related knowledge from science researchers into their works. As early as 1810, painters such as Overback and Pforr believed that colors of the clothes of characters in paintings represented their personalities (Gage, 1999). This represented a practical method of utilizing colors to transmit messages.

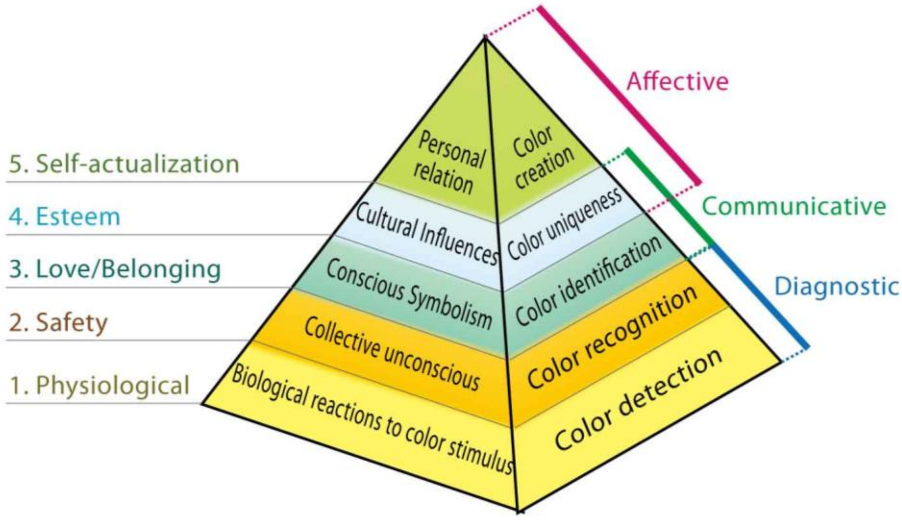

Figure 2: The Color Actualization Pyramid - hierarchy of color needs (Lee, 2013)

The Color Actualization Pyramid shows the color communication process combining Maslow's and Mahnke's pyramids, corresponding to a level of human color experience. On the first level of basic physiological response, humans see color as light presents it to the human eye, like the necessity of physical needs for food, sleep, etc. On the second level, the color experience can be described as the recognition and differentiation of the colored environment as far as needed for survival, i.e. to identify food and avoid potential threats, as it is common to all humans, and not yet a process of individual color interpretation. Next, equal to the need for love and belonging, color becomes aware to the individual through associations with symbols, and therefore, becomes a social issue in a way that color and symbols can connect humans among each other in their family relations and friendship. Proceeding to the level of esteem, color becomes a key element of culture in the sense that the individual now defines and decides on a personal style of fashion elements, creates and follows trends, and develops confidence through these kinds of achievements. On top of this process, color experience becomes a matter of identification, when the individual starts a relationship with color that is unique and personalized.

3. COLOR COMMUNICATION

While the visual path is based on a light source, an object and a recipient of the encoded information, the color response depends on the horizon of the individual color experience. In any given environment, color communication is determined by the local culture and its characteristic color codes. A foreigner who is not familiar with Thai tradition will not understand when Thai people wear yellow clothes to praise their king. The Thai people find color identification through conscious color symbolism, whereas the foreigner relates to the level of unconscious color recognition. Anybody not involved in the local color experience won't be able to understand its encoded color messages, or decode and share the color coded information. This example offers new areas for future color research. For understanding color and human vision and the many fields of research involved, Gerbner's model is used to illustrate the color communication process (in: Severin & Tankard, 1992).

By adding another layer to the model, the process can also be explained by asking for Who, What, When, Where, Why, and How. An observing subject (Who) perceiving a color stimulus becomes the interpreter and encoder, as explored in color preference studies. The observing subject sends out a message and the reaction can be measured. The guiding question of a study is defined by What. A set environment (Where) is described by geographic determinants such as longitude and latitude. Lighting, the season or the weather become constants of the study regarding the time of the event taking place (When). Why stands for the purpose of the study, and How defines the process or reasoning. The scenario shown in Figure 3 includes two subjects communicating in their specific environment, exchanging in a dialogue over certain objects. Each of them can be a sender or recipient, so there are two subjects (Who) encoding and decoding messages.

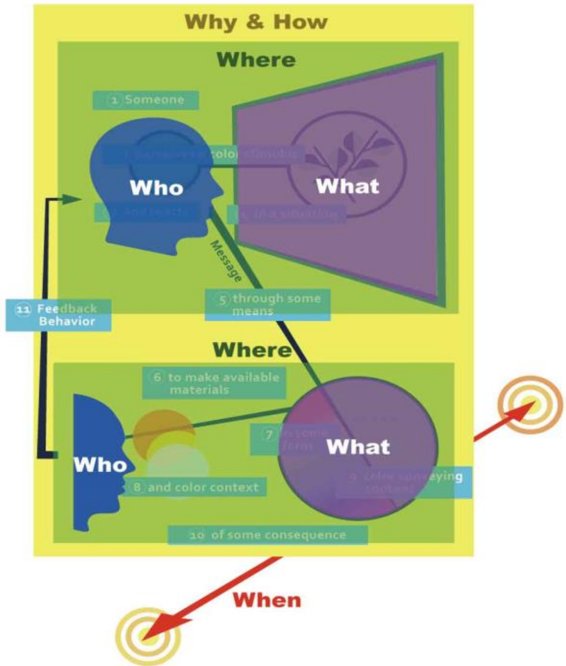

Figure 3: Color communication model (Lee, after Gerbner 1992)

4. CONCLUSION

Modern color research and understanding investigates color from many perspectives. But in spite of the great achievements made, the individual character of human perception remains a topic still involving many questions and challenges to become investigated. Human color perception has led to a great cultural variety of color interpretations and applications worldwide, grown from habitual practice towards conscious well-known patterns of identity. It seems that as color is always available, understanding color can still be applied even more widely. And as color can be enjoyed in cultures and their specific settings, a universal color culture cannot be defined yet.

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A Comparative Study in Asian Countries on Color Preference for Factory Products

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Keywords: Color preference, Customers' impression, Industrial products, Metallic silver, Asia

INTRODUCTION

Japanese industries export various products such as cameras, games, laptops, camcorders, etc., and those products are very popular in overseas markets. We are currently researching the designing conditions for more attractive materials of products in cooperation with a Japanese material manufacture. It is significant for us to understand the customers' preference for each material in each country.

The appearance of a product is one of the important factors for the customers' visual impressions. What kind of impression do you desire for metallic products such as in Fig. 1? And what kind of silver metallic color do you prefer for each product? The desired impression and color preference of the customers may be different by age, gender and nationality.

In this presentation, I'll show you the up-to-date results which we surveyed about the relationship between the desired feelings and the surface colors (Fig. 2) for not only Japanese people but also foreigners, especially Asians.

METHODS OF SURVEY

A questionnaire on the Web was used for our investigation and written both in English and in Japanese. Figure 3 shows an example of questions. Computer graphics have been used to represent the metallic product in the questionnaire and its surface colors have been controlled to reddish, yellowish, greenish, bluish, or a purplish silver color. Then we set five target feelings: "clean / pure", "stylish", "high-quality", "relaxing", and "favorite", which were chosen as the most important feelings of Japanese customers from our previous investigations. The respondents answered with the color that they felt was the most "clean / pure", for example, for five target products: a digital camera, a laptop computer, a DVD player, a television, and a fridge (Fig. 1). The required time was ten minutes on average. More than three hundred persons from seventeen nations have cooperated with us in total and there were four nations where more than twenty responses participated: Japan, China, Korea, and Thailand. We've examined the relationship between the desired feelings and the surface colors in each product and compared them among the four nationalities.

Fig. 1. Target products

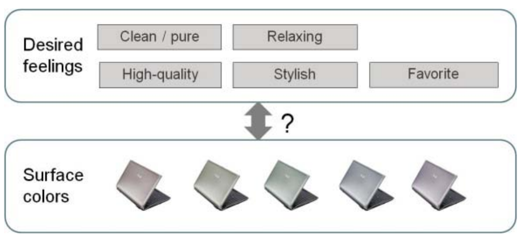

Fig. 2. Our purpose

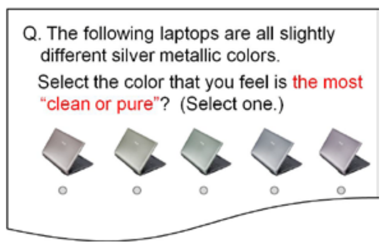

Fig. 3. An example of questions

COMPARATIVE RESULTS BY NATIONALITY

As the result of the survey, we found that many people selected the bluish silver color for all feelings and the yellowish silver color for “relaxing” and “high-quality”. The differences among the five products were small. Some results are shown in Figures 4 and 5 by line graphs. The abscissa shows the color and the ordinate the percentage of choice for the colors. Different line types indicate the products. Figure 4 shows the comparative results for the feeling “clean / pure” for four nationalities: Japanese, Chinese, Korean, and Thai people. The results indicate that the bluish silver color has the highest rate for “clean / pure” in every product and by every nationality. On the other hand, Figure 5 shows comparative results for the feeling “relaxing”. The bluish and yellowish silver colors have higher rates among Japanese, Chinese, and Korean people. In contrast, many Thai people selected the greenish silver color for “relaxing” in every product. For other feelings we found that many Chinese people selected the purplish silver color for “stylish” for the television. The differences among gender were mostly very small with some tendency that women select the reddish silver color for “favorite” and “relaxing” more than men.

SUMMARY AND FUTURE PLANS

We’ve examined the relationship between the customers’ feelings and the surface colors of products by an online survey and compared their results among four nations. Some interesting data were found. For instance, most Thai people selected the greenish silver color for “relaxing” and it is different from other nations. I found out later that Thai people have a traditional culture for inherent colors depending on birthdays. It’s also a fact that a lot of green colored products are often seen in Thailand. In our new investigation, we’ll add some helpful questions for the analysis from a cultural and social point of view. A new questionnaire has been opened on the Web. If you are interested, please contact me.

ACKNOWLEDGEMENTS

We appreciate the help received from Rajamangala University of Technology Thanyaburi, Nagakute Silver Human Resources Center, and Meijo University. We wish to acknowledge valuable discussions with Nagoya Institute of Technology and a material manufacture in Japan.

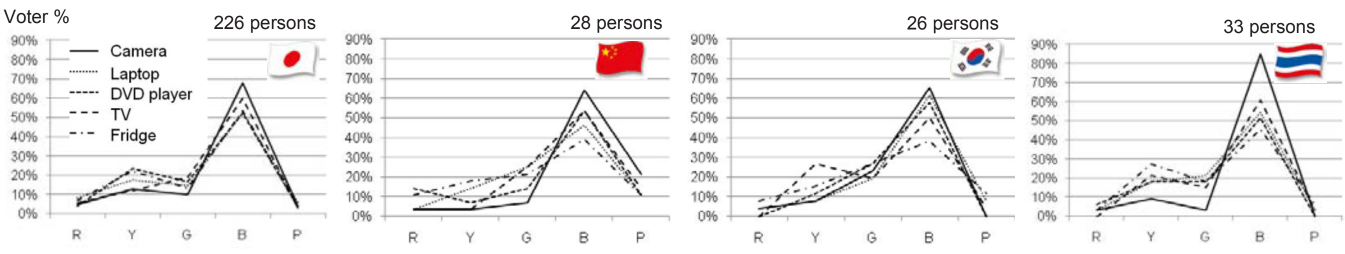

Fig. 4. Comparison by nationality for “clean / pure”

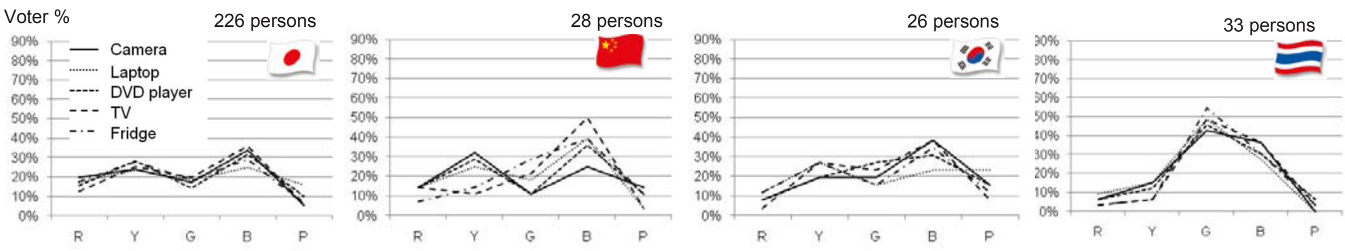

Fig. 5. Comparison by nationality for “relaxing”

COLOR DIFFERENCE EVALUATION FOR DIGITAL IMAGES

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Keywords: color difference evaluation, psychophysical experiment, digital image

ABSTRACT

A review is firstly presented about the history of color difference formulas and the development of color difference evaluation for digital images. This study involves two phases of psychophysical experiments. Phase I was implemented via a categorical judgment method to test the typical color difference evaluation methods for digital images, including CIELAB, CIEDE2000, CAM02-UCS, S-CIELAB, and iCAM, which indicates that iCAM performs best in the evaluation of image color difference. Two visual experiments were involved in Phase II, of which the first one was conducted to determine the threshold of image color difference and the second one was carried out based on a magnitude estimation method to evaluate the suprathreshold color difference for digital images. The visual data illustrate that the mean acceptable threshold is nearly twice the perceptible one and the different thresholds of lightness, chroma, hue and sharpness should be considered in the future modeling of color difference evaluation for digital images.

INTRODUCTION

With the rapid development and application of various digital imaging devices, color digital image has become an information and communication medium, which is extremely important to industrial production and daily life. Color difference evaluation for digital images is a focus and academic difficulty in the research of color science and imaging technology, and there has not yet been any recommended standard method on the color difference evaluation for digital images. What's more, the studies of existing color difference evaluation methods for digital images have mainly stayed at the threshold level, which urges us to further discuss the suprathreshold color difference evaluation for digital images.

DEVELOPMENT OF COLOR DIFFERENCE EVALUATION

There have been many researchers committed to establish and test new color difference formulas since 1935, and more than 40 color difference formulas were developed, including CIELAB, CIELUV, CMC, BFD, CIE94, CIEDE2000, and etc. These color difference formulas have been widely used in industry such as textiles and printing. Based on the color appearance model CIECAM02, three color difference formulas named CAM02-LCD, CAM02-SCD and CAM02-UCS were proposed to calculate large, small and full range of color difference, respectively, which are superior to previous color difference formulas by considering viewing conditions of background, surround, and etc.

Both the traditional color difference formulas and those from the color appearance model were established based on uniform color patch samples. However, a digital image is formed by a large number of pixels with all kinds of colors, which is quite different from uniform color patches, making its pixels difficult to be measured directly with physical instruments. As well known, human eyes cannot detect an individual pixel within an image at typical viewing distance, and, furthermore, the color perception of images is not merely the simple aggregation of the appearance of individual isolated colors. Hereby a sophisticated color difference model must take into account different factors including the spatial sensitivity.

In 1996, Zhang *et al.* derived the S-CIELAB model by considering the human visual system [1]. The first step of this model is a spatial filtering operation applied to the color image data presented on an opposite color space in order to simulate the spatial blurring by the human visual system. In 2001, Johnson *et al.* followed the earlier work by Zhang and developed a spatial color difference formula based upon CIEDE2000 [2]. Then, they proposed a framework, which refined the CSF (Contrast Sensitivity Function) equations of the S-CIELAB model and added modules for spatial frequency adaptation, spatial localization, and local and global contrast detection [3]. In 2002, Fairchild *et al.* put forward an image color appearance model (iCAM), which provides traditional color appearance capabilities, spatial vision attributes, and color difference metrics in a model convenient enough for practical applications [4].

In 2000, Stokes *et al.* tested the traditional color difference formulas applied on images [5, 6]. They compared the calculated mean image color difference with the perceived image difference, which showed that the mean perceived color difference was roughly 2.5 ΔE^*_{ab}, and that the perceived color differences were obviously influenced by the image contents.

In 2002, Hong *et al.* proposed a metric for evaluating the color difference between images based on colorimetric statistics [7]. This metric agreed well with the visual results, but it was too complicated in practical applications. In 2009, Pedersen *et al.* designed a new color image difference metric named SHAME (Spatial Hue Angle Metric) from the hue angle algorithm, which takes into account the spatial properties of the human visual system [8].

In this study, several above-mentioned methods were tested for color difference evaluation of digital images, in which the color difference of each image pair was calculated using CIELAB, CIEDE2000, CAM02-UCS, S-CIELAB, and iCAM, respectively, and then was compared with the subjective assessment results from observers. Moreover, a deep discussion of suprathreshold color difference evaluation for digital images was conducted via two psychophysical experiments to lay the foundation for modeling the image color difference.

EXPERIMENTAL

Two phases of visual experiments were performed in this study. Phase I was designed to test and compare the existing color difference evaluation methods, and two psychophysical experiments involved in Phase II were carried out to assess the threshold and suprathreshold color difference for digital images.

In Phase I, six original images, i.e. four ISO SCID 300 images, one CIE TC8-03 sRGB image, and an additional image containing sky and plants, were selected and clipped to the same size of 15 cm × 20 cm. To generate test images similar to their originals under a limited extent of color difference, the six original images were manipulated in terms of four attributes, i.e. lightness, chroma, hue angle (corresponding to L^*, C, and h of CIELAB color space, respectively), and sharpness. A total of 216 test images (6 images × 36 manipulations) were produced. The visual experiment was conducted in a dark room on a 24-inch EIZO LCD, which was characterized using the GOG (Gain-Offset-Gamma) [9] model under the D65 white point and with the colorimetric accuracy of 0.92 ΔE^*_{ab}. In each session, the image pairs composed by the original images and their modulated versions were presented on the display in a random order, and the position of the two images in a pair on the left or right was also randomized. The horizontal viewing angle was 11.2° with an interval of 1°, and the vertical viewing angle was 6.8°. A panel of 10 observers with normal color vision took part in the experiment to assess the color difference sensation of the image pairs via the psychophysical method of category judgment, which contains seven grades of color difference.

In the first visual experiment of Phase II, the original images, modulation types and the monitor settings were the same as Phase I, except for the modulating parameter settings, which led to more manipulations, resulting in a total number of 540 test images (6 images × 90 manipulations). The same panel of 10 observers were invited to estimate the color differences of the displayed image pairs by clicking the different buttons on the screen as the visual responses of 'no difference', 'just perceptible difference' or 'just not acceptable difference', respectively. The whole assessments were divided into 2 sessions so that any one session lasted about 20 minutes to avoid fatigue.

The second psychophysical experiment of Phase II was carried out based on a magnitude estimation method to evaluate the suprathreshold color difference of digital images. Each modulation of the original images corresponded to its belonging reference scale, which was modulated out according to the perceptible color difference threshold parameter determined in the first experiment of Phase II. Each reference scale had six levels, namely, the original image (no difference), the threshold image (modulated by the perceptible threshold parameter), double (2 times) threshold image (modulated by the perceptible threshold parameter multiplied by 2), then triple (3 times), quadruple (4 times), and quintuple (5 times) threshold images, which corresponded to the grades of 0 to 5, respectively. To ensure the color difference range of the test images being between 0 and 5 times the threshold value, the test image modulation parameters were adjusted slightly based on the results from the first experiment of Phase II. And the total number of test images was still 540 (6 images × 90 manipulations). The visual task of observers was to estimate the color differences between the test images and their corresponding original images based on the reference scales. Altogether, 5400 (6 images × 90 modulations × 10 observers) sets of visual data were collected.

RESULTS AND DISCUSSION

All the categorical data obtained in the experiment of Phase I were transformed into the equal-interval scale values, which was equivalent to the visual judgment of the observer. Then the color differences were calculated between the original images and their modulated versions pixel by pixel using models of CIELAB, CIEDE2000, CAM02-UCS, S-CIELAB, and iCAM, respectively. The correlations between the calculated color differences and their corresponding visual evaluation values were analyzed by standardized residual sum of squares (STRESS) [10], as shown in Fig. 1, with the standard deviations demonstrating the impact of image contents on the correlation. It can be seen that iCAM performs best in terms of the overall prediction accuracy for all the manipulation attributes, followed by S-CIELAB, CIELAB and CIEDE2000, while CAM02-UCS is the poorest.

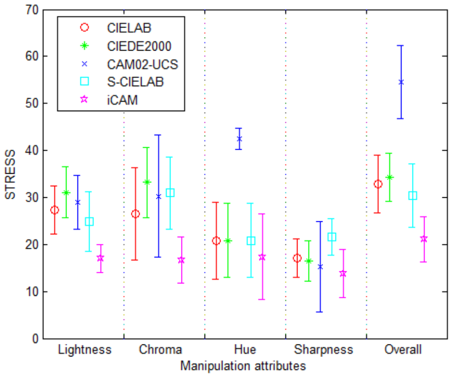

Fig. 1 The average values of STRESS in Phase I.

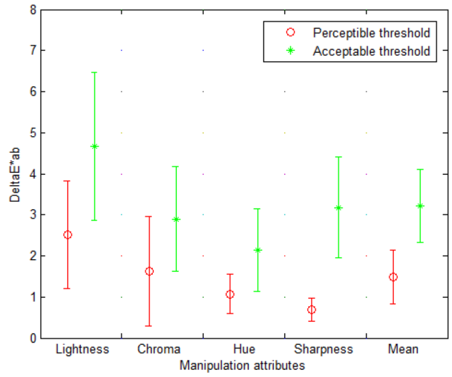

Fig. 2 The perceptible and acceptable thresholds in Phase II.

The visual data gathered in the first experiment of Phase II, as shown in Fig. 2, indicate that the mean perceptible threshold of all the four color parameters is about 1.85 ΔE^*_{ab}, and the mean acceptable threshold is about 3.60 ΔE^*_{ab}, nearly twice the perceptible threshold. The perceptible threshold of lightness difference is 2.51 ΔE^*_{ab}, greater than those of chroma (1.63 ΔE^*_{ab}), hue (1.07 ΔE^*_{ab}) and sharpness (0.69 ΔE^*_{ab}), which implies that it is important to consider the magnitude relationship of lightness, chroma, and hue differences when calculating the color difference of digital images.

The observers' evaluation data collected in the second experiment of Phase II were transformed into the visual evaluation images. Therefore, the threshold and suprathreshold visual color difference data for digital images were combined, which would be used to establish a color difference evaluation model for digital images in the future work.

CONCLUSIONS

By reviewing the development of color difference evaluation for digital images, two phases of psychophysical experiments were carried out to test the typical color difference evaluation methods and to collect the visual data at the levels of threshold and suprathreshold color difference for digital images, respectively. The detailed analysis indicates that iCAM performs the best among the existing color difference models, and that the acceptable threshold is nearly twice the perceptible one and the thresholds of lightness, chroma, hue and sharpness are quite different. Hereby, the image color difference evaluation should consider not only the human visual characteristics and image spatial properties, but also the different contributions of lightness, chroma and hue. Moreover, the suprathreshold visual results from this study would be involved in the further modeling of color difference evaluation for digital images.

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COLOR: CONSTANCY AND INCONSTANCY

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Keywords: color perception, color constancy, contrast, assimilation

ABSTRACT

Color perception is not a passive process. The visual system does not operate like a physical recording device that records and “reproduces” a faithful rendition of the physical world. Rather, the purpose of the visual system is to extract information from the physical world and to create an internal representation. The purpose of this representation is to enable us to locate objects in and navigate around our environment. This view of vision as a non-passive or cognitive process can explain the many so-called illusions that can be created.

INTRODUCTION

The three factors of color are the light source, the object and the observer (Figure 1). Different light sources have different spectral power outputs. That is, some lights (such as the tungsten bulb used at home) contain lots of long-wavelength light whereas other lights (such as the light from a clear sky in summer) contain proportionately much more of the short-wave light. Objects are colored because they reflect certain wavelengths more than others. An object that we would perceive as red, for example, under normal daylight conditions reflects the longer wavelengths of light and absorbs the shorter wavelengths. The ‘fingerprint’ of an object’s color is the reflectance spectrum which is the proportion of light that is reflected by the object at each wavelength. The most important component of color vision, however, is the observer. The human eye is the sense organ of the visual system (touch, taste, smell and hearing make up the other senses).

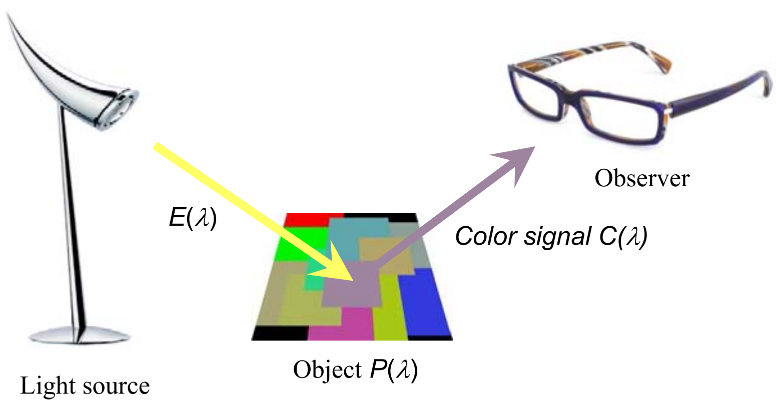

Figure 1. The three factors of color: light source (defined by spectral power distribution $E(\lambda)$), object (defined by spectral reflectance $P(\lambda)$) and observer.

The eye contains three types of cell called cones that are mainly sensitive to long, middle (or medium) or short wavelengths and are sometimes referred to as L, M or S cones. The eye also contains rods, but under normal levels of illumination (referred to as photopic vision) the rods do not operate and color vision is mediated by the three classes of cone. The cones turns the light signals into an electrochemical signal and this signals leaves the eye through the optic nerve and makes it way to the rear part of the brain in an area known as the visual cortex.

The cortex is a very thin part of the outer lining of the brain and is sometimes referred to as gray matter (white matter is inside the brain and is white in color because of the high amount of fat present). Although the cortex is thin it is highly convoluted and the surface area of a typical cortex is the size of a football pitch. The brain consists of a large number (approx. 1012) brain cells called neurones. These cells each received signals from other cells along their dendrites and then pass the signals on along their long axons to other cells. In this way, the visual signal from the retina is processed by many cells in turn and eventually results in cells in the visual cortex being activated. It is not clear how the pattern of activation in the retina gives rise to color perception (nor, indeed, vision at all). Certainly, there is no homunculus (Greek for 'little man') who resides in the brain and watches the pictures transmitted by the eye. In this sense the eye does not work like a television camera. Rather, the actual activation of the cortical cells themselves is responsible for visual perception in much the same way that consciousness arises from the activation of the brain.

COLOR CONSTANCY

One important property of color vision is color constancy. This can be defined as the fact that the colors of most objects in the world tend to remain approximately constant even though the light source may change markedly. It is clear why color constancy should be a desirable property of vision since one important purpose of vision is to be able to recognize objects. It is helpful that the color of objects does not change very much. If the color of an object, such as an apple (Figure 2), changed every time the illumination changed (such as when a cloud passes over the sun or when an apple is viewed under a green-leaf canopy) then it would make the task of identifying the apple much more difficult.

Figure 2. If the color of an object changed every time the illumination changed it would be rather difficult to spot the fruits from the trees.

Similar computation processes enable us to recognize an object (such as a chair) no matter which angle it is viewed from or even if it is partly obscured. However, what is less clear is how color constancy occurs. The changes in the intensity and color of the light that we experience when we move from indoors to outdoors or from one time of day to the other are large and yet seem to have no effect on the colors that we perceive for objects. One process that is probably connected with color constancy is retinal adaptation. For example, the visual system would like to extract illuminant-invariant information for objects (e.g. Finlayson, Drew and Funt, 1994; Hurlbert, 2002; Foster, 2003). However, retinal adaptation is unlikely to be the only factor involved and cognitive processes are also known to be involved.

COLOR INCONSTANCY

Contrast

It is extremely well known that a gray patch displayed on a dark background will look brighter than a physically identical gray patch on a light background (see Figure 3). This is spatial contrast (Hurlbert, 2002). Figure 3 illustrates an example of lightness contrast, but the same type of phenomenon occurs for color stimuli. Thus, a yellow patch viewed on a green background will appear more reddish than the same physical yellow patch on a red background. Spatial contrast occurs because the visual system computes the contrast in the image that it views; this computation helps the visual system achieve its aim to extract invariant information from the image. Invariant information is information that does not change.

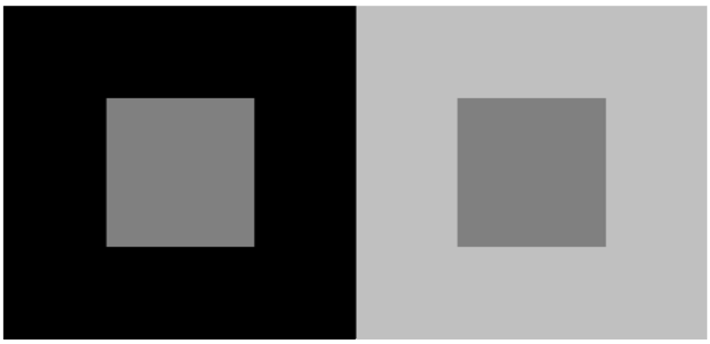

Figure 3. The two small gray squares are physically identical but do not have the same appearance because they are displayed against different backgrounds.

Assimilation

The process of spatial contrast is a consequence of the active process of vision. However, sometimes a gray patch appears darker when it is on a dark background than on a white background. Figure 4 illustrates the opposite of contrast (where the object takes on the opposite color of the background) and it is referred to as assimilation (Ripamonti and Gerbino, 2001). Whether contrast or assimilation occurs depends upon the nature of the image and is not entirely understood.

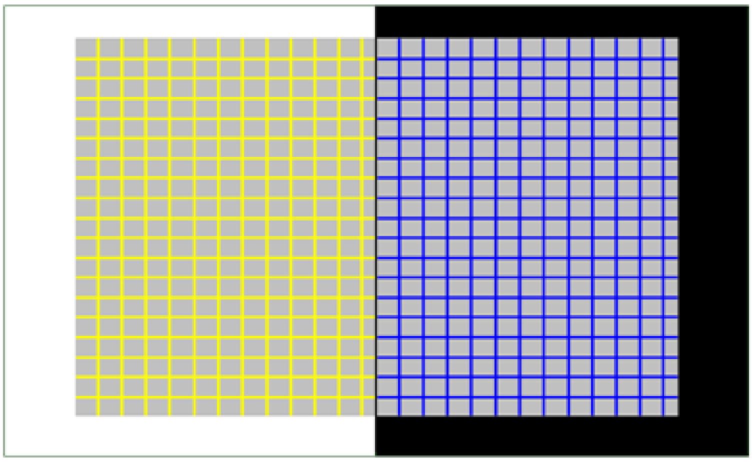

Figure 4. The color of a patch takes on the hue of the surrounding background rather than contrasting with it.

CONCLUSIONS

Color is a perceptual phenomenon; a sensation. Color is not the property of an object. The eye captures the light reflected by objects in a way that is analogous to a camera in many respects. However, color vision is much more complicated than the operation of a camera because the signals detected by the eye are processed by the neural network of the brain. It is believed that the activity in the brain that most closely correlates to color perception occurs at the back of the brain in an area referred to as the visual cortex. If color occurs anywhere it is in the visual cortex. However, it is important to realize that the visual system does not simply record the information out there in the world; rather, it constructs an internal representation of the world. When it comes to vision; what you see is not what is out there but rather what you think is out there. Vision is an active process.

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EFFECT OF INITIAL VISUAL INFORMATION ON CONSTRUCTION OF A SPACE PERCEPTION AN ON THE COLOR CONSTANCY

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Keywords: Color constancy, Space recognition, Initial visual information, Illumination

ABSTRACT

We always perceive the color of an object correctly even if the color of illumination changes, which is called the color constancy. According to the Recognized Visual Space of Illumination (RVSI) developed by Ikeda and his colleagues the color constancy takes place only when the observer recognizes a space where the object is placed. This paper investigated how the space recognition was constructed and the color constancy took place by introducing clues, which we call the initial visual information IVI, one by one in a test room without illumination. The uniform white board at the back of the test room was observed through a large window from a subject room. The amount of whiteness of the wall was measured by the elementary color naming. The wall appeared a mere black paper filling the window if no object was placed in front of the board. But it gradually became whiter when the number of objects was increased and the white board began to appear white to indicate a gradual construction of a space perception or RVSI with increase of the IVI.

INTRODUCTION

The concept of the recognized visual space of illumination RVSI can explain clearly how the color constancy works [1-3]. When we enter a room illuminated by a red light we quickly adapt to the illumination and perceive a white object as white in spite of red light coming to our eyes from the white object. This phenomenon is called the color constancy. Pungrassamee et. al. [2] showed that it is important and vital to recognize the space where the object is placed to perceive the color of an object itself correctly. They employed two rooms technique where a subject observed a test patch placed in a test room from a subject room through a small window opened on the separating wall of the two rooms. When the subject could see only the test patch in the window without seeing any other objects in the test room the test patch appeared as an object pasted on the window and its color was determined by the subject's brain which adapted to the red illumination of the subject room. It appeared a vivid greenish blue patch. But as soon as the subject could see any objects in the test room surrounding the patch the color appearance of the test patch returned to the original achromatic patch. They explained the result as that the subject could recognize a space of the test room and could construct a RVSI for the test room by which the color of the test patch was judged. The objects in the test room were called the initial visual information IVI. The effect of IVI was investigated by Ikeda and Kaneko [4], Mizokami et al. [5, 6]. In their cases the lightness and color of objects in the test room were altered to change IVI and their effect on the illumination perception was investigated. Here in this paper we changed number of objects to change IVI and observed the change of degree of the color constancy.

APPARATUS AND EXPERIMENT

The experimental room of the size, 120 cm wide, 300 cm long, and 200 cm high was built. It was divided into two rooms, a subject room and a test room as shown in Fig. 1. On the separating wall a large window W of the size, 30 cm high and 40 cm, was opened. The subject room was illuminated by fluorescent lamps of the daylight type Ls and the test room by the same fluorescent lamps Lt. The subject room was decorated as the living room with picture frame, books, clock, pillow and artificial tree. The test room had a shelf at the height 85 cm from the floor so that the initial visual information IVI can be put. At the back wall of the test room a white board WB of the size 91 cm

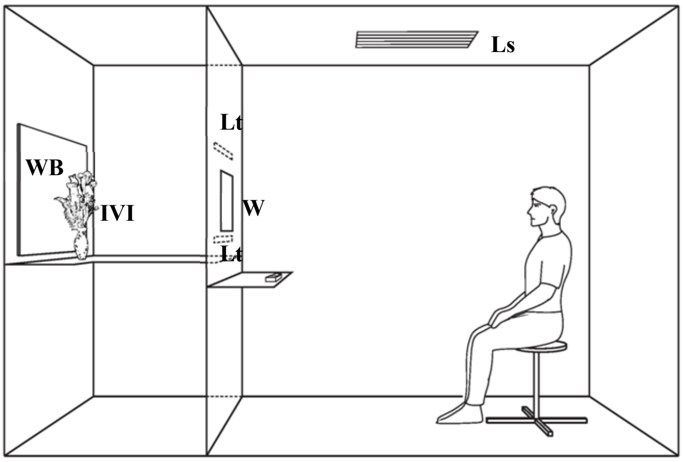

Fig. 1 Scheme of experimental room.

wide and 61 cm high was placed. It was large enough to cover the window and if there was no IVI in the test room the subject could not see any objects within the window. There were prepared six IVI as shown in Fig. 2. They were artificial flowers inserted into respective vases and the number of flowers was varied to make different IVI, I_1, I_2, I_3….I_6. The flowers were white carnations, red roses, small white flowers, and green leaves. If there was no IVI we used I_0 as the code. Beside these seven variations of IVI we prepared another IVI adding a pillow and flowers another vase to I_6, which appears as I_9 in the results. Initial visual information I_1 could not be put in a vase and it was hung by a thin string from the ceiling. Each IVI was placed near WB so that the flower(s) was touching WB. Subject could not see the bottom portion of the vase as indicated in Fig. 2.

Fig. 2 Six different initial visual information.

The subject room was illuminated at 757 lx all the time when measured on a front shelf. The test room was illuminated at 10, 20, 40 and 80 lx when measured on the shelf at the closest position to

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WB. In fact the illuminance 10 lx was given without Lt but only with Ls of which light illuminated the test room through the window W.

A subject was asked to enter the subject room and to sit down on a chair at the distance 180 cm from the window W. The subject task was to judge binocularly the amounts of whiteness and blackness at the immediate surroundings of flowers by the elementary color naming method. The subject was asked not to fixate his/her eyes at a specific point of WB. The experimenter changed IVI in a random order and five repetitions of judgment were carried out for every condition.

RESULTS

When there was no IVI, which is the case of I_0, the entire window appeared very black with 10 lx of the test room illuminance. The subject could not recognize the white board at all but a black surface on the window. It was indeed a large black surface at the window. The black surface instantly turned to a gray board placed at the position of WB when I_1 was placed. The whiteness amount increased for the increase of IVI.

Figure 3 shows the results from the subject MI. The abscissa gives the IVI, I_0 through I_9 and the ordinate the percentage of whiteness. Different symbols correspond to the illuminance in the test room, squares for 10 lx, triangles for 20 lx, circles for 40 lx, and diamonds for 80 lx. If there was no initial visual information at all the subject could see only 1 % of whiteness and 99 % of blackness in spite he was seeing the surface of the white board in the test room. With I_1, that is only a carnation flower without leaves, the subject could see the board behind the carnation and could see whiteness of 29 %. The small initial visual information already let him to recognize the test room and the color constancy took place to some extent. The whiteness amount rapidly increased with increase of IVI and the increase became gradual for further increase of IVI. With I_9 the whiteness became 84 % and the subject perceived the white board as white with this large amount of IVI.

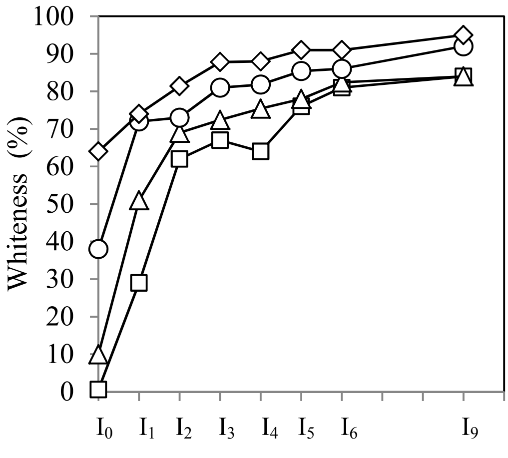

Fig. 3 Result from MI.

When the illuminance was increased the whiteness increased even with I_0 but the subject could not perceive board at the back of the test room but the gray surface on the window without IVI. There was no space perception and no object perception.

Figure 4 shows the average of five subjects. Tendency of curves is similar to that obtained from the subject MI but a clear increase of whiteness was observed when IVI was changed from I_0 to I_1. The increase is not so rapid for further increase of IVI. In other words the initial visual information of I_1 was very significant to construct a space perception for the test room. It was only a carnation flower but it gave information to subjects enough to construct a RVSI for the test room, though it was not a complete RVSI yet. We can understand now that the color constancy became perfect when the

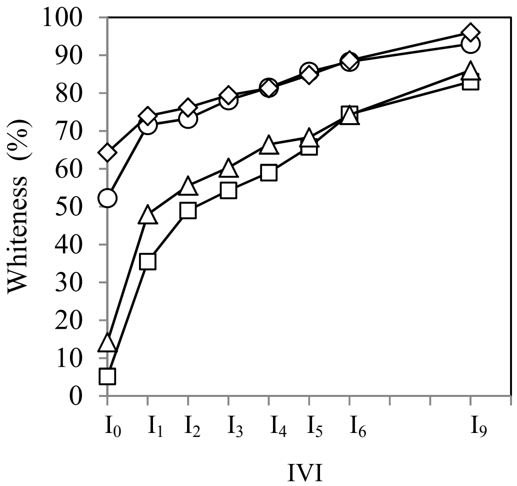

Fig. 4 Averaged result of five subjects.

window size was increased slightly so that it included only few objects in the test room surrounding a test patch in Pontawee et al.'s experiment [2]. Objects seen through the window in their case were larger in number than I_1 of the present case.
It is considered that the whiteness amount at I_0 simply reflects the luminance of the white board under the illuminance set for the test room, 10, 20, 40, and 80 lx. We took power of 1/3 for these illuminance values E to obtain the amount equivalent to L^* and plotted the whiteness amount at I_0 to see if the whiteness amount was determined only by the luminance. The results are shown in Fig. 5 with filled circles for the subject MI and open squares for the average. The whiteness is fairly proportional to E^(1/3) to confirm the supposition that the whiteness amount was determined only the luminance of the white board.

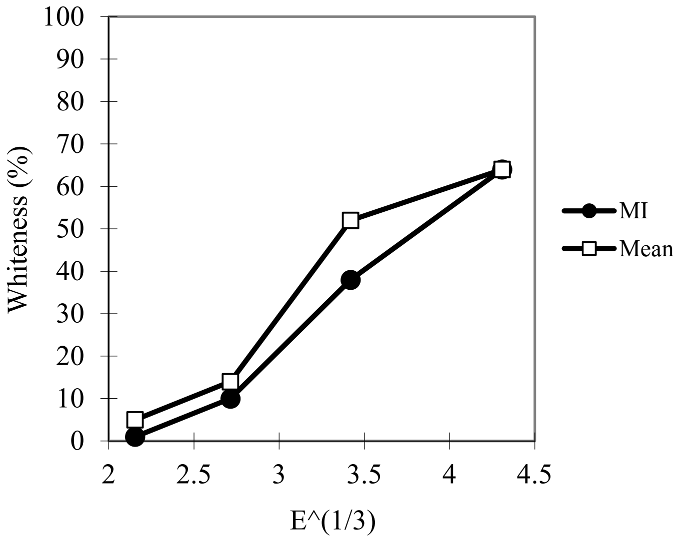

Fig. 5 Amount of whiteness at I_0 for *E*^(1/3) in lx.

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MEANINGFUL POSITION OF AN OBJECT IN A SPACE TO CONSTRUCT A RECOGNIZED VISUAL SPACE OF ILLUMINATION RVSI

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Keywords: Lightness constancy, elementary color naming, space recognition, recognized visual space of illumination, illumination.

ABSTRACT

When a subject looked at a uniform white board placed in a test room from a subject room through a large window the window appeared a mere black sheet if the former was illuminated very low while the latter was illuminated high. If an object was placed just in front of the white board the board immediately appeared a white board. This indicates that the object worked as the initial visual information IVI for the subject to construct a recognized visual space of illumination RVSI for the test room. If, however, the object was gradually separated from the surface of the board the power of the object as the initial visual information decreased and the whiteness decreased. In this paper the power of an object as the initial visual information was investigated as a function of the distance of the object from the white board. A subject judged the amount of whiteness of the board by the elementary color naming. It gradually decreased from 80 % down to 10 % or less when the object was changed from 0 cm to 86 cm.

INTRODUCTION

The concept of recognized visual space of illumination RVSI was introduced to explain the color appearance of objects and lights [1, 2]. A subject adapts to the illumination of a space where an object is placed. The state is expressed as the subject constructs an RVSI for the space and perceives the color of object in relation to the RVSI. By using two rooms technique composing of a subject room and a test room connected by a window limited in its size it was clearly shown that the color appearance of a test patch placed in the test room changed radically whether the patch was perceived in the subject room or in the test room [3]. To construct the RVSI of the test room it was necessary for the subject to be able to see objects in the test room. The objects are called the initial visual information IVI for the RVSI. When IVI was increased the RVSI became more complete [4]. If there is no IVI in a space a subject should not be able to construct an RVSI. Even if there is an object in a space its ability to work as an IVI for the space should be different depending on its position relative to the RVSI. The ability is investigated in relation to the position in this paper.

PRINCIPLE AND APPARATUS

Figure 1 shows a scheme of apparatus drawn in a scale. It was composed of a subject room and a test room of the depth 210 cm and 90 cm, respectively, and the rooms were illuminated by fluorescent lamps of the daylight type Ls and Lt. There was a window of the size 30 cm high and 40 cm wide opened on the separating wall of the rooms. Inside of the subject room was pasted by a white wall paper. At the back wall of the test room a white board WB of the size 61 cm high and 91 cm wide was placed. A subject looked at the white board from the distance 180 cm from the window subtending 10°×13°arc of visual angle. When there was no object in the test room, in other word there was no IVI, and the test room was not illuminated by Lt but the subject room brightly by Ls, the window appeared to be pasted by a black paper. There was no space perception for the test room. The space perception only took place when there were placed some objects in the room such as flowers as shown by IVI in Fig. 1. Once the space perception took place in the subject the white board appeared as a white board. The white appearance was the result of constructing the RVSI for the test room in the subject. But the construction should be different depending on the distance of the IVI from the white board. In the present paper the whiteness was judged by the elementary color naming method as a function of the distance.

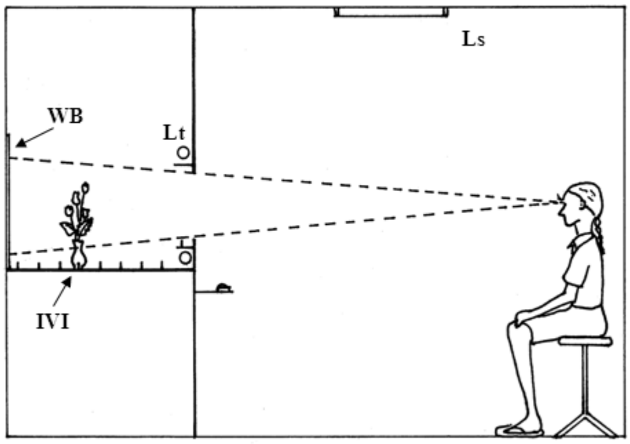

Figure 1 Scheme of apparatus.

The object to work as IVI is shown in Fig. 2. It was composed of artificial flowers of some colors, deep red, white, green, and deep green. The flowers were arranged to a white vase and the total height was 45 cm. The frame of Fig. 2 shows the window and subjects could see only flowers and an upper portion of the vase in the window. To locate the position of the vase marks were drawn on the table in the test room as 0, 1, 2, , , 7, each interval being 10 cm apart. The position 0 was at the distance 5 cm from the white board and thus the position 7 was 75 cm apart from the white board. There was additional position 8, which was not on the table but on a cover over the lower lamp, which was 86 cm from the white board.

At each position of 9 positions of IVI a subject judged the whiteness and the blackness of the white board around the flowers by the elementary color naming method. Five repetitions were made at different time or day.

The horizontal plane illuminance of the subject room was kept constant at 757 lx when measured on the front shelf as illustrated in Fig. 1. The horizontal plane illuminance of the test room was set at either of four levels, 10, 20, 40, and 80 lx when measured on the table in the test room closest to the white board. The illuminance was changed by a light controller connected to the two

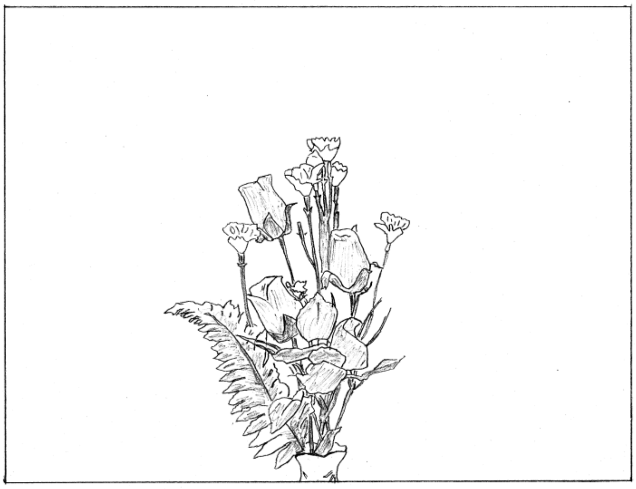

Figure 2 Flowers as initial visual information IVI.

fluorescent lamps. The measurement was conducted while the subject room was lit at 757 lx. Ten lx of the test room was provided when the two lamps were off.

Five subjects participated in the experiment, CP, MI, PS, RT, and SM, who were all normal in color vision when tested by 100 hue test.

RESULTS

Results of the subject CP are shown at the upper section of Fig. 3. The abscissa gives the distance from the white board in cm and the ordinate the whiteness amount in percentage. Four curves correspond to the test room illuminance, circles to 10, squares to 20, triangle to 40, and diamonds to 80 lx. The whiteness without IVI or flowers in the test room is shown by the respective symbols on the left ordinate. When the IVI was closest to the white board the whiteness amount was a little over 80 % regardless the illuminance level implying the subject constructed the RVSI for the test room and judged the white board as white. When the IVI separated from the board the whiteness decreased and the decrease was most rapid with 10 lx. When the distance was 86 cm the board appeared almost black to imply that the IVI did not help to construct the RVSI for the test room at all. When there is no IVI in the test room the whiteness became almost zero. The window appeared very black in spite of the fact that the subject was looking at the white board. The subject judged the board by the luminance of the board and not by the lightness of the board. When the illuminance became higher in the test room the effect of IVI decreased but the RVSI was constructed to a certain extent by the illumination itself and the whiteness did not go down to zero even at 86 cm.

There were some individual differences and the averages of five subjects were taken, which are shown in the lower section of Fig. 3. The decrease of whiteness continues for increasing distance of IVI from the white board. In other words the effect of IVI to construct the RVSI or the space perception for the test room gradually decreased for more distant IVI from the test surface.

It was argued that an RVSI could be constructed even for a uniform plane by which the simultaneous lightness contrast takes place1). The present investigation showed that a space perception over a uniform plane constructed by IVI decreases when the IVI separates from the plane.

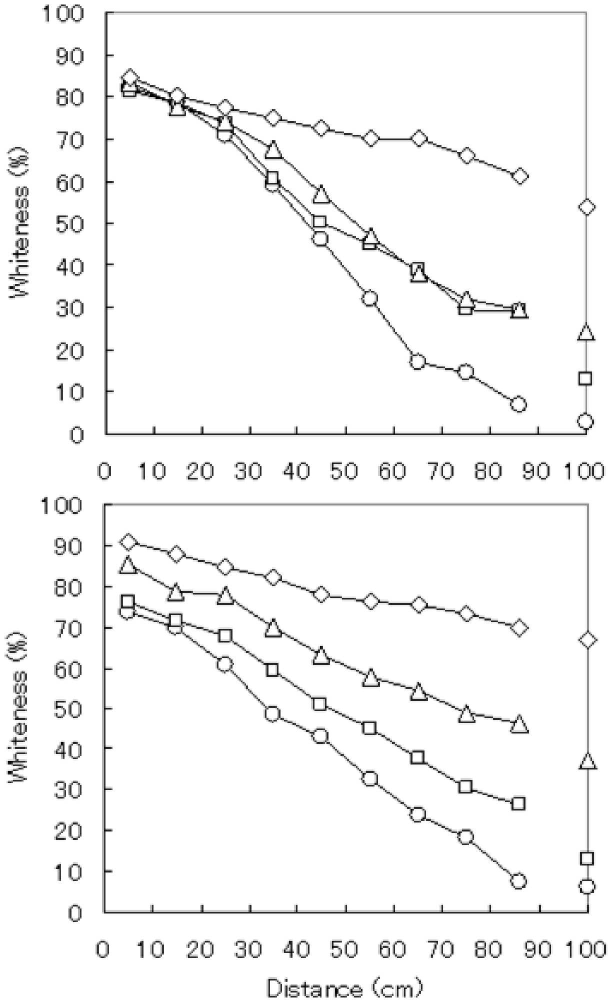

Figure 3 Whiteness amount as a function of the distance of IVI from the white board. Upper, results from subject CP; lower, averaged results of five subjects. Symbols indicate the luminance level of the test room, circles, 10 lx; squares, 20 lx; triangles, 40 lx; dimonds, 80 lx.

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THE IMAGES OF COLORS WITH DIFFERENT SHAPES AND IN DIFFERENT MOTIONS

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Keywords: color: image: shape: motion: SD

ABSTRACT

A color stimulus (red, green or blue) of different shape (circle, triangle or square) was presented on the screen in different motions of circular, vertical and horizontal, or steadily (without motion). The images were evaluated with 7-points SD scales. Twenty-five subjects participated.

The main results are as follows: (1) the image of color considerably changed both due to shape and motion. Sometimes it completely reversed. (2) The image of green was easy to change generally both due to shape and motion. (3)The image of red, on the contrary, was least affected both due to shape and motion. (4)The shape of ○ was affected by color most when it did not move, and △ was most resistant to the color. (5)When the motion was introduced, the shape of △ and □ turned to be most changeable , and that of ○ least. (6)The circular motion did not affect much the image of color, and the vertical one did much. (7)The image of "soft - hard " was most changeable due to shape and the images of "thick - plain" and "monotonous -changeful" were most affected due to motion.

INTRODUCTION

It appears that the movements of dancers wearing in different colors gives us different images when they move straight or move around. Also we feel different images when the F1 racing cars of different colors run straight or when they come around in the corners. Many studies have been done so far on the images of colors[1][2][3][4]. Some of them were conducted to explore the interactive effects in the image between the shape and the color. Tomita et al showed that the colors of red, orange, blue and especially purple were less affected by their shape, and that the colors of green and yellow were more affected by their shape[5]. Ohmi et al. showed that the geometrical figures tended to change their image by their colors and less affected were the figures having names and least were the meaningless figures[6].

But none of them were studied in different motions. The motion is quite a strong cue for the animal to find out a target in the environment. It is, therefore, possible that the image of a color could change by their motion, as well as by their shape. Such effect of the motion seems quite important for, e.g. web designing with motions.

The aim of the present paper is explore how the image of colors do change due to shape and motion using SD method

METHOD

Apparatus and Stimuli:

Color stimuli were presented on a screen via a computer-projection system. The luminance (cd/m^2) and the chromaticity coordinates(CIE x, y coordinates) were (65.3, .530, .366) for the red stimulus, (110, .191, .239) for the blue one, and (210, .268, .539) for the green one. The luminance and the

CIE x, y coordinates of the screen off the stimulus were (334, .285, .392). The average horizontal illuminance (lx) and the chromaticity coordinates(CIE x, y coordinates) during the stimulus on the screen was (46.3, .330, .389) for the nearest seat to the screen and (39.6, .336, .376) for the farthest seat.

The nearest and the farthest seats was about 3m and 5m away from the screen respectively forming the visual angles of the stimulus in 3.42° for the diameter of the circle and a side of the equilateral triangle, and 3.14° for the square. The visual angles of these stimuli at 5m were 2.05° and 1.88° respectively.

The distances of the motion were 16.15° (9.69°) in visual angle for the diameter of the circular motion at 3m (5m), 15.2° (9.12°) for the vertical and 22.8° (13.68°) for the horizontal motions respectively.

The temporal condition of the stimulus was controlled by the Power-Point System of Microsoft Co. Ltd. after preliminary experiments. When the speed of motion of the stimulus was slow, the image was formed solely by their color irrespective of their motions. The speed of motion of the stimulus, therefore, should have been set for their image to be affected by both of their color and motion. Eventually the speed of motion turned to be at the maximum, i.e. 1 back-and-forth in 1 second for the horizontal and vertical motions and 1 rotation in circular locus in 1 second.

Three colors, red, green and blue were examined in three different shapes, circle, triangle and square, in four motions, circular, vertical, horizontal and steady, i.e. without motion. Each of those 36 patterns of stimuli were presented at random.

Participants:

In total of 25 participants were recruited. All of them were students of Kanagawa University at ages ranging from 18 to 21. The experiment were conducted in their classes and so they were not paid.

SD scales:

Fig.1 shows the SD scales used. These scales were adopted with reference to Oyama et al [1].

1. like - dislike
2. soft - hard
3. thick - plain
4. elegant - vulgar
5. monotonous - changeful
6. heavy - light
7. dynamic - static
8. simple - tedious
9. romantic - realistic
10. modern - ancient
11. natural - unnatural
12. beautiful - ugly

Fig.1 SD scales used.

Procedure

The participants evaluated the image of the color in different shape and motion using 12 SD scales with 7 points (See Fig. 1). Each stimulus was on the screen until all the participants completed the SD sheet for that stimulus. The circular motion was repeated on the same site and the horizontal and vertical motions were repeated back-and-forth. Almost one hour was needed to complete the experiment.

RESULTS AND DISCUSSION

Table 1 Average evaluation points in each motion for circular red (○).
S: Steady, C: Circular, V: Vertical, H: Horizontal

	Motion			
SD scale	S	C	V	H
1	0.71	0.5	-0.07	-0.14
2	0	0.57	0.71	0.43
3	0.71	1.36	2.14	1
4	0.5	0	0.07	-0.14
5	1.5	0.43	-1.14	0
6	0.71	0.21	-0.21	0.5
7	0.86	0.79	1.57	0.79
8	-0.21	-0.21	-1.14	-0.57
9	0	0.21	0.29	0.43
10	0.93	0.57	0.71	0.29
11	0.57	0.14	-0.79	0.14
12	1.43	0.21	0.36	0.21

Table 1 shows the average evaluating points for each scale for the red ○stimulus, where ○ indicates the shapes of the stimulus and S, C, V, H Steady (without motion), circular , vertical and horizontal motion respectively. The negative signs mean the higher evaluation towards the right hand in each scale.

The image of the scale 1, "like-dislike", for the steady red ○ stimulus reversed when it moved in vertical and horizontal ways. On the other hand the image of the scales 2, 3, 7, 8, 9, 10 and 12 did not change from the steady one whatever motion was introduced.

In summary, the red color was least affected by the shape and the green color most. The shape of △ was least affected by the color and ○ most by the definitions. The scale of 2. "soft-hard" was easy to change due to the shape.

Table 2 Reverse of image due to motion (The digits inside the matrix are the kinds of SD scale reversed) .

	Motion			
Color	C	V	H	Total
red	-	5	-	1
blue	-	3,5,7	3	4
green	-	1,3,4,5	3	5
Total	0	8	2	10

Table 2 shows the cases in which the image of the steady color reversed for all three shapes when it was presented with motions. It should be pointed out that the digits inside the matrix show

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the kinds of SD scales reversed. It is clear that the circular motion did not change the image of a color presented steadily, and the vertical motion did affect much. As for the color, the red color seems to resist to motion in image.

Also the images of 3 ("thick-plain") and 5 ("monotonous - changeful ") were easy to change due to motion. The images of "plain" and "monotonous" turned to be "thick" and "changeful" respectively when a motion, especially the vertical one, was introduced for any kinds of shape.

The red color has very strong image generally in that the images changed least both due to shape and motion. Despite of that, the image of 5 ("monotonous - changeful ") reversed in the vertical motion.

The green color was easy to change for both characteristics. As for the effect of shape, the tendency in the present results is coincident with Tomita et al.[5]. Green is included in "neutral colors" which are not either "warm" nor "cold" in the dichotomy of "warm-cold" impression.
It can be said that the green color does not have any distinct or strong image. The present results demonstrated that the image of green was also affected due to motion, particularly by the vertical one.

It was seen that the shape of ○ was affected due to color more than △ or □, and △ least, indicating △ was most stable as a shape when it was seen without motion. The stability of red as a color and that of △ as a shape may produce similar images, which was suggested in Babbit (from Tsukada [7]).

As for the cause for the changeability of the image of △ or □ when the motion was introduced, it was suggested that the diminished recognizability of corners, rather than the locus of the motion, should be concerned.

ACKNOWLEDGEMENT

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Oral paper OA15

EVALUATION OF COLOR DISCRIMINATION UNDER LED LIGHTING BY TWO TYPES OF 100-HUE TEST

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Keywords: light-emitting diode, light source, color discrimination, 100-Hue Test, color quality

ABSTRACT

The light-emitting diodes (LEDs) have become popular, and it is necessary to evaluate the color qualities of LED lighting. Color discrimination is one of the important aspects of color qualities at museums, stores and so on. In this study, we compared two types of 100-hue test under LED and conventional lightings to examine the influence of test samples, especially saturation on the evaluation of color discrimination. One was ND-100 (average C^*_{ab} = 13.43), the other was Farnsworth-Munsell 100-Hue Test (average C^*_{ab} = 25.67). The colors of test lights were daylight, neutral white, and incandescent color. Observers performed two types of 100-hue test under all test lights. Results show that the trend of color discrimination in ND-100 and Farnsworth-Munsell 100-hue test are similar, and there is a little difference between LED and conventional lights in general.

INTRODUCTION

Light-emitting diodes (LEDs) lighting has become popular because of their advantages such as energy saving, long life. Conventional light sources are getting replaced by LED light sources and we often see LED light sources at stores, at home and at museums. As the color appearance of objects is influenced by light sources, it is necessary to evaluate the color quality of LED lighting.

One of the important aspects of lighting quality would be color discrimination especially for situations that small color difference is critical, such as museums, stores, offices dealing with color management. There are some studies on discrimination task under various lightings, but they do not focus on difference between conventional lights and LED lights. Although some studies used a 100-hue test to evaluate the light sources [1][2], they did not examine the effect of saturation on the performance. In this study, we investigate the difference of color discrimination between conventional lights and LED lights and examine the influences of test colors with low and high saturation on discrimination performances by comparing two types of 100-hue test.

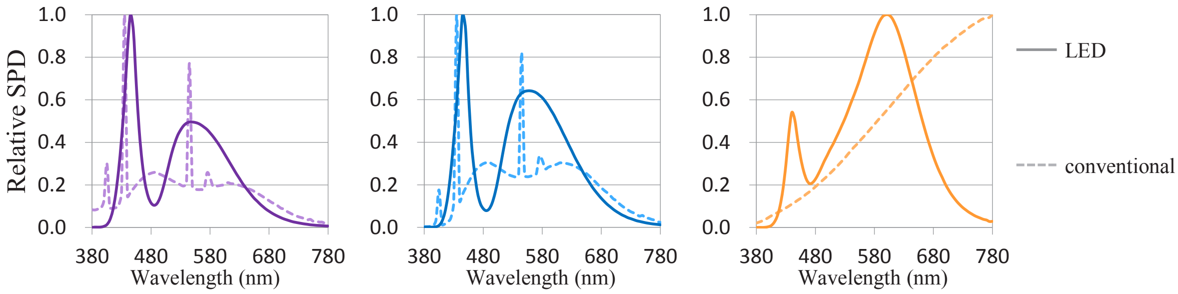
EXPERIMENT

Experimental setup

A viewing box covered with medium gray (approximately equal to Munsell N6.5) matt paper was used for the experiment. Its size was 60 cm (length) × 89 cm (wide) × 40 cm (height). It was illuminated by one of test lamps and a 100-hue test was placed on the center of its bottom. Horizontal illuminance at the position of a 100-hue test was approximately set to 1000 lx (±10 %).

Light sources

We used 3 color types of light (Daylight type, Neutral white type, incandescent color type) for fluorescent lamp, incandescent lamp and LED light sources: fluorescent lamp simulating D65 (approximate correlated color temperature 6200 K, *Ra* 98) and daylight type LED (6500 K, *Ra* 70), neutral white fluorescent lamp (4700 K, *Ra* 97) and neutral white type LED (5000 K, *Ra* 68), incandescent lamp (2800 K, *Ra* 99) and incandescent color type LED (3000 K, *Ra* 84). Figure 1 shows the relative spectral power distributions (SPDs) of the light sources. We compared the combination of fluorescent lamps simulating D65 (D65) and daylight type LED (LED-D), neutral white fluorescent lamp (FL-N) and neutral white type LED (LED-N), incandescent lamp (IL) and incandescent color type LED (LED-L), respectively. It has been already shown that color appearance differs a little under these combinations of light sources in previous studies [3][4].

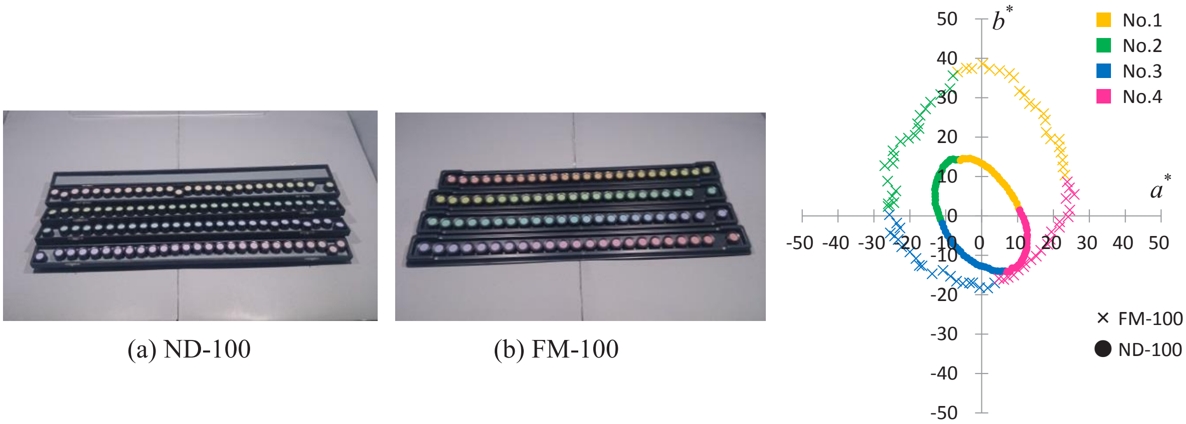


(a) Daylight (b) Neutral white (c) Incandescent color

Figure 1. Spectral power distributions (SPDs) of the light sources

100-hue tests

We used two types of 100-hue test for discrimination task. One was ND-100 (Japan Color Research Institute) consisted of 100 color disc samples with low saturation (average C^*_{ab} = 13.43 under D65 illumination), and the other was Farnsworth-Munsell 100-Hue Test (FM-100) consisted of 85 color disc samples with high saturation (average C^*_{ab} = 25.67). Using two types of 100-hue test, we can examine the capabilities of color discrimination for colors with both low and high saturation. Figure 2 shows the appearances under D65 and the chromaticity coordinates in the CIELAB (a^*, b^*) diagram (under standard D65 illuminant). Each 100-hue test consists of four trays (No.1-4). A discrimination task was carried out for each tray separately.



(a) ND-100 (b) FM-100 (c) Chromaticity coordinates

Figure 2. Two types of 100-hue tests.
Pictures of ND-100 (a) and FM-100 (b) taken under D65. The chromaticity coordinates calculated based on standard illuminant D65 and the spectral reflectance of 100-hue tests (c).

Procedure

After light adaptation for three minutes, an observer started a discrimination task. They arranged color samples of 100-hue test in consecutive color order. Time for the task was limited to two minutes. Each observer performed the two types of 100-hue test under all test lights, one time for each light condition. Six observers with normal color vision (average age 22.3 years old) participated.

RESULT AND DISCUSSION

Each color sample was printed the number of correct order in the back. We calculated the error scores from the results of the task for each tray. The calculation of error score is based on the differences of neighboring sample's numbers. With increase of the degree or the frequency of misarrangement, the error score also increases. The calculation methods of error score for ND-100 and FM-100 are slightly different. In this study, however, we calculated the error scores of each 100-hue test by each calculation method because the results of both methods show little difference.

Figure 3 shows the error scores of each tray (No.1 ~ 4) and the sum of error scores for all trays (Total) under each combination of LED and conventional lighting. Error bars show the standard deviations of six observers and asterisks show the results of significance level ($N = 6$; $p < .05$).

The error scores of ND-100 and FM-100 showed similar trend. They tended to be high in greenish color samples (No.2). The difference of the error score under LED and conventional lighting was not large. The error scores of some color samples under LED lighting were a little higher compared to conventional lighting in general. In the case of incandescent color type, the error scores of some color samples under LED lighting were a little lower compared to those under conventional lighting. In most cases, the error scores did not show statistically significant differences between LED and conventional lighting. The error scores and the standard deviations of incandescent color type lighting were larger than the other color types.

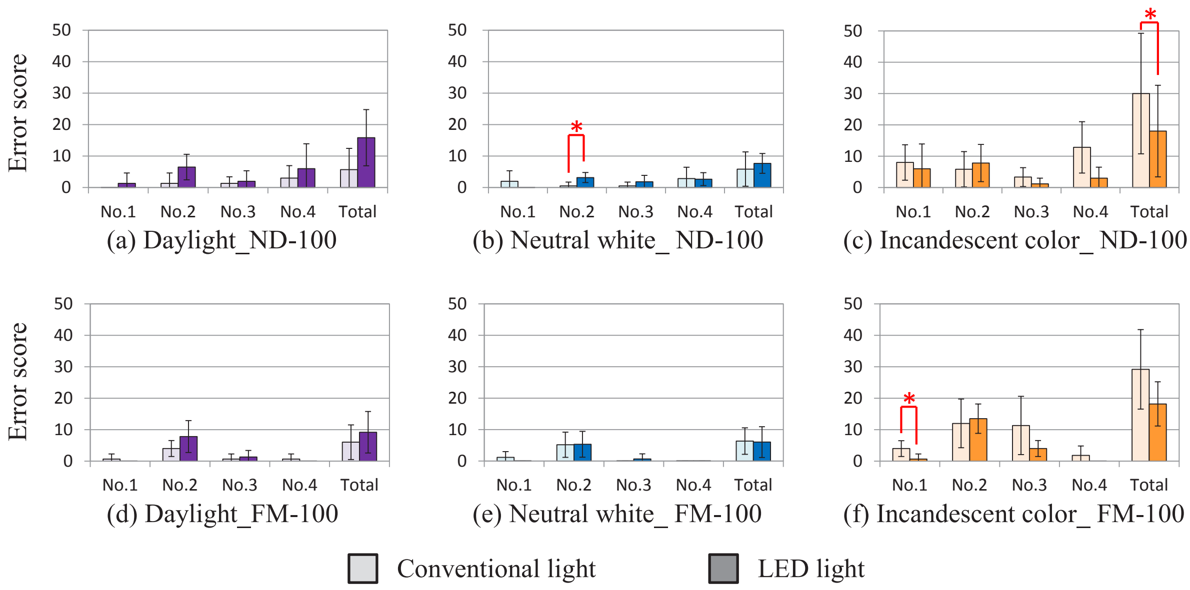


Figure 3. The error scores for each condition.
Error bar indicates Standard Deviation. Asterisks show results of t-test
($N = 6$; *, $p < .05$)

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In order to examine the effect of saturation, we also compared the error scores of ND-100 and FM-100 for each condition and carried out the t-test to the results ($N = 6$; $p < .05$). Although the error scores of FM-100 were a little higher than those of ND-100 in most cases, they did not show statistically significant differences.

We calculated chromaticity differences between neighbouring color samples by CAM02-UCS color difference formula [5]. This uniform color space (UCS) can predict color appearance under various viewing conditions and provide better correlation between visual and calculated color rendering values than previous color difference formulae [6]. Comparing the chromaticity of color samples under conventional light and LED light, we found that the chromaticity circle of 100-hue samples under LED light was a little bit distorted. Especially, the chromaticities of yellow and green samples shifted toward green-yellowish direction, and those of blue and red-purple samples shifted toward purplish for both 100-hue tests. These trends are consistent with previous studies [3][4] which shows a small difference in color appearance. These suggest that the color appearances under conventional and LED light are different influenced by the distortion, but the color discrimination is not affected as much as color appearance. At least we did not find the differences of light sources statistically significant enough in the present study.

The results of this study show the possibility that there is a little difference between LED and conventional lighting for color discrimination. Although they did not show enough significant difference, the error score increased with the decrease of color differences between neighbors for some color samples. Because the number of observers and test light sources was limited in this study, the difference of color discrimination between LED and conventional lighting is still unclear and we need further research.

CONCLUSION

We compared discrimination performances for two types of 100-hue test under LED and conventional lights. Our results show possibilities that there are a little difference in color discrimination under conventional light sources and LED light sources, and little difference in saturation of test samples. However, we need further research because the number of observers and test light sources was limited.

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Oral paper OA21

The influence of public facilities color on landscape preference:A case study of telecommunication boxes in Taipei city

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Keywords: color; public facilities; landscape preference; design criteria

The purpose of this research is to understand how the colors of public facilities under different background environments affect people's preference for landscape. This research took telecommunication facilities of Taipei city as a case study. A computer simulation experiment was conducted. The colors of the facilities and background environments were manipulated as the independent variables and the preference for landscape was the dependent variable. Forty colors were selected from the Natural Color System (NCS) by stratified random sampling and applied to the surface of the facilities. The facilities were then shown in three different environments (apartment, park and riverside) to the subjects in random order. Their preferences for landscape as well as background information were analyzed. Relationship between their preference of landscape, family background as well as prior education on color theory and aesthetic were also discussed. The results of the study may contribute to the design criteria of future urban planning.

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A COMPARISION BETWEEN TAIWANESE AND JAPANESE CATEGORICAL COLORS

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Keywords: Categorical Colors, Basic Colors, Color Names, Color Foci, Mandarin

ABSTRACT

While humans are capable of discerning millions of colors, it is beyond our cognitive capacities to deal with every discriminable color as a single category. Previous studies have shown that people use a very limited number of names to classify and label all visible colors [1]. The number of basic color names, i.e. the cognitive/linguistic color categories, varies from language to language. It thus follows that the boundaries between adjacent color categories also vary with language [2]. We conducted a large survey on the frequency of color terms in use in Taiwanese Mandarin speakers. A systematic mapping of the CIE foci and boundaries of the twelve most commonly used color terms was performed on the CIE1931 space. The Taiwanese results were compared to the Japanese data [3]. We found that there are significant differences in the boundary between green and blue, and the area of grey between these two groups. Japanese grey is warmer than its Taiwanese counterpart.

INTRODUCTION

The purpose of this study is to investigate the current use of color names in Mandarin, including the number of basic color terms, the popularity and the referenced color appearances of frequently-used color names. A color lexicon survey and a series of constrained color naming tasks were conducted to answer questions like: (1) What are the most commonly used color terms by Mandarin-speaking Taiwanese? (2) How do Mandarin color terms differ from the reported English color terms in composition (e.g. the proportion of monolexemic vs. compound words). (3) What are the CIE foci and boundaries of the most commonly used Mandarin color terms? (4) How are the territories of Mandarin color terms in the CIE space compared to that of Japanese data [3]?

FREE-RECALL COLOR LEXICON SURVEY

To answer the above first two questions, a free-recall color lexicon survey was conducted to collect the most frequently used color terms in Mandarin. There were 189 informants in total that performed this free-recall task. The informants were provided with a blank sheet, and a pencil or pen. The task instruction was to "write down color terms/ vocabularies you frequently use, hear and read." After the frequent terms recalling was done, the author encouraged the informant to freely recall color terms as many as he/she could and also write them down on the sheet.

The results of this survey, along with the comparable data from other studies [3],[4], are listed in Table 1.

Table 1: The Top 11 Color Terms Found in Three Studies

	Current	Japanese(1990s) [3]	Mandarin (1990s) [4]

	Mandarin	English	Japanese	English	Mandarin	English
1	藍 Lan	Blue	Shiro	White	桃 Tao	(deep) pink
2	紅 Hong	red	Aka	Red	灰 Hui	Grey
3	綠 Lu	Green	Kuro	Black	黑 Hei	Black
4	紫 Zi	Purple	Ao	Blue	褐 He	Brown/tan
5	橘 Ju	tangerine /orange	Ki-iro	Yellow	白 Bai	White
6	黃 Huang	Yellow	Midori	Green	橙 Cheng	
7	粉紅 Fenhong	(light) pink	Cha-iro	Brown	黃 Huang	Yellow
8	灰 hui	Gray/ash	Murasaki	Purple	紫 Zi	Purple
9	咖啡 ka-fei	Brown/cof fee	Pinku	Pink	紅 Hong	Red
10	桃紅 Taohong	(dark)pink	Orenji	Orange	綠 Lu	Green
11	橙 Cheng	orange	Kon	Dark blue	藍 Lan	Blue

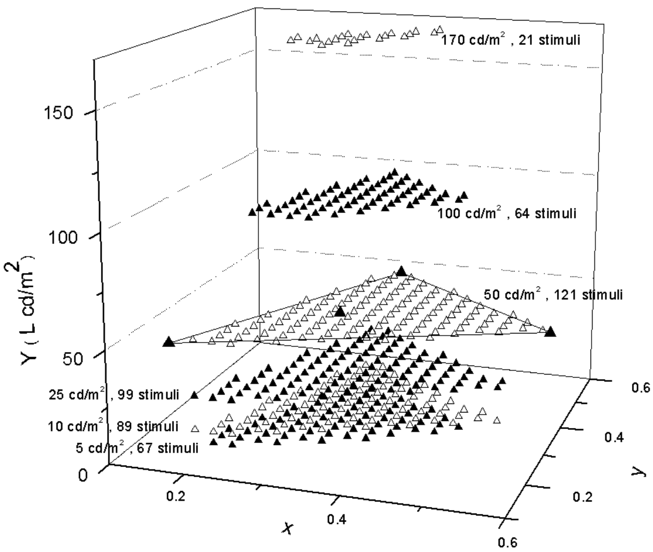

Figure 1. All color stimuli used in sorting experiment as sampled at six different L levels.

TWELVE-COLOR-TERM SORTING EXPERIMENT

From the results of free-recall survey, we picked the first 12 most frequently used color names. The participants of this experiment were asked to label color stimuli with these 12 color names, i.e. to

sort all stimuli into 12 categories. Six sets of color stimuli were generated, corresponding to six different L levels: 5, 10, 25, 50, 100 and 170cd/m2. Stimuli of the same L surface were evenly sampled along x- and y-axes in the CIE1931 x-y diagram. At each L surface, the sampling interval is 0.025 units, sweeping along the x- and y-axes to produce a regular and equal sampling of points within the gamut of display media. Six stimulus sets contain unequal amounts of colors—67, 89, 99, 121, 64, and 21, respectively—and these amounts depend on the availability of LCD colors at different L levels. There are 461 distinct stimuli in total. The complete set of color stimuli on the CIE1931 x-y diagram can be seen in Figure 1.
Stimuli were presented and controlled by an ASUS F6E 13.3" laptop. Each stimulus was displayed in the exact center of the monitor. The output uniformity stability check of the LCD was carried out according to a standardised procedure. A well-calibrated PhotoResearchTM PR-650 SpectraScan spectroradiometer was used to repeatedly measure the center output of the LCD. The measuring distance was 355mm, and the sample size was 10cm2, covering the whole field of the spectroradiometer lens. The measuring geometry followed the recommendations of PhotoResearch, Inc. The adopted standard observer model was CIE1931, and the reference white selected was D65. The mean output intensity was 235.8cd/m2 (STD=3.28, maximum value=241 cd/m2 (+2.11%), with a minimum value of 229cd/m2 (-2.96%)). A look-up table was generated by the standard measuring procedure, and the Matlab interpolation function was used to produce all color stimuli. The results of sorting at each of the six L levels are shown in Figure 2, where the boundaries are demarcated by 75% and 50% votes ratio, which are marked with color fills and color lines, respectively. These two threshold levels partition the x-y surface into mutually distinct zones without significant overlapping.

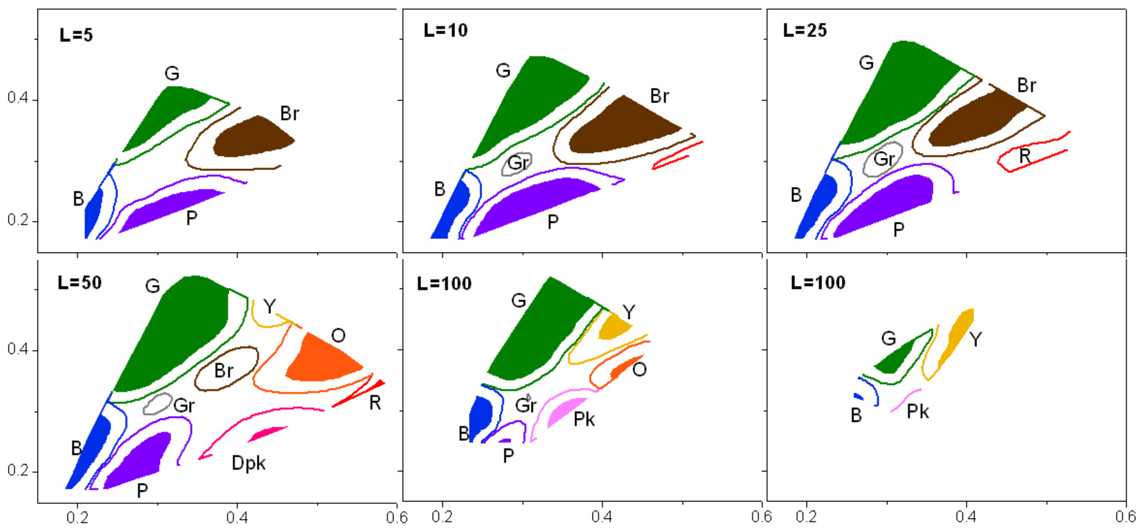

Figure 2. Zones of color categories in six luminance conditions.

The left panel of Figure 3 shows the collapsed results across all L levels which can then be easily compared with the Japanese data reported in [3] (right panel). A marked difference can be found in the boundary between green and blue. The territory of green in Mandarin speakers' mind is larger than that in Japanese mind. Furthermore, the Japanese gray zone is roughly centered around the standard white, while the area around white is split into two 'gray' and 'brown' zones in Mandarin space.

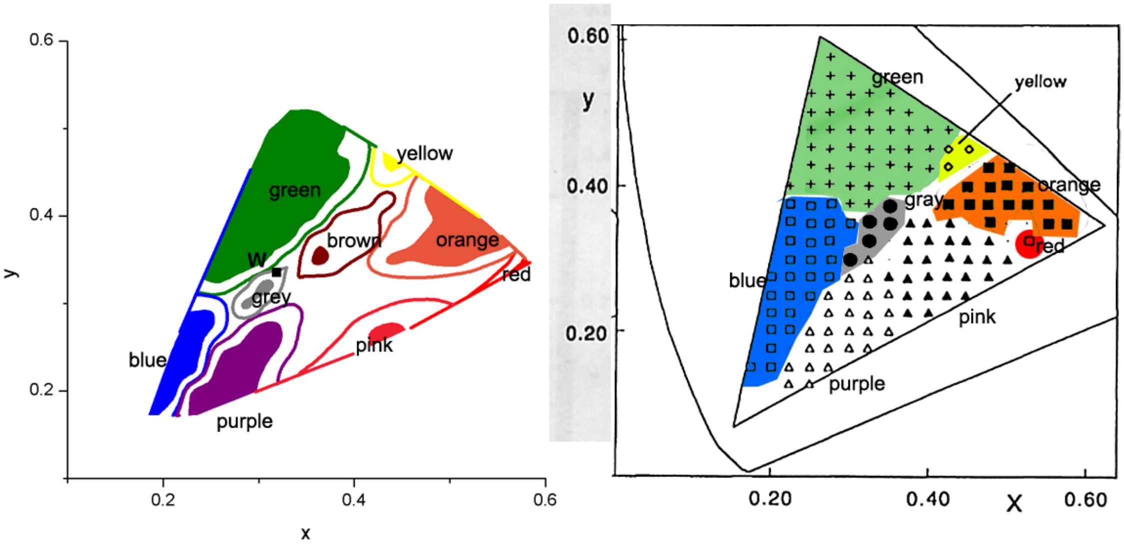

Figure 3. Left: Results of color sorting by Mandarin speakers. Right: Color naming results by Japanese speakers [3].

CONCLUSION

Our results show that (1) The top 12 basic Mandarin color terns match well with the 11 basic color categories coined by Berlin & Kay [1]. (2) The foci and boundaries of blue and grey in Mandarin speakers' eyes are markedly different from the Japanese results.

ACKNOWLEDGEMENT

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Oral paper OA23

CONSUMER COLOUR PREFERENCES FOR HOME TEXTILE PRODUCTS MADE FROM SILK FABRICS

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Keywords: Colour preference, Home textile, Silk Fabric, Thai consumer, Market survey

The objective of this study was to apprehend the colour preferences for home textile products made from silk fabric in Thai consumer market. The study investigated for colour preferences through marketing survey research methodology, designed to collect structured data through questionnaire given to a sample of respondents that is representative of Thai consumers. The approach to consumer behavior was more micro and cognitive, which emphasised the individual consumer: attitudes, perception, and lifestyle and demographic characteristics, were studies in context of how they influence the individual consumer colour preferences. The survey gathered information from both men and women and the observations were made at three locations: Bangkok and its metropolitan, Cheingmai, and Surin. After the respondents completed the questionnaires the data were analysed with descriptive statistics; SPSS were performed post hoc for analysis. The colour scheme received the highest preferences scale for home textile products made from silk fabric was the earth tone with harmonised colours combination.

STUDY OF CHINESE TRADITIONAL COLOR NAMES

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Abstract

During thousand years in Chinese history, lots of colors were named and used in people’s life. And now, some traditional color names are still alive in the modern language, and the others are not used at all. For collecting and saving the name, cultural content and connotation of Chinese traditional colors, questionnaire with 386 colors were made for investigation among 1824 individuals of different ages and education backgrounds in China. 166 color names commonly used are chosen to representative of traditional Chinese color names, and the appearance information of the colors is collected, which include: traditional color names, habitual color names, colorimetric values and grades in Chinese color system.

Keywords: Chinese traditional color, color name, Chinese color system

1. Introduction

During thousands of years, Chinese ancient literatures showed the variety of quantities, meanings and applications of color names, from the Pre-Qin period (BC1100) to Qing dynasty (AD1900), and some of them were reserved till today and still commonly used in the modern language, are called traditional color names.

Traditional color names of China are closely related to Chinese culture and people’ life, and in some degree, are the symbol of one time. To identify the relation of appearances and names of Chinese traditional colors will supply some useful information in traditional culture study and modern industry design and so on. For this purpose, the project of recording and naming traditional colors in China is executed from 2011 to 2013.

2. Procedure and methods

The researching procedure of naming traditional colors is shown in figure 1:
1) 1600 traditional color names are collected referring to ancient literatures and literature reviews[1-76].
2) Compare with existed research results and publications [77-81], and measure representative samples, such as cloisonne, Nanjing brocade, almost 500 color samples and color values are collected.
3) 700 traditional color names are left in the first trial after classifying, combining and deleting, and 386 color values are chose for making color cards (some color names have same color values).
4) A large-scale questionnaire survey has been conducted with the color cards (386 color in one set) and, habitual color names are collected, more information of the questionnaire survey is shown in table 1.
5) Traditional color names, habitual color names, colorimetric values and grades in Chinese color system is specified basing on the data of the questionnaire survey.
6) 166 traditional color names are selected, and then standard color cards are made.

Table 1 Information of the questionnaire survey

Quantity of questionnaires		Gender of participants		Scope of survey			
total	valid	Male	Female	Provinces	municipalities	Citys /counties	ethnic groups
2200	1824	850	974	27	4	185	34
Education level				Ages			

Primary school	Junior school	High school	College school	Under 18	18~35	36~60	Above 60
49	258	713	804	6	756	1032	30

Oral paper

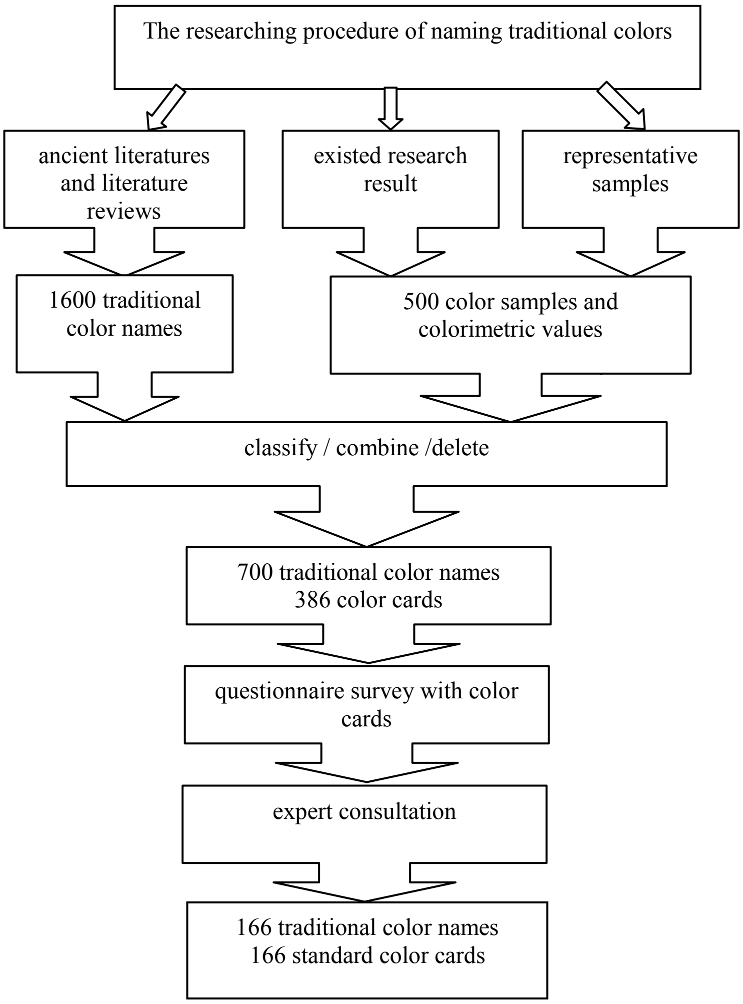

Figure 1. The researching procedure of naming traditional colors

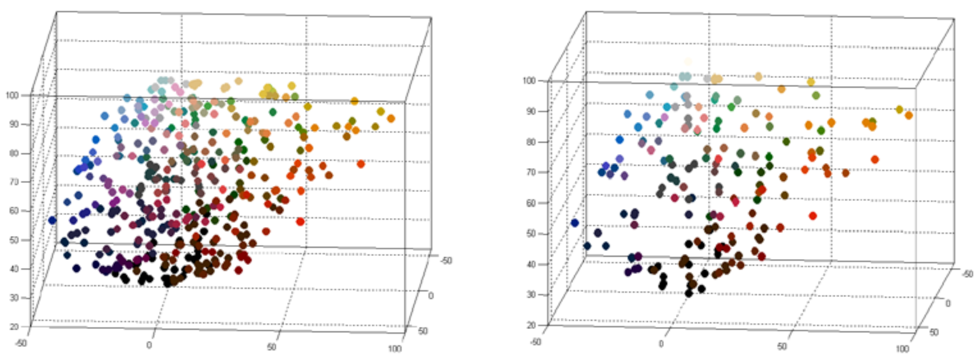

Figure 2. The values of 386 color cards (left) and 166 traditional colors (right) in L*a*b*

3. Results

Base on the ancient literature query and the questionnaire survey results, 166 color names with their appearances are identified, including 155 chromatic samples and 11 achromatic samples. The appearance information include: traditional color names, habitual color names, colorimetric values and grades in Chinese color system.These colors are classified into 8 color groups, which named brown, red, orange, yellow, green, blue, cyan and purple. Each color is given by two names, one is traditional color name, and the other is habitual color name, the former comes from ancient literature, and the latter comes from the questionnaire statistics, and in some occasions, the latter is just same as the former, and sometimes one color corresponds to two habitual color names.

Besides names, each color is specified by their CIE colorimetric values (Y_{10}, x_{10}, y_{10}) and the corresponding grade (H, V, C) in the Chinese Color System. For Example, the traditional name of No.7 color is “鹰背褐”（means “the eagle back brown”）, its habitual color name is “黄褐”(yellow-brown) or “深棕”（deep brown）, and the colorimetric value of it expressed by Y=8.0, x=0.681, y=0.369,(CIE standard illuminant D65, CIE1931 standard colorimetric observer) and in Chinese Color System, its grade is expressed by H=1.7Y, V=3.4, C=2.1.

Standard color cards of traditional color names in China will be published in the next year, and the tolerance for the chromatic and achromatic cards are $\Delta E^*_{ab} \le 2.0$ and $\Delta E^*_{ab} \le 1.0$ respectively.

4. Conclusions

166 colors with traditional and habitual names are identified base on the combination of ancient literature query and the questionnaire survey results, and their CIE colorimetric values and corresponding grade in the Chinese Color System is specified.

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Oral paper

Oral paper OA31

EVALUATION OF DISCOMFORT GLARE FROM COLOR LEDS UNDER DIFFERENT ILLUMINANCE

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Keywords: color vision: discomfort glare: color LED: elderly vision

ABSTRACT

This experiment aim to investigate the discomfort glare from the color LEDs on young and elderly under 3 different illuminance, 0, 100 lx, and 800 lx. Four color LED lamps, red, green, blue and yellow were used as stimuli. Five young observers and 2 elderly with normal vision participated in the experiment. The intensity of the LED lamp was controlled to give 4 levels. The observers evaluated discomfort glare subjectively in 8 levels scale [1]. The experiment was repeated 5 times. The result shows that as the intensity of the LED increase the degree of discomfort glare increases. By contrast, the illumination of the room, when the surrounding light increases, the degree of discomfort glare decreases. The discomfort glare affects the elderly more than the young subjects in most conditions. The blue LED causes discomfort glare more than the others.

INTRODUCTION

LEDs are increasingly used in various fields: entertainment, advertisement, house hold products automobiles and including traffic signs. As it is a kind of light source, it‘s ray shines directly into the eyes. Without precaution this might cause discomfort glare. Many research works concerned discomfort glare of automobiles have been published [1]. Glare occurs when scattered light in the optic media reduces the clarity of visual images. These effects on young and older adults are different in degrees. Beginning in the fifth decade, age-related changes increase a person’s sensitivity to glare and time required to recover from glare [2]. Functionally, these age-related changes can significantly affected the person’s ability to read signs, see objects, drive at night and maneuver safely in bright environment. This experiment was aimed to investigate discomfort glare of color LEDs in young and elderly people under different illumunance 0,100, 800 lx.

EXPERIMENT

LED stimuli preparation: The LED stripes, red, green, blue and yellow were arranged into array of 7 by 6, 7 lines each line contained 6 LED lamps. They were pasted on 8 x 8 cm^2 a white rigid plastic plate. One color was on one plate. They were separately wired and connected to a control knob which was used to adjust the intensity of the LEDs. Each LED plate was placed in a slot fixed behind the wall of the experiment room.

Table 1 LED luminance.

Log Luminance of LED			
Y	**G**	**R**	**B**
2.1	2.1	2.1	1.7
2.7	2.7	2.7	2.1
2.9	2.9	2.9	2.7
3.1	3.7	3.1	2.9

The experimental room was constructed in dimensions of 1.5 m width x 2 m length x 2.15 m height. The walls were covered with near neutral white wall paper. And it was decorated with pictures, bookshelf, dolls and flowers to look as a normal living room. There was 7 x 7 cm^2 hole on the wall at eye level when subject sitting. The subject could see the LED array through it. There were 6 fluorescent lamps on the ceiling. The intensity was able to adjust by the controller knobs.

Experiment conditions: The color LEDs were adjusted to obtain the 4 levels of log luminance as in Table 1. The researcher wanted to set the same 4 levels for all color LEDs but there were limitation of the LEDs. The blue LED could be adjusted as high as 2.9 cd/m^2. Thus the blue was set start from log 1.7, cd/m^2. The other LEDs were not able to adjust at this point because they blinked. The color luminance meter, Minolta CS-A100 was used to measure the LED arrays randomly at 3 positions and then averaged and marked on the control knob .The luminance was checked from time to time during the experiment. The illuminance of the subject room were set at 3 levels,0 lx, 100 lx and 800 lx, measured at the fixed position on the shelf in front of the LED slot. The each test stimuli was randomly presented at a time under each illuminance level. The distance between LED and observer was 1.5 m.

The 5 young student's age 20 – 23 years and 2 elderly age 62 and 68 years, with normal vision, participated in the experiment. They were instructed to evaluate the discomfort glare of the LED stimuli subjectively in 9 scales as the Kimura-minoda and Ayama's experiment [1]. However, in this experiment only 8 scales could be evaluated because of the different technique of presenting the LED. The scales ranged from unbearable, disturbing, just acceptable, satisfactory and just noticeable (9) was omitted. The young subjects repeated all combinations 5 times. The two elderly repeated only 3 times.

RESULTS AND DISCUSSION

Figure 1 and figure 2 show the subjective evaluations of a young observer AP and an elderly PP respectively. When intensity of the LEDs increases, the subjective evaluations decrease. As the illuminance of the experimental room increases the satisfaction increases, which means lesser discomfort glare. The results of average of 5 young, solid lines and subjects and 2 older adults, doted lines, are shown in figure 3. All the curves show the same tendency for all illuminance conditions. That means the stronger the LEDs' intensity the more discomfort glare occurs for both young and elderly subjects. But the degree of effect of these two groups is not the same.

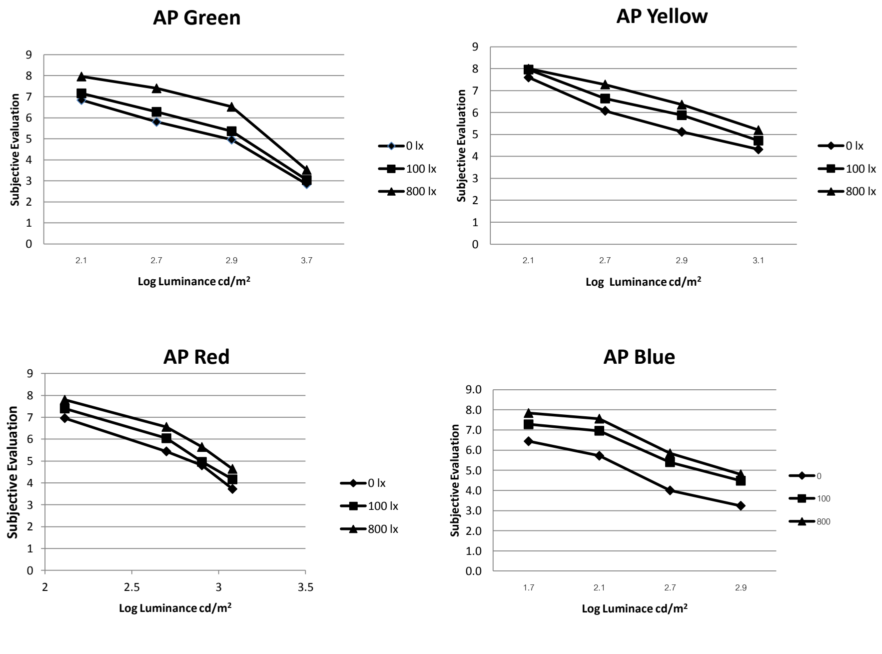

Figure.1 Subjective evaluation of AP

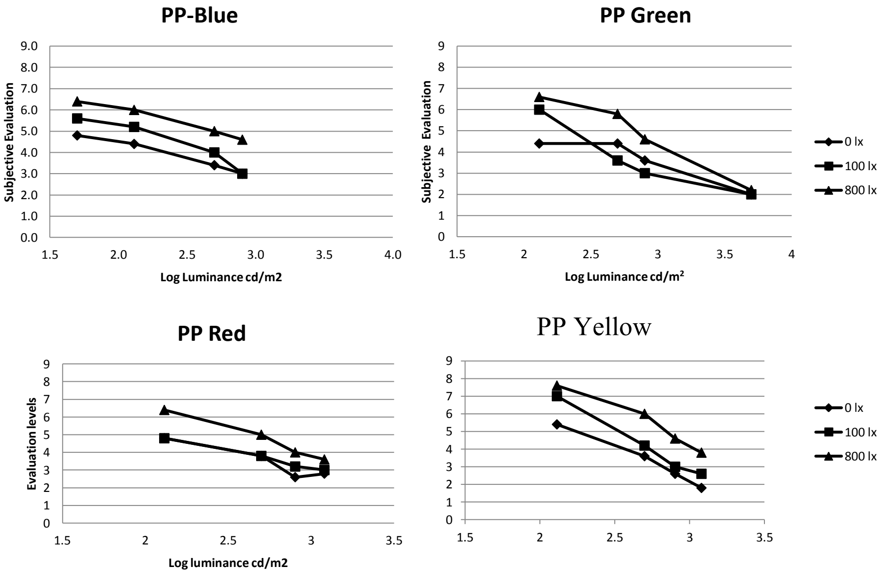

Figure.2 Subjective evaluation of PP

In figure 3, the dotted lines are lower than the solid lines. This mean the older subjects are more sensitive to discomfort glare than the young ones. This result agrees with the finding of Miller [2]. At 0 lx, discomfort glare has the strongest effect compare to 100 lx and 800 lx. The curves of yellow LED show that the illuminance conditions have very little effect on the young observers. The average subjective evaluations on color LEDs of 5 young subjects under 0 lx and 800 lx are shown in figure 4. The blue LED causes more discomfort glare than the other colors. Though at 800 lx, the effect of all color LEDs are almost the same

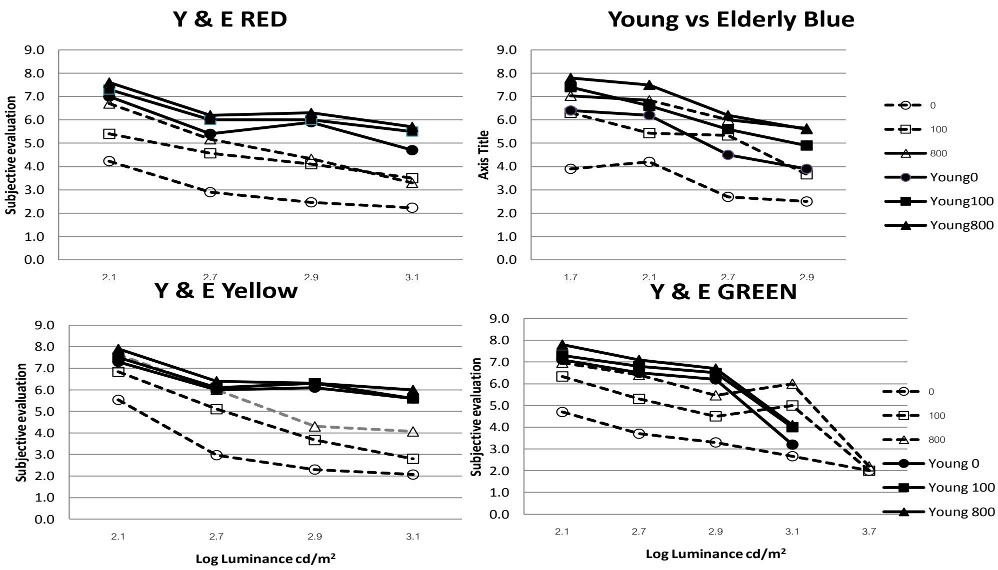

Figure 3 Average subjective evaluations of 5 young subject and 2 elderly.

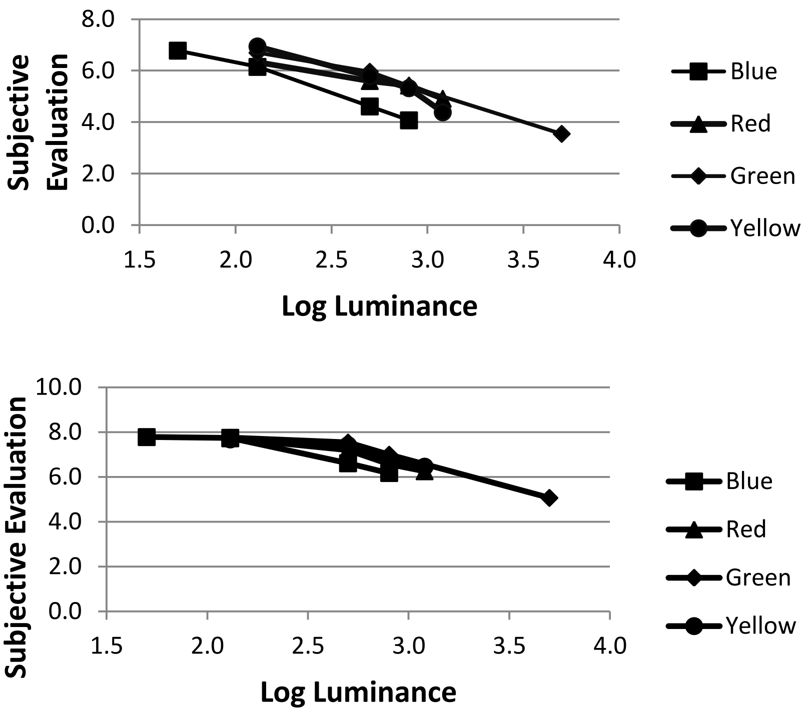

Figure 4 The average subjective evaluation of 5 young subjects under 0 lx and 800 lx.

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DISTINGUISHED COLOR GRAPHIC SIGNS FOR THE ELDERLY UNDER DIFFERENT ILLUMINANCE LEVELS

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Keywords: color appearance: elderly vision: color vision

ABSTRACT

The objective of this study was to examine the color vision of elderly for color graphic signs under different illuminance. The subjects of 50 elderly age 60 years and over, lived in Bangsaen Community, Chonburi province. A caution school sign, consist of a man and a child, was selected as the stimuli. They were designed in two styles. One was color figure on white background in a frame of the same color. Another was white figure on color background. Red, green, blue, cyan, magenta orange and yellow colors were used. Only the yellow color was designed in combination with black. The experiment was conducted under the ambient light with 2 conditions. High illuminance was above 3000 lx and lower one was below 300 lx. The size of the test charts were 27 X 27 cm^2. The distance between the stimuli and the observer was 10 meters. All 14 stimuli presented to an elderly at one time. She/he was asked to choose the most outstanding one. Under the high illuminance 24 % chose the reverse cyan sign and at lower light, 20% selected the reverse red as the most distinguished sign.

INTRODUCTION

Aging societies seem to be developing all over the world. By the year 2020, more than one billion people worldwide will be age 60 years and over. At the present, Thailand aging has become a global phenomenon. The increasing rate of elderly affects the health problem and life style of themselves. Age-related changes of the biological are affect to physiological function, such as, changes in structure and function of vision. Nowadays most of information is from the visual media. Thus visual impairment might reduce the quality of life of the elderly. To make the proper environment in such a way that the elderly be able to spend their life by themselves is the most economical way. This research is aim to investigate the color vision of the elderly under different illuminance. We chose the below 300 lx for low illuminance because from the previous survey we found that most of private residents the lighting is much lower than 300lx. And above 3000 lx employed as high illuminace, because we concerned the safety of the subjects avoid to experiment under strong sun light. The experiment was designed to conduct under the real situation. A caution school sign, consist of graphic figure of a man and a child was selected as the stimulus [1]. Eight basic colors used for traffic and safety sign were applied to the graphic figures [2]. The 50 local elderly living in Bangsaen community were employed as the observers to evaluate the color graphic signs.

EXPERIMENT PROCEDURE.

Stimuli preparation: The school sign was selected as graphic figure for the test stimuli. It composes of figure of a man and a girl hold hands. I chose this sign because there were two sizes figures together in one sign which gave more details than others. The colors were chosen according to those used for traffic sign and safety sign regulation [2]. These are red, green, blue, yellow, black, cyan and white. Magenta and orange were also added to provide more alternative colors. All colors were designed to fill the figure of the school sign as the solid color on white background, with the same color frame, except yellow and black. The yellow figure was designed on black background. Another set of color stimuli were designed as reverse color figures as shown in figure 1. The size of the sign was 27 X 27.cm^2. Altogether there were 14 stimuli.

Solid color in white Reverse color

Figure 1. The school sign design in two styles solid color and reverse color.

Fifty elderly aged 60 up, living in Bangsaen community, Chonburi Province were the subjects. The experiment was taken place at the building and large open area nearby where the elderly came to exercise every morning. And another place was at the dormitory in the Faculty of Nursing, Burapha University. The experiment was conducted under the ambient light. There were 2 conditions, inside a building where the illuminance was under 300 lx and outside the building, above 3000 lx.

All 14 test stimuli were randomly hung in two rows on the athletes nest. The test set was carefully placed so that every stimulus was similarly illuminated. They were presented to the elderly inside the building illuminance was measured in front of the stimuli horizontally. And in case of outside the building the setting was the same. The distance between the stimuli and the subject was 10 meters. Thus the visual angle was 1.5 degrees. This visual angle was employed to make sure that most of elderly was able to see the color correctly [3]. In open area the stimuli was carefully placed in the direction that no direct light shine toward the subjects to avoid glare. Each subject was asked to tell the number of the stimuli which appeared the most distinguished to her/him. The test was done one by one.

RESULTS AND DISCUSSIONS

The results are shown in figure 2. The histograms show the number of elderly who selected the color stimulus under low illuminance and high illuminance in percentage. Under low illuminance the reverse red sign has the highest percentage 20 and under high illumunace the reverse cyan sign employs the highest percentage 24. The second rank is black figure on yellow background and reverse cyan have the same 14% under the lower illuminance. For high illuminance second rank is yellow figure on black background 16 %. In figure 3 the reverse color signs have the higher percentage compare to the same solid colors on white background under low light surrounding. The yellow and black combinations, under high illuminance the yellow on black background and the reverse design are small difference, 16% and 14%. In the low lighting, the yellow figure is only 2% but the black figure is 14%. No one chose red, magenta and orange signs. In contrary reverse magenta sign is 12% under high and low light. But the orange reverse is very low in both conditions 0 and 2%.

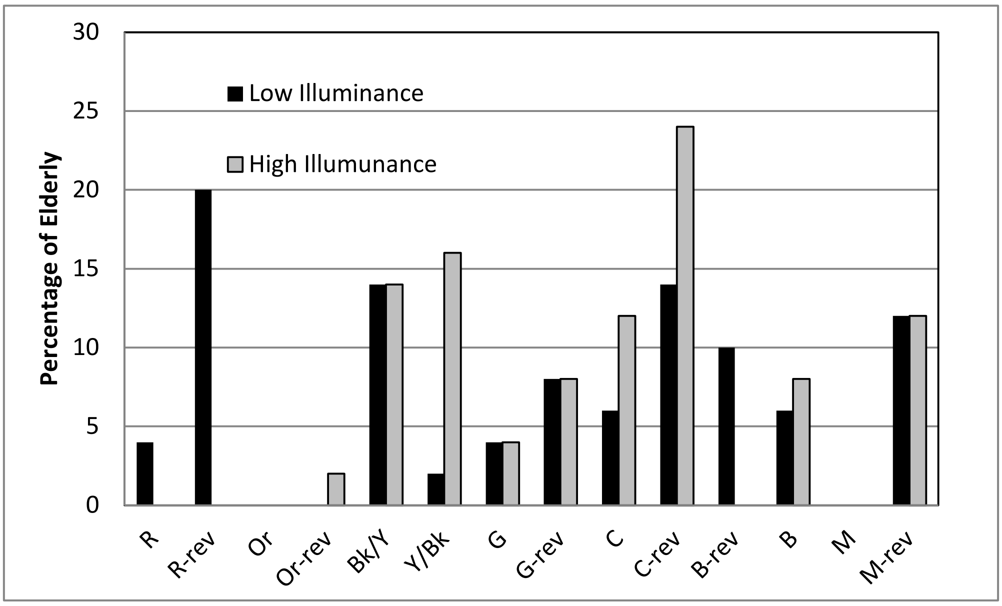

Figure 2 Histograms show the percentage of elderly selected the clearest color graphic signs under high and low illuminance.

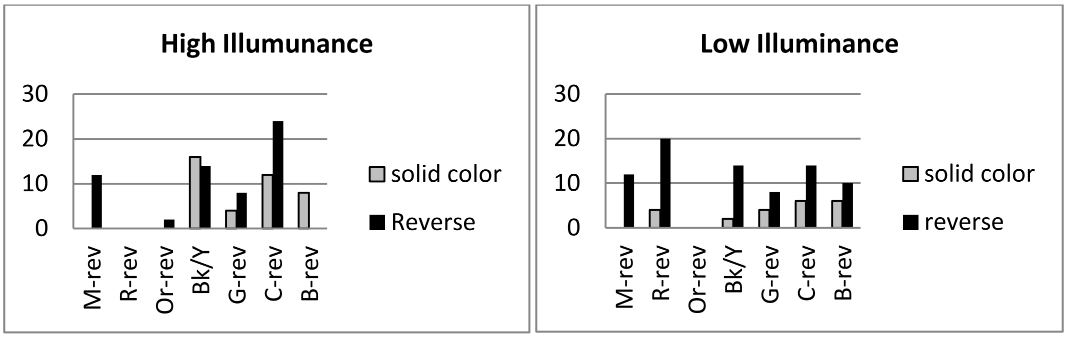

Figure 3 Comparison of solid color and reverse color styles.

The color graphic sign with white figure in cyan background appears the most distinguished to the elderly in the open area. But in lower illuminance, inside the building the white figure in red background is the most distinguished one. The graphic sign with more color area, reverse color sign is easier to see than the solid color in white background. This can be explained that the white background might have glare in bright surrounding, which causes desaturate color of the figure. This effect much more pronounces for the elderly with cataract eyes[4], [5], [6].

The color stimuli which being selected with the same percentages, under both conditions, are black figure in yellow background 14%, reverse magenta 12%, green reverse 8% and white in green 4%. The level of illuminance does not affect these color graphic signs.

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ELDERLY VISION ON LEGIBILITY OF THAI LETTERS PRESENTED ON LED PANEL

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Keywords: Cataract Experiencing Goggle, Elderly Vision,

ABSTRACT

Some of Thai letter differ from their similar letter only the length of the letter tail or the gap inside the letter. Presenting Thai letter on LED panel may cause the difficulty for elderly people to discriminate the letters, because the glare from the bright part (text itself or background) of LED panel may obscure letter details. The objective of this research is to investigate the legibility of Thai letters presented on the LED panel with the real and simulated elderly people. The stimuli were sets of Thai letters varied on their size. The letters were black and presented on white background. Subjects were asked to read the random letters. We found that result of the young and the simulated elderly are quite similar whereas the smallest legible letter size of the real elderly is larger than those of two groups.

INTRODUCTION

LED panel is now widely used to present information because the LED panel can present variable and up-to-date information. Since the LED panel is self-emitting source, no additional projected light is required even if the LED is used to present information in dark place. Figure 1 shows an example of Thai letters. Thai letters in the above line are quite similar to the below letter in the same column. The difference between these pairs is only the direction of letter head, or the existence of letter head or the gap inside the letter. When Thai letters are presented on the LED panel, there is not much difficulty for young people to read it. However, elderly people possibly suffer than young people because the elderly vision suffers from scattered light due to cataract in their eyes. The glare from the bright part of the LED panel may obscure letter's details. To help the elderly see Thai letters clearly, larger Thai letter size is possibly required. The objective of this research is then to investigate the legibility of Thai letters presented on the LED panel. Thai letters varied on their size were presented to the young and the elderly. They were asked to read the random letters under a dark or bright environment.

ส ก ค ม พ ช ร
ล ถ ด น ฬ ซ ธ

Figure 1 Example of similar letters

Oral paper

METHODOLOGY

Apparatus

The schematic diagram of apparatus was illustrated in Figure 2. Two rooms (subject room and test room) were separated by a wall with a square aperture. Both rooms were covered by black curtain in order to avoid undesirable light from outside. An LED panel (Toshiba LED40PU200T) was placed in the test room and connected to a PC via HDMI cable. This LED panel was used to present stimuli in this experiment. In the subject room, the inside wall was covered with white wall paper. A set of intensity-controllable fluorescent lamp was attached on the ceiling. The subject room illuminance was measured by Minolta CL-200A placed on the shelf closed to the front wall. On the front wall, there was a 5 cm × 30 cm aperture placed at the subject eye's level. The distance between the front wall and the subject's eye was fixed at 2 m. A cataract experiencing goggle is used to simulate elderly vision. The cataract experiencing goggle is made from three filters (58% transmittance filter, 14% of haze values filter and yellow filter. [1]

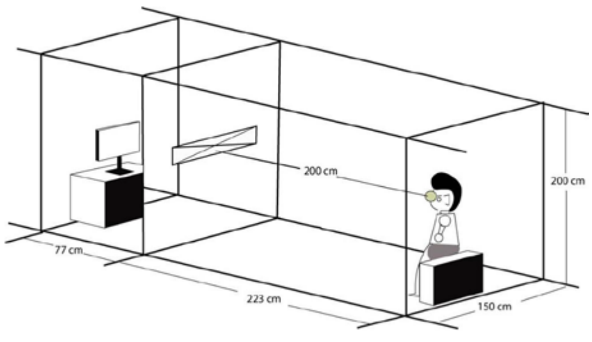

Figure 2 Schematic diagrams of the apparatus

Subjects

Ten undergraduate students (age: 22-25) and three elderly (age: 55-59) were participated in this experiment. All subjects had normal or corrected to normal visual acuity.

Experimental Conditions

The experimental conditions consisted of two levels of subject's room Illuminance (0 and 300 lux). Five letter's size is selected in this experiment. The RGB values of text and background are "0, 0, 0" and "255, 255, 255", respectively. The stimulus is a line of ten Thai letters which are randomly selected.

Experimental Procedure

The subject was asked to complete two tasks in two separated session. The first task is reading task. The experimenter set one of two illuminance level for each experimental session. One subject was asked to sit in the experimental room and look around inside the room for two minutes. After two-minute adaptation, a line of ten random Thai letters was presented. The subject was asked to read each letter. The experimenter will record %correction of each line. After finishing, a new line of ten letters with different letter's size is presented. The procedure is repeated until all letter's size is tested.

RESULT AND DISCUSSION

Figure 2 shows relationship between Thai letter size and percentage of correct responses from the young (square), the simulated elderly (circle) and the elderly (triangle). The solid line and dashed line represent the results when the subject room's illuminance is set at 0 lux and 300 lux, respectively. To compare between results of the young and the simulated elderly who are the young wearing cataract experiencing goggle, the results are quite similar. The percentages of correct response of the simulated elderly are slightly lower than those of the young. When the effect of the subject room's illuminance is considered, both groups of subject show just slightly better reading performance under dark room than under bright ambient illuminance. Our result agrees well with previous research. Waleetorncheepsawat [2] applied two-room technique, where the letter chart is illuminated independently from the light illuminated in the subject room, in his legibility test. He found that the reading performance of the simulated elderly is improved and nearly equal to the reading performance of the young. Our experimental setup then can be compared to Waleetorncheepsawat's two-room technique that presenting letter on LED panel, which is a self emitting source is similar to presenting letter chart with independent illuminance in the test room in his condition. Our result, therefore, show the same tendency as Waleetorncheepsawat's result. Both groups require the same letter size to maintain the legibility of letter on LED panel.

When the elderly participated in this experiment, the results of the elderly are quite different from both previous groups. The percentage of correct reading suddenly decreases when letter size changes from 0.20◦ to 0.18◦. At the 0.18◦ letter size, the performance of the elderly is only around 15% correct compared to around 50-65% correct of the simulated elderly's reading. To compare between dark room and bright room condition, we found that the legibility of letter is similar when letter size is smaller than 0.20◦. When the letter is larger than 0.20◦, the letters are more legible under the dark room than under the bright room.

Note that there is significant difference between the result of the elderly and the simulate elderly in our experiment. This difference is possibly due to the imperfect simulation of elderly vision by the cataract experiencing goggle. Since the cataract experiencing goggle was developed to simulate elderly vision on color, we are not sure that the goggle can perfectly simulate the elderly vision in legibility test. It is, therefore, interesting to improve the cataract experiencing goggle for use in legibility test.

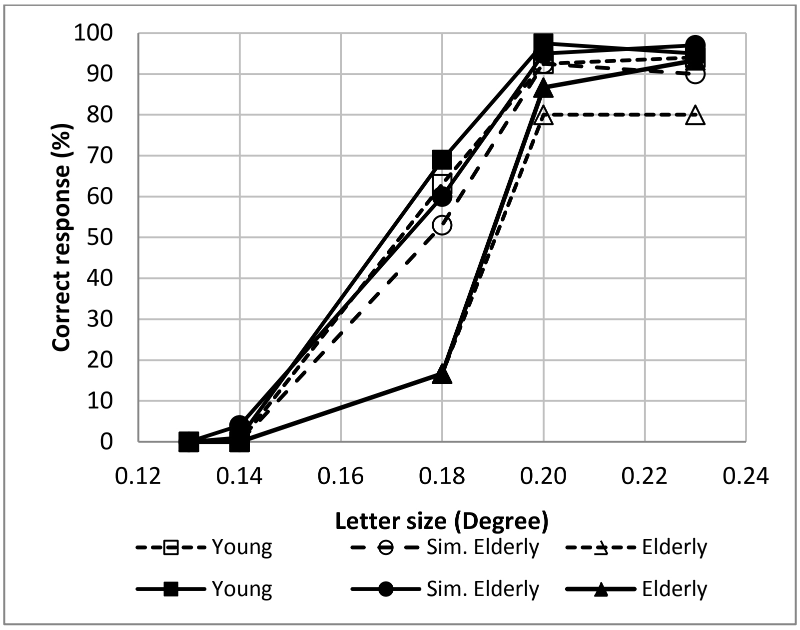

Figure 2 Average % correct response. Solid lines and dashed lines represent results under 0 and 300 lux illuminance, respectively.

Oral paper

CONCLUSION

Our results indicated that the minimum legible letter size for the elderly is larger than those of the young. The minimum letter size should be larger than 0.18◦. We will conduct further experiment to confirm the exact recommended letter size not only in term of legibility but also reading comfort in order to standardize the use of Thai letter on LED panel.

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Oral paper OA34

PROPER-SIZED THAI LETTERS ON DIFFERENT BACKGROUND CONTRASTS AND ILLUMINATION ENVIRONMENT SUITABLE FOR ELDERLIES.

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Keywords: cataract experiencing goggles; legibility; cataract; contrast; illumination

ABSTRACT

Printed labels represent visual environment as they are the targets for getting information of the products. They have been found to be expressed by so small letters and are too difficult for elderlies to read. A serious problem of the visual performance of the elderlies come from the cloudy crystalline lens of the cataract that scatters the incoming light all over the retina. The cataract experiencing goggles composed of color filter, brightness filter, and haze filter that together simulate the elderly vision with cataract. This study experimented on young observers wearing cataract experiencing goggles for the result of elderlies cataract vision on Thai letters legibility. The Thai letters test charts of varying letter sizes for adjustment experiment method made into 3 sets of different backgrounds. The one-room and two-room experimental techniques for different illumination environment study was experimented. Different background contrasts gave different results especially the lower contrast gave worse result for the cataract vision. The two-room technique preserves cataract vision to be as good as normal vision.

INTRODUCTION

The elderly population in Thailand is increasing, and Thailand is emerging the elderly society. When people get older they get cataract and their visual performance deteriorates [1-2]. It is an urgent matter to investigate the performance of elderly vision and to provide proper infrastructure and environment to assure them the quality of life. In this study we pay attention to letter size and background contrast of product labels as the elderly people get information from labels for their daily living. Legibility by elderly people has been investigated by some researchers, Elliott et al. [3] for English, and Ayama et al. [4] for Japanese. They all showed deterioration of the visual acuity by elderly people. But in our knowledge, none investigated for Thai letters and no proposal was made for the Thai letter size recommended for labels to suit elderly people. Thai letters are different from English or Japanese letters. as seen in Figure 1.

The study on legibility was mainly done with high contrast letters, either positive or negative contrast. In the real product labels there are variation of contrast on product labels. It is needed to investigate the minimum letter height of Thai letter visible by elderly people. We employ the cataract experiencing goggles developed by Panasonic in stead of employing real elderly observers. The goggles are composed of density filter, color filter, and haze filter which simulate elderly vision that has cataract in their eyes in the level of the irritating stage that begin to cause some inconvenience in their daily life [5].

The visual performance changes depending on the illuminance level and the contrast of the stimulus. We measured the minimal Thai letter size legible with goggles worn by young subjects under the various illuminance levels and different background contrasts. The same experiment is done for the same young subjects without the goggles to compare visual performance deteriorates when people get older. To observe the effect of environmental illuminance the 2-room concept developed by Ikeda et al. [6-7] were employed. The subject room and the test room are separated by a wall with a viewing window so that the environment light which caused the scattered light into the eyes was reduced.

EXPERIMENT

The letter charts were made with 24 varying letter size which were logarithmically linear distributed for visual angle increment of 0.05 minutes. The 3 charts backgrounds were white, N5 and N4 equivalent in lightness value. Letter charts in each backgrounds are shown in Figure 1.

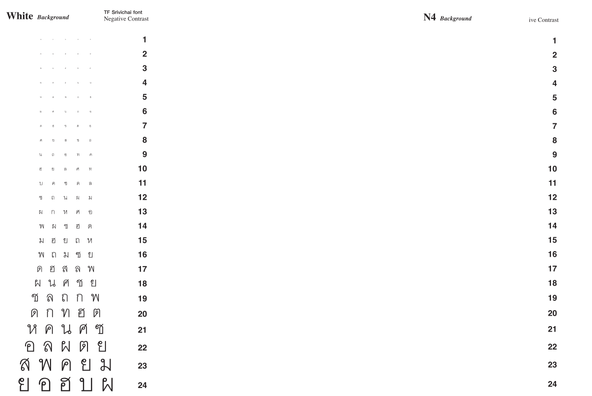

Figure 1. Test charts in White, N5 and N4 backgrounds.

The adjustment experimental method was used for acquiring the 100% correct response of letter legibility under each illumination levels and background contrasts. Figure 2 shows the adjustment procedure in the one-room experimental room. The cataract experiencing goggles were worn to simulate cataract vision in comparison to the normal eyes of the other session. Five subjects aged 25-35 years old experimented for normal eyes and eyes with goggles. The 1-room and 2-room experiment were conducted for comparison of illumination environment affect on legibility. Experimental conditions for 1-room and 2-room were concluded in Table 1.

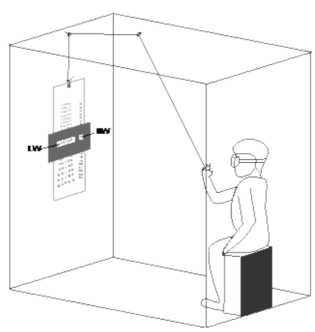

Figure 2. Subject performs adjustment method in 1-room with goggles wearing on.

Table 1. Experimental conditions

Experiment	1-room Conditions	2-room Conditions
Subject room illuminance (lx)	20, 80, 280, 800, 1500	0, 5, 20, 80, 280, 800, 1500
Test room illuminance (lx)	-	280
Font type	TF Srivichai	TF Srivichai
Background contrast	White, N5, N4	White, N5, N4
Goggles	Off, On	Off, On
Viewing distance (cm)	120	150
Repeating (sessions)	10	5

RESULT

The results from 1-room experiment showed that legibility of eyes with goggles lowered when illumination decreased from 800 lx to 20 lx, compared to normal eyes. The result of darker background or lower contrast label showed that eyes with goggles were greatly affected with the lowered illumination, while the normal eyes were not much affected, as demonstrated in Figure 3.

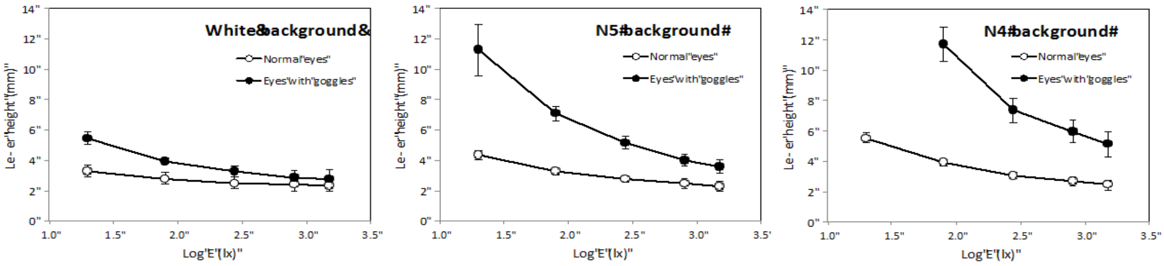

Figure 3. Letter height comparison on 3 backgrounds for 1-room.

The results from 2-room experiment showed that legibility of eyes with goggles preserved when illumination of subject room was not higher than illumination of the test room (dotted vertical line). The result from lower contrast backgrounds showed greatly deteriorated legibility on eyes with goggles while not much affect on normal eyes, as shown in Figure 4.

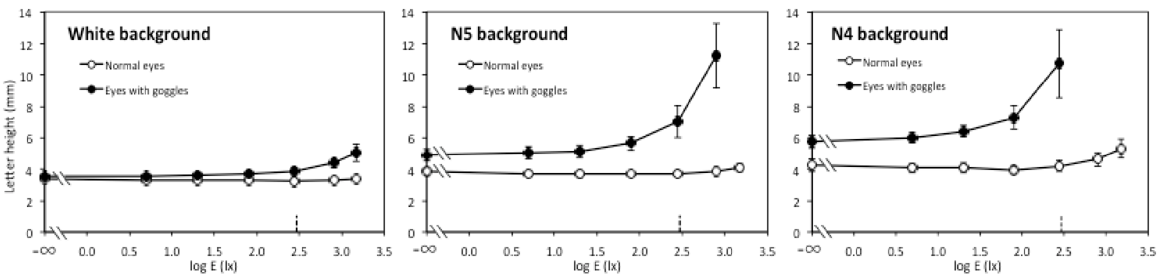

Figure 4. Letter height comparison on 3 backgrounds for 2-room.

The integrated analysis of 1-room and 2-room comparing visual angle of 100% correct reading showed that eyes with goggles suffered a lot when background contrast is lowered compared to normal eyes, as shown in Figure 5 of N4 backgrounds. However, the reduction of subject room illumination can improve legibility greatly for the eyes with goggles.

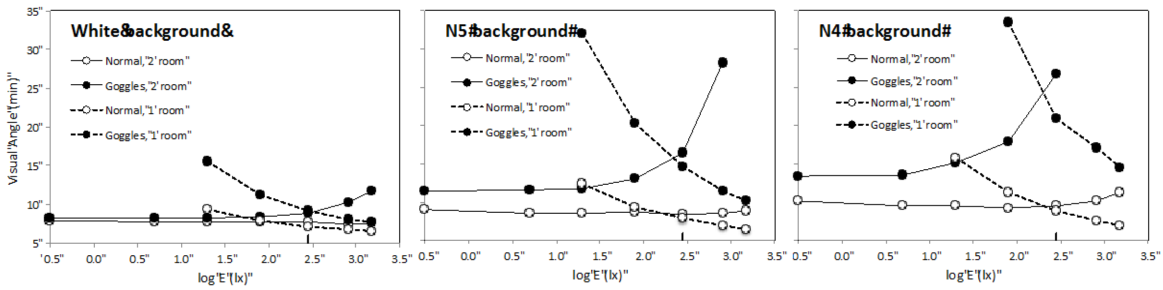

Figure 5. Compare result of 1-room and 2-room

CONCLUSION

Legibility of cataract eyes lowered substantially when illumination decreased from 800 lx to 20 lx, compared to normal eyes. The deterioration increased when background contrast decreased. The lower contrast labels greatly affect legibility of cataract eyes or elderly vision, compared to higher contrast labels. The letter sizes, background contrast, and illumination factors should be together concerned to prepare labels suitable for elderly. The 2-room illumination system where light in the subject room was kept low and light at stimulus area was normal, is suitable for elderly. The environment light should be controlled to avoid the direct scattering to elderly eyes.

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COLOR CONSPICUITY FOR SINGLE COLOR AFFECTED BY COLOR ATTRIBUTES

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Keywords: Color conspicuity, monochromatic design, ecological designs

ABSTRACT

Color conspicuity, although, has been investigated since the early times, it remains a source of debate among the public in many fields such as advertisings, product design, packaging and so on. It is well known that a colorful design catches a customer's attention. This design is required to use more inks in printing process. As environmental conservation issue, monochromatic design is one of methods in ecological designs, using ink decreasing technique. The major aim of this study, hence, is to investigate the effect of monochromatic design on color conspicuity. A psychophysical experiment was carried out to examine the relationship between color conspicuity and color attributes. Fifty-two color chips in Munsell notation varying in hues and chromas were simulated on monitor as stimulus. Ten subjects were asked to evaluate a color conspicuity score for given color by using a conspicuity rating scale. The experimental results showed that the color conspicuity score correlates with chromaticness and lightness. The empirical evidence reveals that it might be possible to use monochromatic designing technique as an application for ecological design.

INTRODUCTION

Color was often considered as an important element in customer choice. The Institute for Color Research reported that people make a subconscious decision about a product in 90 seconds or less of their first interaction with it, and between 62% and 90% of that assessment is based on color alone. This is especially important for in-store purchases where a product often has little time to make an impression. One of the important roles for catching a customer's attention is to color conspicuity of product package. It indicates a characteristic that which product can be distinguished most clearly among various products. It said to be that a colorful package attracts a subject's attention and to arouse the desire to consume in marketing [1, 2].

Regarding the environmental conservation matter, ecological design in printing seeks to conform to the environment and substantially reduce material consumption. Monochromatic design in printing has been noted as alternative technique as ecological design. Amount of ink on substrates for this design is less than that for color printing in printing process. Moreover, this design reduces the printing troubles and cost of packaging. Although monochromatic design seems to conform to ecological design, the color conspicuity is required for product design. It would like to know how to catch customer's eyes with the monochromatic design. Several factors are said to be responsible for color conspicuity for instance difference in age, gender and so on [3-6]. Color conspicuity, although, had been widely studied, a few studies have concentrated on monochromatic color. In this study, hence, the relationship between color conspicuity and color attributes was explored.

EXPERIMENT

The individuals who took part in the experiment served as subjects were 10 undergraduate student (mean age = 21 years). All subjects had either normal or corrected-to-normal vision. Fifty-two color chips selected from the Munsell Color System were used as the stimuli. The color chips included N5 and eight hues (5R, 5YR, 5Y, 5GY, 5BG, 10B and 5P) varied in different chormas. The Munsell value of all color chips was 5. The xy chromaticity coordinate of them are shown in figure 1. The color stimuli were successively observed through 1^{O} square aperture (T) at a viewing distance of 1.3 m in the windowless room as shown in figure 2. The test stimuli were large enough for the aperture to be filled with the color of one of the stimuli. All subjects received verbal instruction about task before the assessment. Subjects were asked to judge the degree of color conspicuity for each given stimuli by using the scale which divided into 7 level from -3 to +3 according to subject's unnoticeable – noticeable. Within each session, color stimuli were randomly presented on LCD monitor. Each subject did five repeatable to make 260 judgments. No time limits were set for making the judgments.

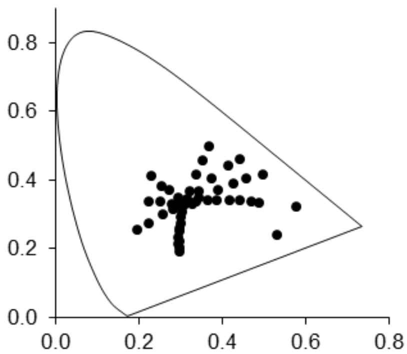

Figure 1 *xy chromaticity coordinate of stimuli.*

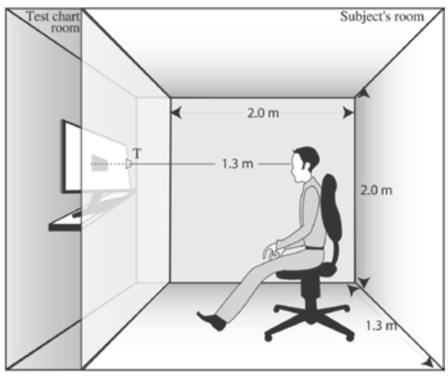

Figure 2 *Schematic diagram of the apparatus.*

RESULTS AND DISCUSSIONS

For each color stimuli, the color conspicuity scores from all subjects were averaged. Figure 3 shows the effect of the Munsell chroma (a) and Munsell value (b) on color conspicuity. As seen in figure 3 (a) the results showed that color conspicuity score increased when the Munsell chroma was increased and then gradually dropped off after Munsell chroma 8. The same tendency occurred in all hues. This implied that the vivid color was not ranked as the most conspicuous color. In addition, figure 3 (b) showed that the higher the Munsell value of the color stimuli, the higher the color conspicuity score. This suggests that a brighter color reaches the target of color conspicuity.

Next, we sought possible correlations between the color conspicuity and the color attributes. The CIE-Yxy value of each color stimuli was measured from the observational position using Minalta CS-100A chroma meter. Then the CIE-Yxy value was converted to CIEL*a*b* in order to investigation. Figure 4 showed the correlation between color conspicuity and hue angle (h_{ab}). The results seem to be no correlation between them. The result differs from the previous study. An effect of hue on color conspicuity was founded by many researches [3-8]. However, we thought that the contradict result may be effect by a low number of test stimuli and subjects. In the future work, then, more subjects and test stimuli will be recruited.

In addition, the relationship between color conspicuity and chromaticness (C^*_{ab}) is expressed in figure 5. The results corresponded to figure 3 (a). This showed that the color conspicuity score was increased with chromaticness and started to decrease at chromaticness approximately 60. This confirmed that more saturated colors might be inconspicuous.

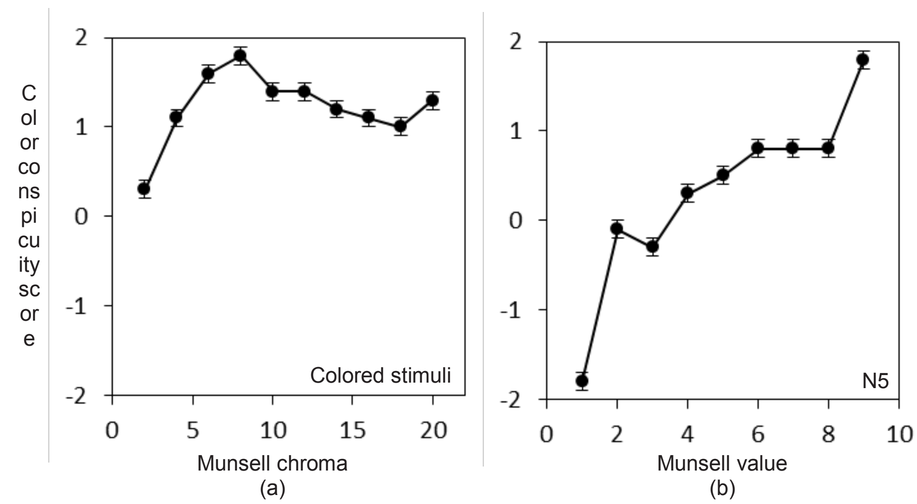

Figure 3 *Mean color conspicuity score plotted against (a) Munsell chroma and (b) Munsell value*

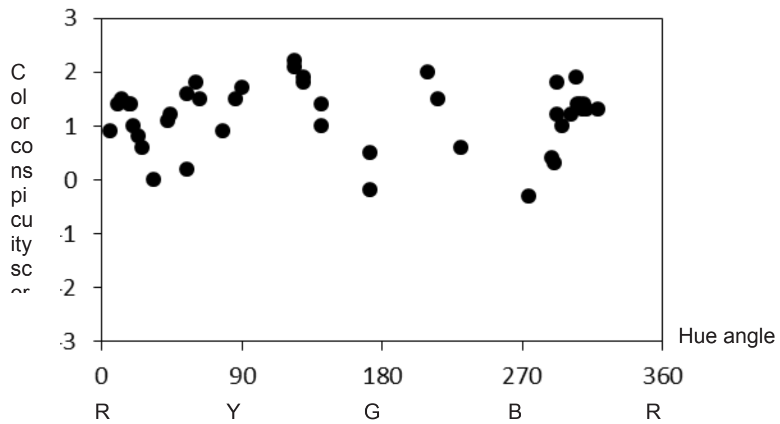

Figure 4 *Mean color conspicuity score plotted against hue angle (h_{ab})*

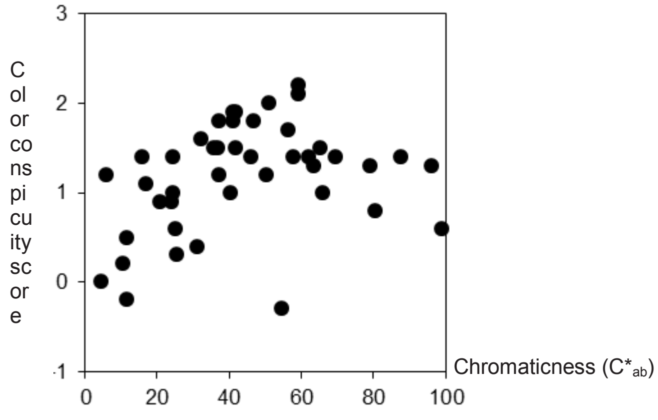

Figure 5 *Mean color conspicuity score plotted against chromaticness (C^*_{ab})*

CONCLUSION

In this study, a psychophysical experiment was carried out to investigate the color attributes effect on color conspicuity. Fifty-two color stimuli varying in hues and chromas were assessed. The findings show that the chromaticness and brightness corresponded to conspicuity score. It was clarified that the more saturated and brighter color would not reach eye-catching. The proper chromaticness and brightness remain a source of debate in the future. However, this study explored that decreasing amount of ink in printing process could be considered as monochromatic printing for ecological design.

Oral paper

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THE HUMAN SKIN COLORIMETRIC AND EALUATION WAY APPLIED SPECTRAL IMAGING WITH 3-DIMENSIONAL SCANNING AND LAPLACIAN FILTER IMAGE PROCESSING

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Keywords: Spectral Imaging, Human Skin, Image Processing

ABSTRACT

The human skin measuring way was applied non-contact spectral imaging. And system was composed by White LED Illumination, Liquid Crystalline Tunable Filter, Pertier cooled monochromatic CCD sensor, Laser projector for 3-Dimensional metric to compensate curvature of image measuring area which related optics geometry of illumination and detection.

Subjects were males and females medial surface of lower arm and measured 420 to 700nm each 10 nm images. Each wavelength images, XYZ, and L*a*b* images were applied Laplacian filter calculation and analyzed correlation between calculated value and each subject age. The results of correlation about human age, Laplacian filter value, wavelength were shown in this study. This colorimetric way was useful and high possibility for evaluation of the human skin and characterizes condition.

INTRODUCTION

The human skin is one of the difficult objects to get high accurate measuring result by ordinary contact type spectrophotometer. As the reason, the human skin surface has extremely complex structure and half-transparence phenomenon. Ideally, non-contact type colorimetric measuring way is necessary. Especially, spectral imaging is useful to measure and evaluate of human skin. On the other hands, human body has curvature and need 3-Dimensional metric to compensate optics geometry. In this study, combined spectral imaging way and lattice pattern projection for measuring part to compensate optics dimension, and applied Laplacian filter calculation to evaluate skin surface.

EXPERIMENT

A gonio-photometric spectral imaging system was applied to measure spectral reflectance and texture of human skin. It was composed of white LED illuminates, a liquid crystalline tunable filter (LCTF), and CCD imaging device with Peltier cooling unit. Illuminates direction were 20 degrees from normal direction, and detect direction was normal against sample, and the CCD device captures the images via the LCTF. And laser projector was applied to get 3-Dimension human skin object by lattice pattern projection to compensate optics geometry and schematic diagram is shown in Figure 1. Left side is optics geometry of measuring system, and right side is captured image of lattice pattern projection on human lower arms. Measuring area was around 10cm by 7.5cm and pixel resolution is 772 by 580 pixels in this area, and resolution is 192 dpi. Measured part of human skin was middle part of lower arm and measured 5 people male and female, ages were around twenties to seventies. Measurement time was need 2 minutes, and arm was fixed during measuring.

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Each wavelength and synthetic Color image under D65 illuminate were shown in Figure 2. There were various textures in each wave length image. Especially long wavelength images see brad tube , and surface texture was very smooth.

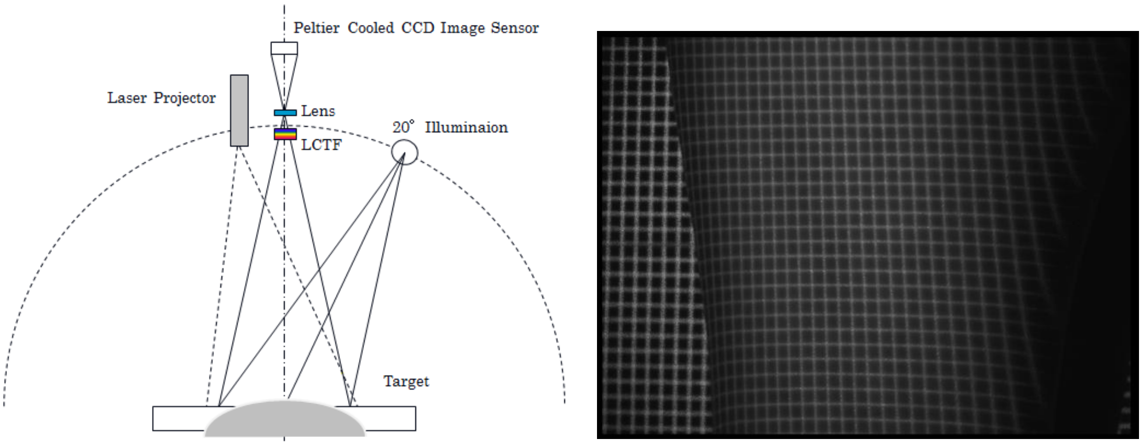

Figure 1. Schematic diagram of measuring system and lattice pattern projection image

Figure 2. Spectral imaging measuring result

After measuring, L*a*b*, XYZ value were calculated from each pixel spectral imaging data under illuminant D65, F10, and A. Each wavelength image, L*, a*, b* image, and XYZ image was applied Laplacian Filter calculated by equation 1.

$$\nabla^2 f(x,y) = \frac{\partial^2 f(x,y)}{\partial x^2} + \frac{\partial^2 f(x,y)}{\partial y^2} = f_{xx}(x,y) + f_{yy}(x,y) \qquad \textbf{(1)}$$

The Laplacian filter calculation way of L*a*b* color image under D65, F10, and A illuminate was applied color difference calculation. Delta E^*_{ab} between two beside pixel is same as deviation. The Laplacian filter calculation way of colour image was applied summation of Delta E^*_{ab} between center and up and down, left and right, total 4 direction pixels.

RESULT

The single wavelength image of 500nm applied Lapracian filter was shown in Figure 3. In this figure, Lapracian filter calculated averaged of 5 different size of area and each size were 3 by 3, 5 by 5, 10 by 10, 20 by 20, and 40 by 40 pixels.

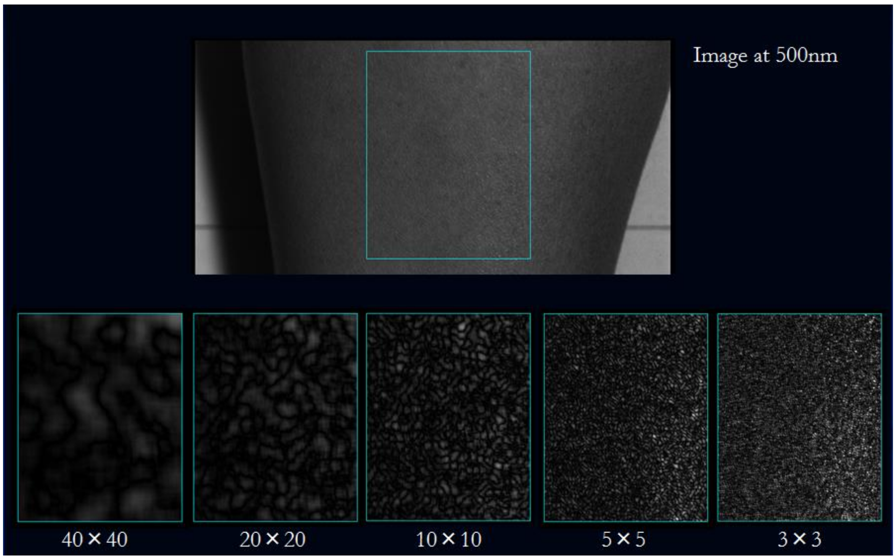

Figure 3. Laplacian filter applied image

The Laplacian value of colour image based on CIELAB coordinate under D65, F10, and A illuminate, average value of each wavelength image were shown in Table 1. Yong age value was smaller than old age, and these Laplacian filter value were correlated with age.

Table 1: Laplacian filter values

Age	20	20	40	50	70
Gender	Female	Male	Female	Male	Female
D65	2.0	3.1	3.2	3.0	4.9
F10	2.6	3.1	3.8	3.2	4.8
A	2.1	2.8	3.6	2.9	4.7
Average of each wavelength	2.2	2.0	3.1	3.0	3.5

Each wavelength image Laplacian filter values are shown in Figure 4. In this figure, horizontal axis is wavelength and vertical axis is filter value. The filter values were depending on wavelength. The long wavelengths between 600nm to 700nm values were smaller than 460nm to 600nm values. Also Laplacian filter values of colour image were depending on illuminate. Especially, in the case of young age and illuminant F10 value was higher than the other illuminant values. These results were indicated human skin image appearance is different under illuminant spectral type.

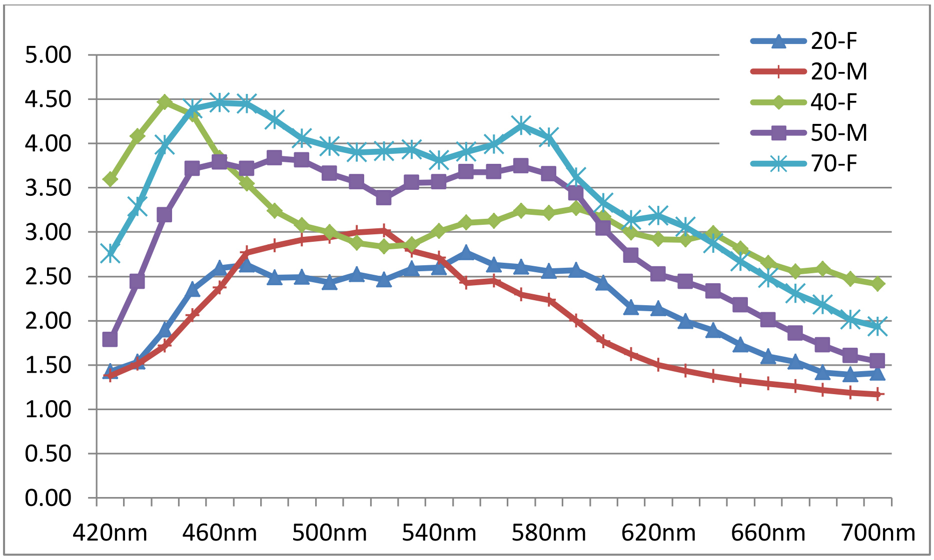

Figure 4. Laplacian filter calculation result of each wavelength of spectral imaging

CONCLUSION

1. Gonio-photometric spectral imaging way with 3-Dimension scanning was useful for human skin color measuring. It is possible to compensate human body coverture and high accurate measuring with non-contact way.
2. There were correlation between Laplacian filter value and age. Laplacian filter value is increase with age.
3. Laplacian value was depending on type of illuminant. That is the human skin image is different under different type of illuminate.

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Oral paper OA43

PERCEIVED QUALITY OF WOOD IMAGES INFLUENCED BY THE RATIO OF SKEWNESS TO KURTOSIS OF IMAGE HISTOGRAM

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Keywords: skewness, kurtosis, histogram, wood grain, perceived quality

ABSTRACT

It is known that the shape of luminance histogram of images is related to material perception. We investigated how luminance histogram contributed to improving the perceived quality of wood images by examining various woods and adhesive vinyl sheets with printed wood grain. In the first experiment, we made a visual evaluation of the perceived quality of wood samples. We also measured the color parameters of the samples in order to examine the colorimetrical property of wood samples. In the second experiment, we evaluated the naturalness of wood images, of which skewness and kurtosis were changed, by a paired comparison method. Results suggest that the ratio of skewness to kurtosis of the luminance histogram affects the perceived quality of wood images.

INTRODUCTION

We can easily recognize the quality of a surface such as color, glossiness, surface material, and surface state in daily life. Clarifying the mechanism of perceived quality is an important issue. Motoyoshi et al. examined the relationship between glossiness and the shape of the luminance histogram of the stucco image [1]. They suggested the skewness of luminance histogram affected glossiness perception. Wada et al. conducted a study to estimate the freshness of cabbage from the image statistics [2]. They found a relationship between freshness perception and the features of the luminance distribution of the images. These studies showed that the luminance distribution was an effective factor for the perceived quality of materials.

Wood is one of familiar materials. There are many kinds of products as well as, their imitations such as computer graphics and prints, which represents wood grain without using real wood. Finding factors that affect the appearance of real wood are useful for various applications such as making imitation wood products. Natural wood is a collection of cells which causes peculiar features of wood such as gloss and pattern [3]. Here, we define the perceived quality of wood as a realistic appearance of wood. Considering previous researches, it would be expected that the shape of luminance histogram also affects the perceived quality of wood. The purpose of this work is to reveal the image statistics affecting the perceived quality of wood when wood samples convert to two-dimensional images.

EXPERIMENT 1 : EVALUATION OF REAL WOOD SAMPLES

In this experiment, the realness of natural and imitation wood samples was visually evaluated in order to quantitatively analyze the perceived quality of wood

Experimental environment and wood samples

A wood sample (65 x 65 mm, 9 x 9 degree) with a reference white frame (1 degree width, N9 in Munsell value) was placed in a viewing booth and uniformly illuminated by fluorescent lamps (5200 K, 1000 lx). Background was gray surface (N5). Observers looked at the sample from a distance of 41 cm. They were not able to see anything except the sample and the background.

We prepared 21 samples of natural wood and 14 samples of imitation wood made of adhesive vinyl sheets with printed wood grain.

Procedure

First, an observer looked at a wood sample, and answered whether it was 'real one' or 'imitation'. After the answer, he or she was asked to score a certainty with three levels; 'very confident', 'a fairly confident', and 'less confident'. Test samples which were a mixture of natural wood and adhesive vinyl sheets were presented one by one in a random order but in the same order in the inter-observers. Observers responded once for each sample.

Seventeen observers in their twenties with normal color vision and normal or corrected to normal visual acuity participated. Nobody had the detailed knowledge of wood.

Result and discussion

The average rate of correct answers in observers responding to real or imitation correctly was above chance level, 0.5 (natural wood 0.68, SD = 0.11; imitation wood 0.73, SD = 0.13). The rate of correct answers would rise when the certainty score is high because the score means index indicating whether observers had self-confidence to their answer. Figure 1 shows the relationship between the certainty score and the rating of answer 'real one'. The abscissa shows the average certainty score in observers. Negative number means answer 'imitation'. The ordinate shows the rating of answer 'real one' to all samples. Coefficient of determination (R^2) between the certainty score and the rating is high. Thus, we defined the average certainty score as realness value to show how observers perceive the samples as real wood.

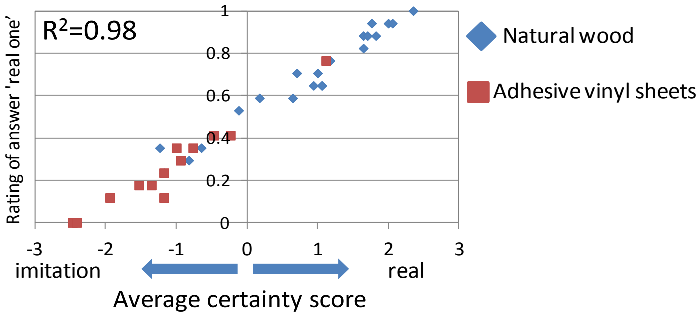

Figure 1. Correlation between the rating of answer 'real one' and the average certainty score

COLORIMETRICAL ANALYSIS OF WOOD SAMPLES

In order to obtain the colorimetrical properties of the wood samples, we measured the CIE 1931 tristimulus values by a 2D color analyzer (KONICA MINOLTA:CA-2000A). Measuring environment was the same as Experiment 1. The resolution of the 2D measurement was 570 x 570 pixels at the area of 57 x 57 mm. Tristimulus values were converted to ATD color space by Eq. (1) and Eq. (2). Then, image statistics was analyzed. In ATD color space, *A* is the same as luminance, *Y*. *T* represents reddish and greenish component, and *D* represents bluish and yellowish component. For the equal energy white, $X = Y = Z$, *T* and *D* are defined to become zero.

$$\begin{pmatrix} L \\ M \\ S \end{pmatrix} = \begin{pmatrix} 0.38971 & 0.68898 & -0.07868 \\ -0.22981 & 1.1834 & 0.04641 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} X \\ Y \\ Z \end{pmatrix} \tag{1}$$

$$\begin{pmatrix} A \\ T \\ D \end{pmatrix} = \begin{pmatrix} 0.3710 & 0.6291 & 0 \\ 1 & -1 & 0 \\ 0.3710 & 0.6291 & -1 \end{pmatrix} \begin{pmatrix} L \\ M \\ S \end{pmatrix} \tag{2}$$

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We analyzed relation between the realness values and some image statistics such as the average, the standard deviation (S.D.), the skewness and the kurtosis of luminance. However, none of them had high correlation. Thus, we considered the relation of three parameters, the skewness, the kurtosis, and the realness values as shown in Figure 2. The realness values are presented by different symbols. Each colored ellipsoid indicates the 90% confidence ellipsoid for each block of realness values that were divided into three levels. High realness values concentrate on the center of the plane, but low values distribute widely, suggesting probability of realness value is high in certain ratio of skewness to kurtosis.

In order to clarify the effect of the ratio of skewness to kurtosis on the perceived quality of wood, we evaluate wood images that were modified their skewness and kurtosis in the next section.

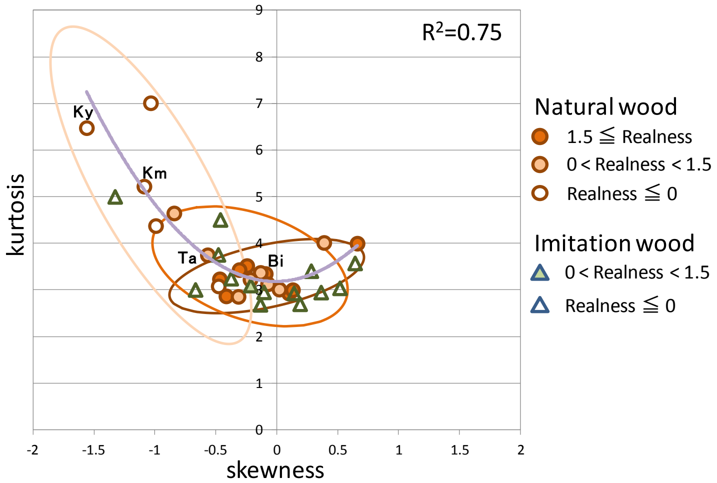

Figure 2. Correlation of skewness, kurtosis and realness values

EXPERIMENT 2 : EVALUATION OF WOOD IMAGES

Experimental environment and stimuli

Wood images created from the 2D measurement data were presented on a 21-inch CRT monitor (Sony GDM-F500) controlled by ViSaGe (Cambridge Research Systems Co. Ltd.) in a darkroom. An observer looked at the monitor with chinrest and viewing distance was about 140 cm. Background luminance on the monitor was about 18 cd/m^2 (corresponding to N5 in Munsell value). The test images were digitally created by manipulating their luminance distribution in a histogram matching technique. The technique needed two images with base and target histogram. We prepared four kinds of wood images, Birch (Bi), Tamo (Ta), Kembas (Km), and Keyaki (Ky) for base and target images that were chosen based on the realness value and the skewness. We divided the realness values into four blocks, and chose each image representing each block with equal interval of skewness on a regression line of the skewness and the kurtosis. The chosen images were

Matched Target 1 (Bi)	Matched Target 2 (Ta)	Matched Target 3 (Km)	Matched Target 4 (Ky)
realness : 2.35	realness : 0.71	realness : −0.12	realness : −1.24
skewness : −0.09	skewness : −0.57	skewness : −1.09	skewness : −1.56
kurtosis : 3.35	kurtosis : 3.75	kurtosis : 5.23	kurtosis : 6.48

Figure 3. Example of the test images (Birch)

denoted by their initials in Figure 2. The shape of the base histogram was modified to match the target's shape, while maintaining the average *A*, *T*, and *D* values, and RMS contrast of the base histograms. Figure 3 shows the example of the test images with parameters.

Procedure

We used the paired comparison method. An image pair from six image pair sets for each base image was presented in random order. An observer was asked to choose an image that was more realistic wood image. There was no time restriction for observing image and making a choice. Then, following to 2 sec break with gray background next image pair was presented. The images presented in a session were 6 pairs for 4 images, 24 pairs total.

Eleven observers in Experiment 1 also participated in this experiment.

Result and discussion

Figure 4 shows the results for each image. The average and SD of all observers were plotted. The abscissa means the ratio of skewness to kurtosis of the test images. The ordinate means the probability of choosing realistic wood images. Regardless of image, the probability is high when the ratio is near zero, and it is low when the ratio is lower. This shows that observers perceived wood image as more realistic when the ratio of skewness to kurtosis of the test image was near zero. Wood images may appear more realistic by making the appropriate ratio of skewness to kurtosis in any wood images.

This result is consistent with the result of evaluation in Experiment 1, suggesting that the ratio of skewness to kurtosis contributes the perceived quality of wood. However, it is necessary to consider the other factors which affect the perceived quality of wood images because there are wood images which have low realness even they have the appropriate ratio of skewness to kurtosis.

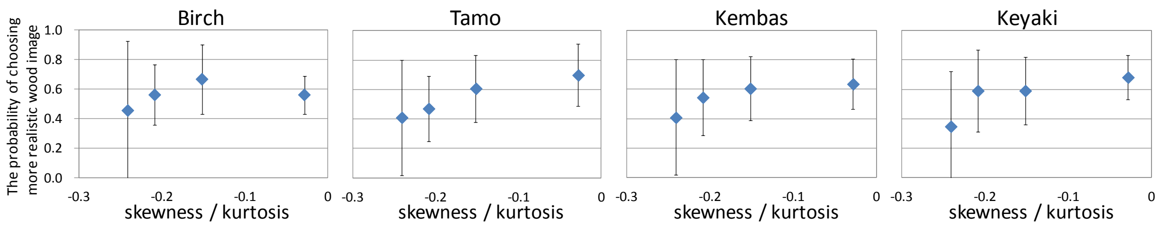

Figure 4. The probability of choosing an image that was more realistic wood image

CONCLUSION

We investigated the perceived quality of wood in relation to the luminance histogram of wood images. We evaluated wood images that modified their skewness and kurtosis of luminance histogram. Our results suggest that luminance distribution of wood, especially the ratio of skewness to kurtosis, affects the perceived quality of wood.

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MODELING IMAGE QUALITY ATTRIBUTES BASED ON IMAGE PARAMETERS FOR MOBILE DISPLAYS

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Keywords: image quality, mobile display, psychophysical evaluation

ABSTRACT

High image quality (IQ) on the widely used mobile displays is extremely desirable for viewing static and moving images. This study focuses on modeling the perceived IQ considering all types of images for mobile displays. Large-scale psychophysical experiments via categorical judgment method were carried out on mobile displays of different physical sizes under lighting conditions of two illuminance levels, in order to visually assess seven perceptual attributes, i.e. naturalness, colorfulness, brightness, contrast, sharpness, clearness, and overall IQ. The results reveal that clearness and naturalness are two principal attributes to predict overall IQ for natural scene images, whereas clearness and colorfulness are key attributes for other types of images (games, maps, and internet). Moreover, the influences of display technology, display size and lighting level have been analyzed as well. Based on the preliminary models of overall IQ with these selected attributes, further expressions to predict individual IQ attributes could be modeled by combining some image and display parameters.

INTRODUCTION

Nowadays, with the increased use of mobile devices such as smartphones, game consoles, and tablet computers, high image quality (IQ) has become extraordinarily desirable for these mobile displays. Therefore, determining the critical factors of overall IQ is helpful to achieve excellent image visual effects on mobile displays. This study focuses on modeling the perceptual IQ attributes of mobile displays, aiming to express the overall IQ by some image and display parameters (image lightness, colorfulness, display size, etc), as well as the lighting conditions [1].

The general application of mobile displays is different from that of desktop displays or TVs, i.e. they are freely applied in a wide range of lighting conditions because of their portability, what's more, images shown on mobile displays involve several application types such as natural scenes, games, maps, internet, and so on [2]. Considering their specificity in practice, the test images in the visual evaluation included both natural scenes and other application types of games, maps, and internet. Moreover, to investigate the influences of display size and lighting level, the experiments were carried out on mobile displays of very different physical sizes, under the dark surround and the 500 lx lighting condition. Seven perceptual IQ attributes were evaluated via psychophysical experiments to reveal the critical factors contributing towards the overall IQ significantly. Thus, based on the key attributes selected to predict overall IQ, the comprehensive IQ model linked to image parameters could be established for different application types of images.

METHOD

Devices and images

The whole experiments were carried out on two smartphones and two tablet computers, in order to take into account the effects of display technology and display size on perceptual IQ attributes for mobile displays. Their physical parameters are listed in Table 1.

Table 1: The basic physical parameters of the tested mobile displays

Parameters	P1	P2	T1	T2
Size (inch)	3.5	4	9.7	10.1
Display material	IPS	AMOLED	IPS	TFT
Resolution	640 × 960	480 × 800	1536 × 2048	800 × 1280
PPI: pixel per inch	326	233	264	149
Peak white luminance (cd/m^2)	539	331	242	315
CCT: correlated color temperature (K)	7658	9407	6595	7023
Gamut ratio to sRGB in CIE1976UCS	0.624	1.362	1.090	0.587

IPS: in-plane switching. AMOLED: active matrix organic light emitting diode. TFT: thin film transistor.

The visual assessments were conducted under the dark surround (for all the 4 displays) and ambient lighting condition with the illuminance of 500 lx (for P1 and T1) to simulate the office lighting, respectively, resulting in 6 experimental phases of Dark-P1, Dark-P2, Dark-T1, Dark-T2, 500 lx-P1, and 500 lx-T1. The model of the lighting tube was OSRAM DULUX-L 55W/954 with the CCT of approximately 5000 K.

The test images covered a considerable scope of common image contents for mobile displays, which not only included some familiar memory colors such as skin, green grass, and blue sky, but also considered other specific application types such as internet, games, and maps as well. Figure 1 illustrates several typical examples of the selected images from different image types.

Figure 1. Some typical samples of the original test images in the IQ experiments

The images shown on the two smartphone displays were resized to the same size of 5 cm × 7.5 cm, while for the two tablet computers, the images were set as 13.6 cm × 19.7 cm. The original images were manipulated by changing image appearance parameters, including three color appearance parameters of hue h, chroma C, lightness L^*, along with the spatial frequency [3]. For each pixel, its L^*, C, h values were calculated from the digital inputs, on which various manipulation methods were performed, including 3 linear functions to change lightness, 3 linear functions for chroma manipulation, 4 shifts of hue, 4 kinds of Gaussian function for spatial frequency. Then, these modulated L^*', C', h' values were rendered to newly manipulated image versions. In addition, 3 manipulations for resolution were obtained by 'bicubic' method directly from digital inputs. Therefrom, a realistic range of variations for each original image was generated.

Psychophysical procedure

The psychophysical experiments were conducted by a panel of 10 observers (5 male and 5 female) with normal color vision. The viewing distance was about 30 cm, and the observers focused their attentions on the panels perpendicularly. Seven perceptual IQ attributes previously proved to be important were chosen, i.e. naturalness, colorfulness, brightness, contrast, sharpness, clearness, and overall IQ [4, 5]. The categorical judgment method was adopted, in which the observers judged the individual IQ attribute with a memorized reference. A nine-point numerical category scale ranging from 1 to 9 was used to describe the perceptual feelings in grades.

RESULTS AND DISCUSSION

Influences of display type and lighting condition

The raw data from categorical judgment is in term of category grades. To deeply analyze the experimental results, these categorical grades judged by the 10 observers were converted to an interval scale value for each evaluated image version by adopting Case V of Thurstone's law on comparative judgment [6]. The mean scale values of the 7 perceptual attributes for each experimental phase are plotted in Figure 2.

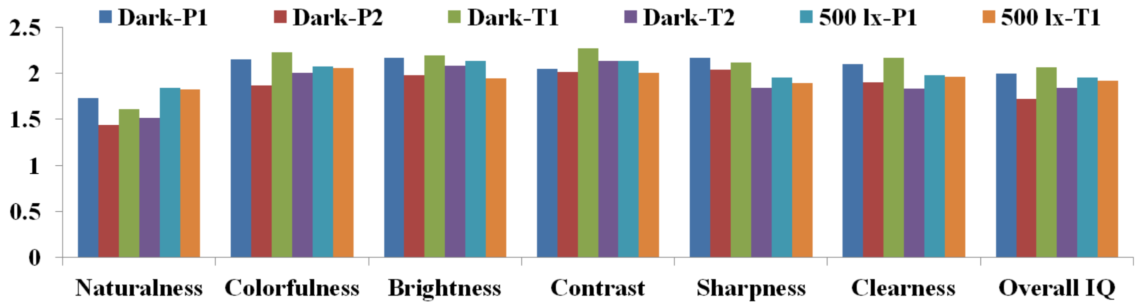

Figure 2. The mean scale values of the 7 perceptual attributes for the 6 experimental phases

For the influences of display technology, as clearly seen from Figure 2, the IPS (P1 and T1) performs better than AMOLED (P2) or TFT (T2) on all the 7 attributes, which may be due to its advantages of high PPI and suitable CCT. As for the impacts of lighting condition, the 500 lx illumination mildly reduces the scores of colorfulness, brightness, sharpness and clearness, but brings about an increase on naturalness, which indicates that the dark surround could accentuate some color appearance attributes such as colorfulness and brightness, and make images be striking. Also depicted in Figure 2, scores of the two IPS displays of different sizes are almost on a par, though T1 performs better on contrast and colorfulness, while P1 gets higher score on naturalness, which implies that it is other factors rather than just size to introduce these differences of their performances.

Modeling overall IQ

For all the 6 phases, the Pearson correlation coefficients between the overall IQ and its six constituent attributes were calculated to determine the principal attributes to significantly influence the overall IQ. The results are listed in Table 2.

Table 2: The Pearson correlation coefficients between overall IQ and its 6 constituent attributes, along with the prediction accuracy of two image types, for the 6 phases

Pearson correlation coefficients		Dark-P1	Dark-P2	Dark-T1	Dark-T2	500 lx-P1	500 lx-T1
Correlation between overall IQ and its constituent attributes	Naturalness	0.795	0.704	0.783	0.698	0.811	0.761
	Colorfulness	0.535	0.413	0.508	0.561	0.527	0.511
	Brightness	0.296	0.218	0.269	0.191	-0.008	0.313
	Contrast	0.504	0.399	0.571	0.509	0.400	0.602
	Sharpness	0.557	0.527	0.754	0.730	0.725	0.767
	Clearness	0.768	0.809	0.803	0.877	0.857	0.814
Prediction accuracy	Natural scene images	0.934	0.930	0.931	0.938	0.948	0.935
	Other application images	0.877	0.879	0.881	0.923	0.926	0.916

It can be seen that naturalness and clearness exhibit high preponderance on impacting the overall IQ for all the 6 phases, while sharpness, colorfulness, and contrast show some influences in a way. Yet as our previous study pointed out, contrast is not an independent variable but a compound attribute, which is influenced by some factors simultaneously, and clearness is more suitable than sharpness to represent the overall IQ, due to the discordance between sharpness and overall IQ in the over sharpened situation [7]. Consequently, the overall IQ for natural scene images could be predicted well by adopting its two constituent attributes, clearness and naturalness. Whereas for predicting the overall IQ of other application images, clearness should be chosen as an indispensable attribute, and colorfulness is considered as a complementary element. The last two rows in Table 2 list the prediction accuracy of the overall IQ models by its two selected attributes (Pearson correlation coefficients between the predicted overall IQ values and the visually evaluated overall IQ results) for natural scene images and other application images respectively, which verifies these above conclusions.

Hence, to create empirical models capable of predicting the overall IQ from image parameters, modeling the overall IQ by its two key constituent attributes is just the first step, the next step is to build the mathematical links from image parameters towards the perceptual attributes of clearness, naturalness, and colorfulness. Therefore, our further research will mainly focus on modeling these above individual attributes, then an empirical procedure will be developed to predict the perceived image quality linked to image parameters presented on displays.

CONCLUSION

Seven image quality attributes were visually evaluated for four mobile displays under two lighting conditions using test images from different application types. Their scale values of different experimental phases were compared to investigate the influences of display technology, display size, and lighting condition. Moreover, the calculation of Pearson correlation coefficients reveals the key attributes to impact the overall IQ obviously for natural scene images and other application images of mobile displays, respectively. To achieve the ultimate goal of modeling the perceptual attributes from image parameters under various lighting conditions, the future research will focus on developing mathematical expressions of perceptual attributes from image parameters. This study may provide helpful suggestions for display manufactories to develop mobile displays with excellent image and video effects.

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DO THE ZEBRA STRIPES INTERFERE THE RECOGNITION OF TARGETS?

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Keywords: zebra pattern, recognition, reaction time, stripe, color

ABSTRACT

Some tropical fishes and also some wild animals and insects have strong stripe (zebra) patterns of vivid colors on their bodies. It is said those zebra stripes are so conspicuous that they conceal their body lines and consequently lower the probability for being caught by their predators. The aim of the present study was to verify the hypothesis that the zebra stripes really interferes the recognition of targets experimentally. A series of stimuli consisted of alphabets, “Hiragana (Japanese characters)", and figures, with and without zebra stripes (vertical or horizontal, and of three revels of spatial densities) of achromatic color were shortly presented one by one on the PC monitor and the reaction times for their recognition were obtained. The results are somewhat controversial, but generally tends to deny the above hypothesis, i.e. the targets with zebra stripes were easier to recognize than plain ones were.

INTRODUCTION

Some tropical fishes like *Amphiprion clarkii* and some wild animals like zebras, after which the title of this paper is named, have strong stripe(zebra) patterns of vivid colors on their bodies. The zebra patterns are so distinguished that they would divide the pattern of the body into several parts. This is why they are called "dividing color". They may make detection of the body by their predators difficult.

Pastoureau argued that the zebra pattern may make the human eye difficult to divide the plane between the figure (focal plane) and the ground (background plane) which is considered important to recognize the object [1][2].

If the above logic can be applied to human recognition, it may be hypothesized that we have difficulty in reading the characters with zebra patterns or take longer times to recognize them than the characters without zebra patterns.

In this study reaction times were obtained between the on-set when the stimulus is displayed and the on-set when the observer push the button recognizing the character.

METHOD

***Apparatus and Stimuli*:**

A PC tachistscope was used to present stimuli on the pc monitor and measure reaction times. The refresh rate of the monitor was 120Hz. So the recorded reaction times should be estimated with the errors of ±8 ms.

The three kinds of stimuli, alphabets (W, X, Y, Z), "Hiragana (Japanese characters)", and figures (○, □, △,▽) with and without zebra stripes. The stripes were achromatic and of two orientations, vertical or horizontal, and of three revels of spatial densities (0.27, 0.54, and 0.95 cpd) for each orientation. The average luminance of the bright part of each stimulus was 42.9

cd/㎡ and that of the immediate grey background 31.3 cd/㎡ (Fig.1).

A series of stimuli were composed of one hundred stimuli from each kind, half of which were with zebra stripes and the half were without stripes. Therefore in the series of alphabets, 25 "W" were with zebra stripes and 25 "W" were without ones, 25"X" were with stripe and 25"X" were without ones and so on. A series of stimuli were presented one by one at random on the center of the monitor 100 ms after the cessation of fixation points lasting for 100 ms (Fig, 2). The stimuli were observed at the distance of 72 cm forming the height of stimulus of 9.5° in visual angle.

The PC the experimenter was operating and the monitor the participant was observing were separated by the curtain making the ambient of the observer almost completely dark.

A session consisted of the completion of a series of stimuli out of three kinds. In each session, a target stimulus, for instance "W" with stripes, was fixed, and the observer was instructed to seek the target as soon as possible. Thus the candidates for targets were W, X, Y, Z, four "Hiragana (Japanese characters)", ○, □, △, ▽ with zebra stripes.

The participants used a chin rest to stabilize their fixation at rest. The stimuli were observed binocularly and naturally, with or without glasses.

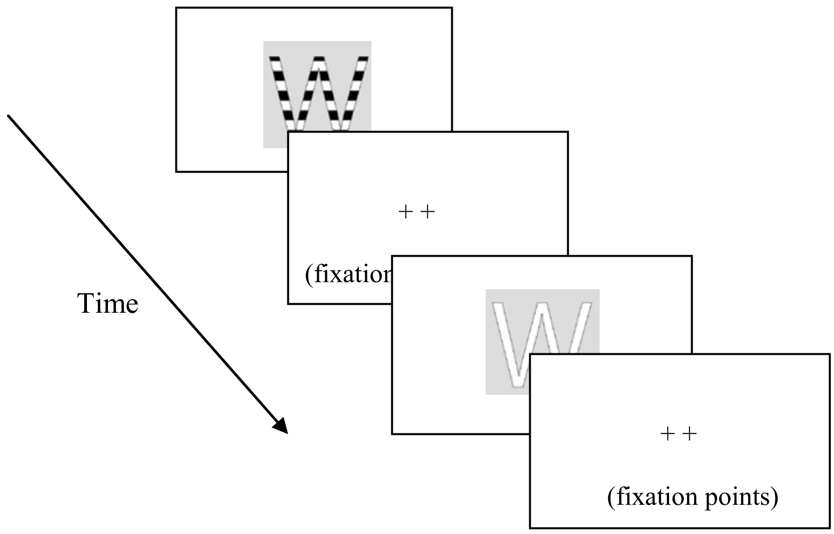

Fig.1 The spatio-temporal configuration of stimuli

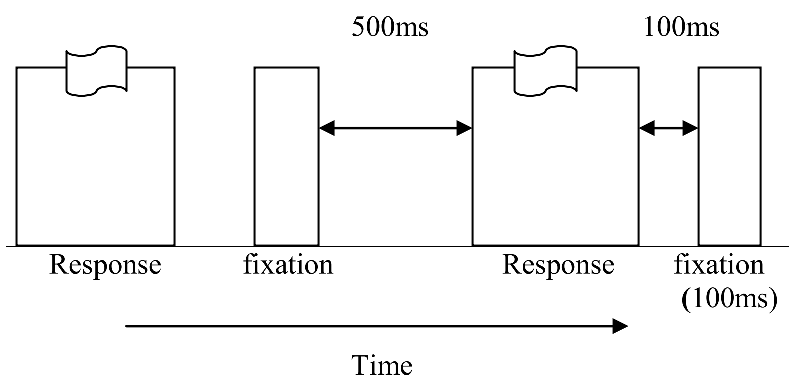

Fig. 2 Temporal configuration of stimuli

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Participants:

Around twenty participants were recruited. All of them were students of Kanagawa University at ages ranging from 19 to 21. They were paid. All of them did not participate in all of 36 sessions. They were all naive to this kind of experiment.

Procedure

The observer was instructed to respond as soon as possible and as correct as possible by pressing one of two buttons when the stimulus he/she recognized was the target and by pressing other button when he/she recognized was whatever of non targets . Three sessions for three series of stimuli were conducted in a day and the session was repeated other day exchanging the buttons which the participant has to press for the target stimulus.

Prior the session, the participant was dark adapted for several minutes. Data in the first several trials were discarded for practice.

RESULTS AND DISCUSSION

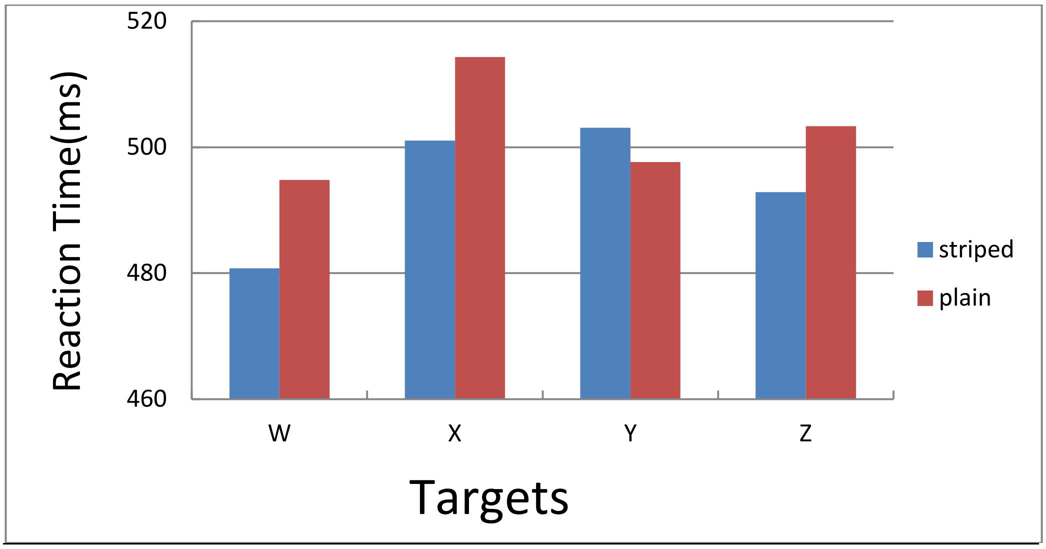

Fig. 1 Average reaction time (ms) for targets of W, X, Y, Z.

Fig. 1 shows the average reaction times for alphabets, with stripes of two orientations and of three spatial densities included all together. The difference in reaction time among 4 kinds of alphabets is irrelevant with the present study. The analysis of variance (ANOVA 4) showed no significant interactions between all kinds of targets and the effect of stripe.

The statistical t-test showed that the reaction time for W were significantly smaller for the one with zebra stripe than the plain one (t(21)=--3.75, p<.01). The results for other targets were all statistically n.s., although the probability (P(T<=t)) was 0.06 for Z!

Fig. 2 shows the average reaction times for 4 figures. The results were statistically all n.s. The results for Japanese characters are not illustrated in this paper, because Japanese characters might not be available in Thailand. Reaction times were significantly shorter for three of four Japanese characters with stripes than those without stripes (P(T<=t) were 0.01, 0.05, 0.01), with one n.s.

Thus the results were somewhat controversial. It seems difficult at this stage to explain how such discrepancies occurred among the targets. There seems no clear geometrical or cognitive difference among the targets.

In spite of that, the targets with zebra stripes were generally easier to recognize than those without stripes. How could the present results be compromised with what is happening in natural

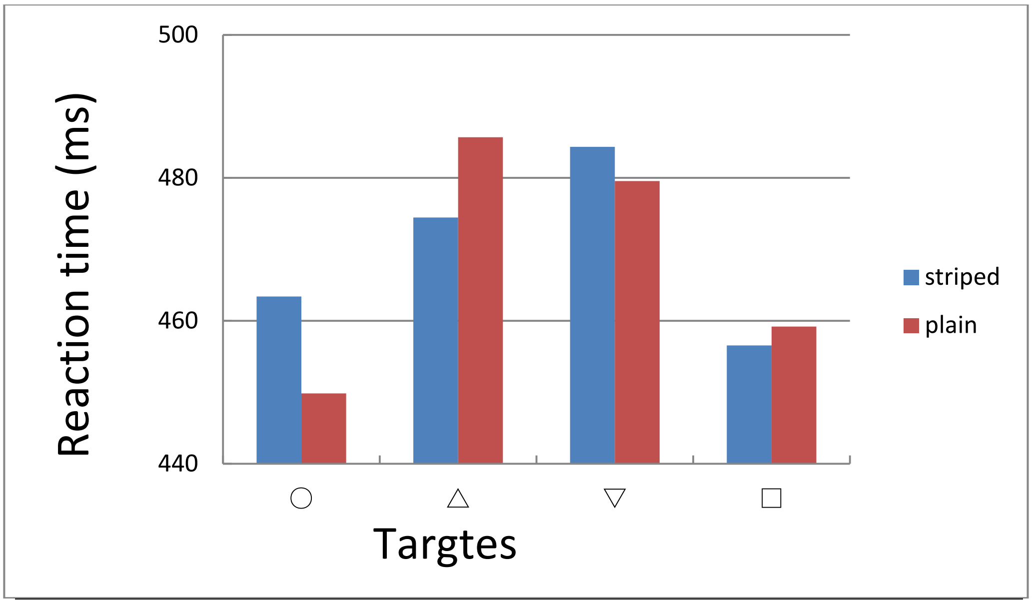

Fig. 2 Average reaction time (ms) for targets of ○, △, ▽, □.

environment? One possible factor to explain the difference is color. Many tropical fishes are quite colorful. So it is worth to conduct experiments with the targets of colors.

Noguchi demonstrated that the targets with "hatching", thin stripes, were useful for the color deficient to recognize them [3]. The present results turned to support it as a result.

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CROSS PREFERENCE FOR COLOR COMBINATION AND SHAPE

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Keywords: Color Combination, Correlation, Preference

ABSTRACT

Preferences for *single hue color* and shape are intertwined; our previous study showed that people who prefer certain colors also tended to prefer certain shapes (Chen, Tanaka, Matsuyoshi, & Watanabe, 2013). In the present study, we investigated the relationship between preferences for *color-pair* and shape. Participants rated how much they liked the color pairs and shapes. The visual stimuli were 56 hue color pairs based on 8 hue colors taken from the Natural Color System, and 12 geometric shapes including 8 kinds of 2D shapes and 4 projected images of 3D shapes. Results showed that there are some correlations between preference for color pairs and shapes. People who preferred the basic 2D shapes (square and triangle) tended to prefer certain distant-color pairs (i.e., orange and blue-green combination). In addition, people who preferred the 3D shapes (pyramid, and truncated pyramid) tended to prefer some similar-color pairs (i.e., yellow and orange combination). These results suggest that preferences for color-pair and shape are intertwined.

INTRODUCTION

People have a general tendency of preferences for colors and shapes irrespectively. For example, people tend to prefer "cold" hue colors (e.g., blue, cyan) to "warm" hue colors (e.g., red) (Hurlbert & Ling, 2007; Palmer & Schloss, 2010) and prefer "curved shape" to "sharp shape" (Bar & Neta, 2006). Then, we previously investigated relationships between preferences for single color and shape and found that people who prefer certain colors would tend to prefer certain shapes sharing the same semantic information (e.g., warmth and lightness) (Chen, Tanaka, Matsuyoshi, & Watanabe, 2013).

Here we were interested in relationships between preferences for color pairs and shapes. Previous studies have shown that preference for color pairs relies on preference of each color, contrast of color pairs, hue harmony and similarity. Thus, preference for the color combinations might be related with semantic impression of color pairs (Schloss & Palmer, 2011; Ou, Luo, Woodcock, & Wright, 2004). Preference for visual shapes were also found to be affected by the positive emotion associated with shape features such as shape symmetry, curve or sharped features, complexity, and process fluency (Bar & Neta, 2006; Fischer & Hawkins, 1993; Leder, Tinio, & Bar, 2011; Silvia & Barona, 2007; Reber, Schwarz, & Winkielman, 2004). Therefore, preferences for color combinations and shapes might also have some correlations by the connections of congruent semantic information as in our previous work (Chen et al., 2013). Then, in the present study, we investigated whether preferences for color pairs (i.e., contrast, harmony, and similarity) and shapes (i.e., basic 2D shapes, basic 3D shapes, and created 3D shapes) were correlated.

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METHODS

Participants

Fifty-eight Japanese participated for the experiment (twenty females; mean age = 21.2, standard deviation = 2.4) and conducted three consecutive sessions: liking rating task for single color, shape, and color pairs, respectively. All participates have normal or corrected to normal visual acuity and normal color vision.

Apparatus and stimuli

Stimuli were displayed central on a 15.5-inch LCD color monitor with 1920 × 1080 resolution with refresh rate of 60 Hz and controlled by a laptop computer.

The visual stimuli in the rating task for single color consisted of 40 hue colors (taken from the Natural Color System Atlas) filled rectangles (7.1 cm × 5.3 cm; 6.7 deg × 5 deg in visual angle). Visual shapes were composed of 12 basic line-drawing shapes, including three basic 2D shapes (circle, triangle, square), and three types of 3D shapes (cone, pyramid, truncated-pyramid). In particular, the 3D shapes had three types of complexity (i.e., simple, regular, complex; Fig. 1a).The geometric shapes were all drawn with black lines with the width of 2.6 mm (0.03 deg) on a white background (100 cd/m^2). We prepared 3 sizes of each shape (i.e., small, medium, and large) and three levels of spatial rotation except for circle (i.e., 0°, 15° and -15°). Thus, we had 102 shape stimuli in total (11 shapes × 3 sizes × 3 rotations + 1 shape × 3 sizes = 102 shapes). The visual stimuli in the rating task for color pairs were composed of two rectangles with different colors (7.1 cm × 5.3 cm; 6.7 deg × 5 deg in visual angle; Fig. 1b). The color pairs were chosen from 8 unique hue colors (yellow, orange, red, purple, blue, blue-green, green, chartreuse), resulting in 56 combinations (i.e., trials). The visual stimulus appeared at the center of the screen, above a 7-point-Likert scale (Fig.1b).

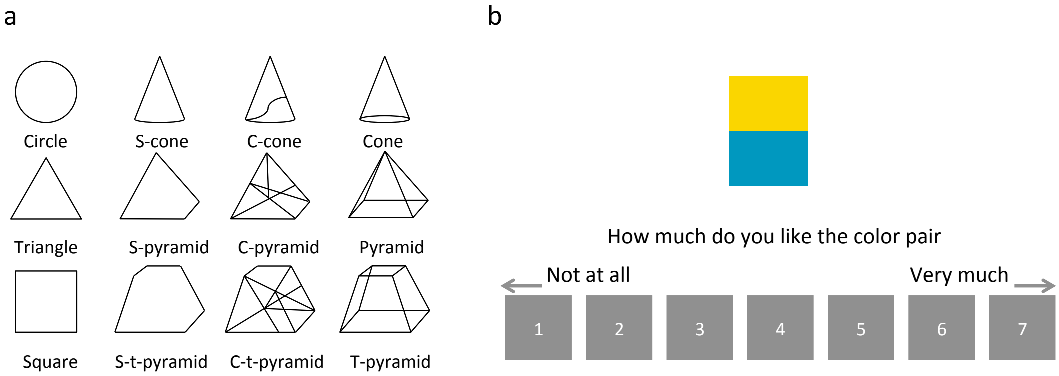

Figure 1. a) Visual stimuli of shapes. 't-pyramid' presents for truncated pyramid. 's' is short for simple; 'c' is short for complex. b) An example of color pairs in the task.

Procedure

The experiment was carried out in a laboratory with dimmed lighting conditions (1 lux on the wall). Participants seated in front of the monitor and were instructed to rate how much they liked each of color, color pair stimuli and shapes on a 7-point-Likert scale (from '1': "strongly dislike", up to '7': "strongly like"). Participants responded by mouse-clicking the numeric square labeled form 1 to 7. After they made their decision, the next trial started immediately. They performed the three rating tasks for single color, shape, and color pairs, in order. The experiment lasted about 20 minutes.

RESULTS

First, we compared the ratings of preferences for single color and color pairs. One-way ANOVA for the mean ratings of each hue distance of color pairs (i.e., 0, 1, 2, 3, 4; "0" indicates single color and "4" indicates contrast color pairs) showed significant differences (F (4, 57) = 13.1, $p < .01$). Post-hoc multiple comparison revealed that people like the single color (i.e., zero hue distance) better than other color pairs ($p < .05$), which was identical to the previous study (Schloss & Palmer, 2011).

Second, we investigated whether preferences for single color and shapes were correlated as in our previous work (Chen et al., 2013). As a result, we could replicate our previous result that people who preferred the basic 2D shapes tended to prefer warm colors (e.g., orange) and people who preferred the basic 3D shapes tended to prefer light colors (e.g., yellow), which can be accounted for "warmth" and "lightness" as the shared semantic information.

Correlation analysis was performed on standardized liking ratings of color pairs and shapes. Since the number of levels for rating was more than 5 and the ratings followed the normal distribution, we employed Pearson's correlation coefficients as indication of the relationship between color pair and shape preferences. Preferences for the hue distance of color pairs were significantly correlated with preferences for some shapes ($r > .22$, $p < .05$) (Table 1). Notably, preferences for basic 2D shapes (triangle, and square) were positively correlated with preferences for contrast color pairs (the largest hue distances; HD4) such as green/orange, orange/blue-green, blue-green/orange, blue-green/red. Preferences for 3D shapes (pyramid, and truncated pyramid) were positively correlated with preferences for similar color pairs (the smallest hue distances; HD1) such as orange/red, red/orange, orange/yellow, yellow/orange color pairs, but, negatively correlated with preference for contrast color pairs (hue distance; HD3). Both preferences for complex 3D shapes (C-pyramid, C-cone, C-t-pyramid) and simple 3D shapes (S-pyramid, S-cone, S-t-pyramid) positively and negatively correlated with preferences for contrast color pairs of hue distance HD3 and HD4, but failed to show specific correlation tendencies.

DISCUSSION

The present study investigated the relationships between preferences for color pairs and geometric shapes. We found that participants who prefer the certain 2D shapes (i.e., square, and triangle) tended to prefer contrast color pairs (e.g., the largest hue distance; green/orange, orange/blue-green) and participants who prefer the certain 3D shapes (pyramid, and truncated pyramid) tended to prefer similar color pairs (e.g., the smallest hue distance; red/orange, orange/yellow). The created simple and complex 3D shapes did not show specific tendencies. Therefore, the present results show that preferences for color pairs (i.e., contrast, harmony, similarity) and shapes (i.e., basic 2D shapes, basic 3D shapes, and created 3D shapes) were correlated, which might indicate that these relationships can be accounted for the shared semantic information. Further investigations are warranted to examine the exact congruent semantic information between color pairs and shapes.

Table 1. Correlated preferences for hue distance of color pairs and shapes

	HD1	HD2	HD3	HD4
Circle	-0.061	0.064	-0.010	0.078
Triangle	-0.084	-0.096	0.008	**0.269**
Square	-0.109	-0.145	0.056	**0.308**
S-pyramid	-0.055	0.141	0.037	-0.079
S-cone	0.118	-0.011	**-0.248**	0.096
S-t-pyramid	-0.117	-0.061	**0.236**	-0.009
C-pyramid	-0.021	0.136	0.114	**-0.251**
C-cone	-0.003	0.159	-0.005	-0.152
C-t-pyramid	-0.126	0.046	**0.236**	-0.100
Pyramid	**0.247**	-0.177	**-0.254**	0.003
Cone	0.105	-0.032	-0.208	0.092
T-pyramid	**0.266**	-0.199	**-0.308**	0.057

Note: Cells in yellow indicate significant positive correlations, and cells in green indicate significant negative correlations; "HD" means hue distance

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Pictorial Expression Techniques Used in the Wall Painting of Each Thai Dynasty Period

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Keywords: Thai dynasty periods, Wall paintings, Representative colors, Impression of color arrangement, Perspective techniques, Depth feeling.

ABSTRACT

Thai dynasties consist of Ayuthaya(1351-1767) and Bangkok(1782-Present).The culture and diplomatic features were different in each dynasty. Most historical wall paintings of Thailand were drawn in the temple. In the present study, colors used in Thai wall paintings of various dynasties were measured and plotted in the L*a*b* color space. Representative colors were obtained by K-means clustering in combination with 2 step clustering, and their characteristics were discussed by comparing with Pompeii (first century) and Renaissance fresco (15th century). It was found that Thai wall paintings in Bangkok dynasty were influenced by Europe and the way of using color was very similar to European way at renaissance time. In addition, impressions of the color arrangement of these paintings were obtained by a color image scale.

INTRODUCTION

In Thailand, people's life or the traditional art are strongly connected to Buddhism, and it can be said that the wall paintings drawn in the Buddhist temples represent the Thai art. In Ayutthaya era, the influence of China was greatly received, and a lot of wall paintings of the Buddhism story came to be drawn in the inner wall (UBOSOT) and main temple (VIHARN) of the Buddhist temples. At that time exchange with not only China but also with Europe took place, but there seemed to be little influence on picture. Because pigments in Ayutthaya were made from natural materials the color of Ayutthaya had few kinds. In Bangkok age the Bangkok dynasty is divided into three ages, the first term (Rama 1－3 generation), the middle term (Rama 4－6 generation), and latter term (Rama 7－9 generation of the present age). In the time of the Rama 1 (1782-1809) the feature of wall painting just kept influence of Ayutthaya culture. The influence of Chinese art was strongly received in the age of Rama 3 generations (1824-1851). At that time pigments were imported from China. The western countries started to exchange with Rama 4 generation (1851-1868) and the influence appeared to the wall painting. The shadow method, perspective drawing, spatial placement, and split plot design were adopted. The Rama 9 (1946-present) who made effort for maintenance of the infrastructure of his country and planned improvement of the living environment of the nation. Enlightenment for knowledge took place and culture and art of the original style aroused in Thailand. In this study the wall painting of the period of each dynasty was analyzed. The representative colors were derived from the color distribution in L*a*b * space, which were taken from photo books for the wall painting in Pompeii (one century) and Renaissance (about the 15th century). Their feature of the coloring was investigated and was compared with the wall painting. Perspective expression technique used in wall paintings of each Thai dynasty period was investigated. The use of aerial perspective was discussed with the help of the difference in lightness, chroma, and contrast among short-distance view, middle-distance view, and long-distance view, and the use of linear perspective was discussed with the help of distance dependence of the object size (here limited to figures), comparing them with Renaissance and Baroque paintings.

Analysis of coloring

The coloring in the wall painting of each age and color information were acquired from the picture collection by a suitable size, and the representative color was taken by k-means clustering method. The method used is as follows.

1. The wall paintings were captured and digitized by using an image scanner (EPSON10000G). The resolution was 96dpi, which was not influenced by the printing dots of the print and adequate color information was obtained.
2. Color information was calculated as sRGB color space. Average size of a 5x5 color information for each selected pixels. The visibility distance in visual MTF as best seen from a 2x2 pixel size (0.5x0.5mm) would be reasonable to do, and even in the most detailed picture seems to be a pattern in this analysis, these two different sizes, color distribution, there were no differences for a representative color, the less amount of calculation for 5x5 pixels.
3. X, Y, Z tri-stimulus values and L*, a*, b* values were calculated on sRGB color space, and were plotted on L*a*b* space to obtain the distribution of colors used in each mural.
4. Based on the color distribution in L*a*b* color space of wall paintings from each era, the IBM SPSS Statistics software package for statistical analysis (IBM Co.) was used to determine the number of clusters K through two-step clustering based on distance (color difference) in L*a*b* space. Using the K, representative colors were automatically determined via the K-means method.
5. The color distribution on L*a*b* space was analyzed by k-means clustering and the representative color was found and color patches were presented as the representative color by Adobe Photoshop.

RESULTS

Impressions imparted by color combinations (classification using color image scale for color combinations)

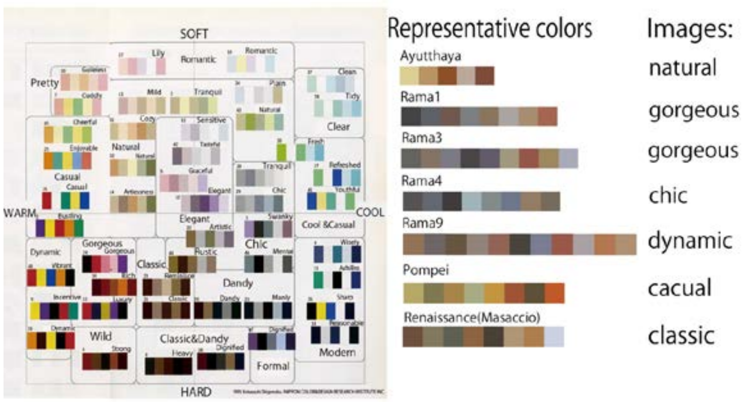

Fig. 1 Determination of the emotion associated with representative colors of each era by using a color combination image scale.

Figure 1shows the swatches of representative colors for each era. On the far left of the diagram, the color image scale for color combinations is shown for comparison. Emotion words for representative color patches were found by comparing with image scale. At this time, colors with high percentages were stressed.

This study analyzed color usage in Thai paintings which was not investigated previously. Important temple paintings representing each dynasty were selected as the subjects of the research. The characteristics of Thai paintings were elucidated by comparing them with European paintings from Pompei and the Renaissance.

In the Ayutthaya Era red and yellow pigments were used without mixing, and this imparts a warm and natural impression. In the Bangkok Era, during the reigns of Rama 1 and Rama 3, powerful black backgrounds were adopted, and color combinations incorporating red impart a new, gorgeous emotion. In the reign of Rama 4 cultural exchange with Europe began, and color materials began to be imported. Color usage became richer and the expression itself began to exhibit a European influence. The artist Khrua In Khong, a representative of that era, used black and blue as his base colors, and left wall paintings which impart a chic impression characterized by extremely low chroma. In the reign of Rama 9 Thailand's distinctive Benjarong painting style was established. This style imparts a dynamic impression with greater power by adding a strong orange color to the color combinations used in the reigns of Rama 1 and Rama 3.

In comparison with Western painting, wall paintings from the Ayutthaya Era impart an extremely warm impression due to their use of highly saturated yellow and red. The impression is similar to that of the wall paintings of Pompei. The wall paintings of Khrua In Khong during the reign of Rama 4, which are said to have been greatly influenced by Western painting, have low saturation compared to Renaissance wall paintings. Black and blue account for a large percentage of the color combination, and the paintings impart a cool emotion. The color combinations for Rama 1, Rama 3 and even more so Rama 9, are warm and hard, and similar in impression to Renaissance wall paintings.

The pigments used in each era of Thai and Western art

Few pigments were used in the Ayutthaya Era, and mixtures of pigments were not used. Therefore the distribution of color usage was narrow. In the Bangkok Era, gradation of dark tones appeared due to the mixture of achromatic and chromatic pigments. On the other hand, there was a broadening of color usage because pigments began to be imported from China. The rich color usage of the Bangkok era became "Benjarong"—the color combination method using black, white, red, yellow, blue and green which became the basic color usage of Thailand. Basically, the pigments used to produce Thai wall paintings are the same as those used in the West, but Thai art is characterized by its method of applying paint, color usage techniques and other factors.

Depth perception expression technology of wall painting□

The contrast and the chroma of the wall painting in the Ayutthaya and Bangkok Dynasties of Thailand were examined. The use of aerial perspective was discussed with the help of the difference in lightness, chroma, and contrast among short-distance view, middle-distance view, and long-distance view, and the use of linear perspective was discussed with the help of distance dependence of the object size (here limited to figures), comparing them with Renaissance and Baroque paintings[3,4].

The experiment method for linear perspective

Measurement was done for the position (distance from the place which the painter was drawing) where very thing was arranged in the height (pixel count) from the edge under a picture, and for the relation between the size of what was drawn, and the distance of arrangement. The following steps were taken for the investigation.

1)Wall paintings of each dynasty period of Ayutthaya and Bangkok dynasties were analyzed in a manner as follows.
a) Obtained the correlation between the position on the screen and the size of the person drawn, then introduced the linear perspective.
b) The existence of introduction of aerial perspective was examined by measuring and comparing the lightness, chroma, and contrast of a close-range view, a middle-distance view, and a distant view which were drawn.
2) Clear linear perspective was used only with the wall painting of Khrua In Khong of the Rama 4 in the pictures of Thailand. It could not be found in the wall painting of other dynasties.
3) In the corridor wall painting of the Rama 3 which introduced the bird's-eye view method a strong depth perception was given. It was comparable to the pictures of the Renaissance age which introduced clear linear perspective.
4) In the wall painting of Main hall of Wat Bowonives Voramahavihah of theRama 3 and the wall painting of the Rama 9, a strong depth perception was brought about according to the effect of height peculiar to the pictures of Asia as compared with the wall painting of the Rama 4.
5) It was shown that introduction of aerial perspective is performed on the Rama 3 and the column on the Rama 4 .
These results are summarized in Fig. 2.

Era / Techniques	Ayutthaya	Rama1	Rama3 (Corridors)	Rama3 (Main hall)	Rama4 (Column)	Rama4 (Wall paintings)	Rama9	Renaissance (Wall paintings)	Renaissance (Oil paintings)	Baroque
Aerial perspective	×	×	Δ	Δ	Δ	×	×	Δ	○	○
Linear perspective	-	×	Δ	×	-	○	×	○	-	○

Figure 2: Presence or absence of introduction of perspective techniques
○:present; Δ:present but not clear; ×:absent; -:unmeasurable

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Oral paper OB12

The Tropic of Cancer in Taiwan: Preliminary Approaches to Regional Colors

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Keywords: Environmental Color, Tropic of Cancer, Geography, Landscape Characteristic

ABSTRACT

Environmental colors heavily relate to geographical climates, latitudes, altitudes, and the whole landscape being envisaged by the interaction between nature and culture. As a result, the countries and regions where the Tropic of Cancer 23.5° passes, owing to their very diverse landscape, exhibit great differences in their environmental and cultural colors of natural landscape. Taiwan, situated between the Pacific Ocean and the Taiwan Strait, has owned a very critical position. Thanks to the coverage by the Tropic of Cancer, Taiwan prides itself with the richest biodiversity. Accordingly, this paper, based upon field surveys, explores how the Tropic of Cancer renders environmental characteristics and a splendid variety of landscape colors. With preliminary studies on chromatogram and literature reviews, it is the objective of this paper to build a cross-Asia, even a global, database of diverse landscape colors endowed by the trajectory of the Tropic of Cancer.

INTRODUCTION

Studies of environmental chromatics have been very challenging because they involve with disciplines outside of traditional color science—geographical climate, latitude, altitude above sea level, and regional characteristics related with specific topography and geomorphology, land, and vegetative eco environments. With so many fields interrelated, a common base that integrates all these fields is not seen yet; comparative studies on environmental chromatics are still limited.

This paper suggests that we use "environmental color" as a new aspect with which a system of environmental observation is established. In this study, a geographically shared climatic condition—Tropic of Cancer—will be used as a "global cross section" to show how different geologies, different topographies, different geomorphologies and micro-climates can form landscape color features—thereby proving both of the diversity and universality of environmental color.

As a pilot project, this paper intends to investigate the areas, towns, and environmental color through which the Tropic of Cancer goes in Taiwan. Under the same latitude, it is inspiring to see how environmental color varies in regard to different areas. As a result, the elements that influence the scale of environmental color can be sorted out. Based upon this study, it is hoped that more cross-continent and cross-city studies can be developed into an integrated platform so as to initiate more exchanged analyses and research. Finally, the "color code" presented in this study will also help establish "environmental color" as a scientific and universal subject, enhancing the living condition and sharpening the alertness toward climate change.

APPROACHES

Study assumptions:

1. Conditions of geological climate (including sunlight, rain falls, latitude, altitude, etc.) influence the presentation of natural and liberal colors among regions.
2. The key factor that has an effect on environmental color landscape is sunlight. Under the same latitude, the amount of sunlight appears similar, which offers an objective basis on which landscapes can be compared.
3. Geomorphology (including latitude above sea level) affects temperature and rain falls. Such a factor of geological climate further affects the ecological system, which also indirectly results in differences of regional environmental color.

GLOBAL SCALE — STUDIES ON PHENOMENA

When we draw the Tropic of Cancer from East to West, the section will pass through the Pacific Ocean, the South China Sea, the Bay of Bengal, the Arabian Sea, the Red Sea, the Atlantic Ocean, the Mexico Gulf, and back to the Pacific Ocean. This section covers an extreme presentation of rain falls: from no rain falls in one year to such a high rate as 3100mm on Taiwan's mountains. In other words, the coverage of the Tropic of Cancer includes both desserts and very humid and rainy subtropical mountainous areas. Certainly, such a variation has to do with the geomorphology through which the cross section goes. Besides, ocean currents and monsoons also have an effect on geographical climate. This is why, from Oman to the West Sahara, there are all dry and unsheltered desserts. If viewed under the satellite, this area shows a gradient that shifts from green to earthy yellow.

Figure1.365days of Global Precipitation

(Source : http://www.cpc.ncep.noaa.gov/products/GIS/map_viewer/cpcgis.html, 2013/09/29)

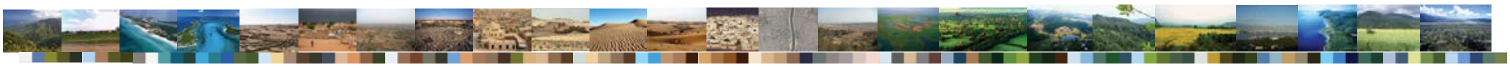


Figure2.Resprestation Color Cross Tropic of Cancer in Global Scale

The spotted parts are small oasis and oceans that are divided by topography. Such landscape and natural ecological characteristics also reflect upon folk customs on this cross section, including architectural material, settlements of dwellings, and traditional clothing. Of course, religious beliefs also can tell how different culture characteristics exist on the same cross section. It is also obvious that in desserts, in order to resist strong sunlight, ultraviolet, and sand storms, the clothing of Muslims resonates with their land color—a convention that also helps reduce radiation from heat. The appearance of their buildings must also keep conservative, coordinating with their land color. Conversely, the low key in their outlook and buildings stimulates them to pursue very colorful styles in their interior design and accessories. Such a contrast exhibits an interesting case study for environmental color and cultural color.

In the same area with the same latitude, high humidity, high temperature and coastlines, monsoons can bring abundant rain falls. This mild and wet geographical climate results in dense vegetation and plants, high biodiversity—thereby rendering very rich natural colors. Overall, settlements in this area must adapt to such an environment: drainage and interception systems must be considered; special building designs, such as pitched roofs and drainage devices, are commonly seen. Clothing and interior design in this area are different from those in desserts. Here, colors of clothing and interior decorations appear subsidiary, which smoothly dissolves with the environment.

To sum up, factors that are used to analyze geographical color on the same cross section in a global scale may include: latitude, topography, distances from sea, wind (monsoons and ocean currents).

REGIONAL SCALE— STUDIES ON PHENOMENA

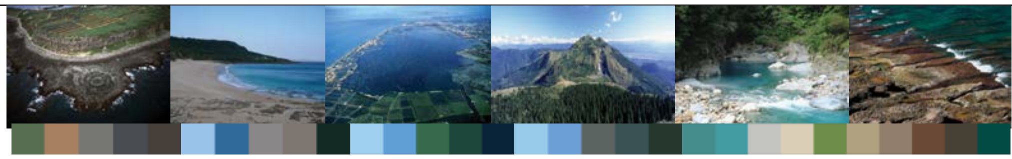
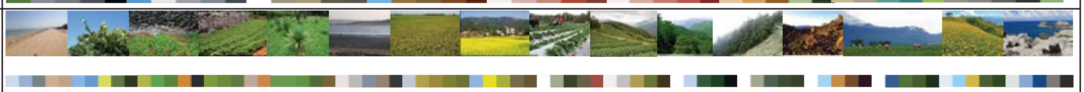
This pilot study consists of both a survey of environments and preliminary analyses on the environmental color of Taiwan's cross section under the Tropic of Cancer. It is used as a case study of Regional Scale.

Compared with any area on the same latitude that is covered by the Tropic of Cancer around the world, Taiwan embraces the biggest amount of topographical variations, including off shore islands, a home island, coastlines, plains and mountains. Although, in regard of general worldwide geographical climate, Taiwan belongs to tropical monsoon climate, it witnesses a very dramatic combination. Since Taiwan experienced a special mountain building movement, between North Latitude 22˚ to 25˚, Taiwan's altitude shifts from the sea level to 3952m—a theatrically gradient shift that brings up great diversity. Moreover, speaking of microclimate, the gradient of plant adaptation can be divided into three climate ecological section: humid tropical zone, humid temperate zone, and polar zone. Subsequently, it can even be categorized into six subfields: savanna, subtropical dryness, temperate rain forest, subtropical zone, sub-polar zone, and tundra.

Accordingly, the hue tone of environmental color can be distinguished from vegetation groupings and soil characteristics. Basically, in this cross section, plain areas include coastline plains, hills, monsoon rainforests, and rain forests, mountainous areas include fagaceae forest, small vegetation areas of pine trees, while only high mountains witness tundra. Because of the Central Mountain Ranges lying in the middle of Taiwan like a string of walls, the overall environmental color of Taiwan is thus determined by humidity. From west to east, the environment appears from dry to humid. As soon as the Central Mountains embraces full water in the air, such humidity continues to the east coast. The vegetation of this cross section, consequently, shows a unique picture because factors of geographical environments all orchestrate here—ranging from tropical to cold zones. As environmental color is concerned, colors of yellow, green, and silver grey green—shown from very dry sand rocks in Penghu, Sisal Agave on sand beaches—gradually encounter mountains, where there are evergreen broad-leaf forest and pine trees. Then, the environmental color transforms into a platform of tundra, where there are Orientalis Arborvitae and Rhododendron shrub, and earth colors by grey, yellow tiny rocks.

As far as culture landscape is concerned, most of Taiwan's rural residences and farm houses are built upon clay, red bricks and grey tiles, viewed from landscape of an intermediate scale, such construction material exhibit local characteristics of "brick" and "clay" —a very representative case is the traditional settlement in Penghu's Wan-an.

Table1.Characteristics of the Environmental Color in the Cross Section Covered by the Tropic of Cancer

Topography	sandy coast---mountain---coastline  0(m)--3952(m)----------------------0(m)
Soil/Geology	
climate	morning-noon-afternoon-evening 
caracteristics of settlements	Gu-lao Stone in Wan-an, coral reef, red-bricked old mansions, red-clayed old mansions 
Landcover (vegetation)	

DISCUSSION AND PROSPECT

This paper, an expression of ambition, attempts to frame a structure in which a globally cross-regional study on environmental color is indispensable. Such a study waits for correlation and linkage from fields such as natural ecology, humanistic history, geographical climate, and others. If any researcher or institute would like to join this cross-regional project, it is advised that regions under the coverage of the North Latitude 23.5° are mutually under the same basis of earth science. It seems very likely that studies on environmental color may be expanded into a globally interrelated applied science.

Tentative conclusions are seen as followed:

1. Factors that have an effect on environmental color are those that belong to natural phenomena:
   geology, temperature, biology, topography, height, microclimate, soil, temperature, rain falls, vegetation, sea, river.
   Factors of culture also play an important role:
   living patterns, forms of industries, land use, patterns of settlements, folklores and customs, religions. Both factors of nature and culture may have cause-effect relationships.
2. Environmental color also serves as an indicator for the transformation of environmental characteristics, including :climate change, environmental change, biodiversity, landscape diversity, diversity of agricultural production, cultural diversity.
3. Latitude is not the absolute factor that determines environmental color. Altitude above sea level and geomorphology also affect environmental color.
4. Microclimates create complex diversity between mankind and land use, and they also influence characteristics of seasonal and space-temporal environmental color of a region.

SUGGESTIONS FOR FURTHER STUDIES AND EXPECTATIONS

Environmental color, a mixed variety of characteristics based upon time, season, and culture, has transformed into an invisible heritage of nature and culture. Thus, further studies with systematic framework are very promising; building a database of environmental color is also very much anticipated. Suggestions are as followed:

1. Conduct an integrated study on the basis of a global cross section.
2. Conduct comparative studies on characteristics of special-featured landscape and landscape color under the same latitude:
3. Conduct research on how civilization has affected land use, thereby causing discordant environmental color.
4. Build methodologies across temporal scopes and scale.
5. Develop regional environmental color into an indicator of Reading Landscape.

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A METHOD FOR HDR IMAGE RENDERING BASED ON ICAM FRAMEWORK

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Keywords: HDR (high dynamic range), rendering, iCAM (image color appearance model)

ABSTRACT

Image color appearance model (iCAM) can predict how an image would be perceived by human visual system under a wide variety of viewing conditions. One of its applications is for high dynamic range (HDR) image rendering. Published studies have verified that iCAM06, the latest iCAM for HDR image rendering, outperforms other tone mapping algorithms. When iCAM06 is used for HDR image rendering, however, there is a hue shift problem with this model and the workflow of iCAM06 is a little too complicated. In this study, a new method based on iCAM framework for HDR image rendering was proposed, which incorporates three main steps, i.e. color adaptation, tone compression and adjustments. Compared with iCAM06, the proposed method is easier to understand and more efficient to apply, and it has better performance for HDR image rendering as evaluated via a psychophysical experiment.

INTRODUCTION

The dynamic range of the real-world scene can reach 8 orders for the sunlight at noon (10^5 cd/m^2), which may be 100 million times brighter than starlight (10^{-3} cd/m^2) [1]. Natural scenes usually span a range of 5 orders [2]. Human visual system is capable of adapting to 10 orders of luminance magnitude in minutes and functions over a range of about five orders of magnitude simultaneously. Through emerging techniques of HDR Imaging, we can capture HDR images by multiple exposures, and store them in HDR formats with HDR encodings. Although the present imaging technology has made it possible to capture and store the broad dynamic range image, the output limitations of common desktop displays as well as hardcopy prints have not yet followed the same advances [3]. The only available commercial HDR display device is a product of Brightside HDR display, but it is far more expensive than we can afford in general usage. Hereby the HDR image rendering algorithms, also known as tone mapping operators (TMOs), are of great importance for displays.

The HDR image rendering algorithm can be classified in different ways [1]. TMOs can be divided into global and local ones by spatial processing techniques. Global operators apply an identical transformation to each pixel in the image, while local operators modulate each pixel dependently on neighbourhood. TMOs can also be grouped into different categories by its mechanism: ranging from sigmoidal compression to image appearance models to a collection of perception- and engineering-based methods.

Published studies have verified that image color appearance model, especially iCAM06, performs better than others, for the rendering images of iCAM06 are more faithful to the real-world scenes and more preferable to those of other HDR rendering algorithms [3]. However, according to recent papers, iCAM06 causes hue shift and color distortion of the output image [4,5,6]. Lee *et al.* proposed the rotation matrix method for hue correction, and they also proposed color adjustment method to compensate the white shift in low-chromatic region and the color distortion in high-chromatic region [4,5].

In this study, a new method was proposed based on iCAM framework for HDR image rendering to solve the hue shift problem and to be of more efficiency for applications. The white point adaptation, chromatic adaptation, and attributes adjustment were inherited from the iCAM framework, while the convenient and efficient tone compression operator was employed.

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PROPOSED METHOD

Our proposed method contains three steps as color adaptation, tone compression, and adjustments, of which the flowchart is illustrated in Fig. 1.

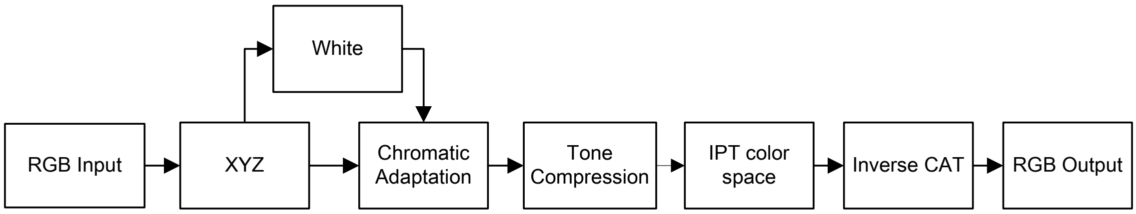

Fig. 1 Flowchart of the proposed method

1. Chromatic adaptation transformation (CAT). The chromatic adaptation transformation embedded in this method is the same as CIECAM02, which is a linear von Kries transformation with an incomplete adaptation factor [7]. The adaptation is processed on the cone response with the equations as follows.

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = M_{CAT02} \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}, M_{CAT02} = \begin{bmatrix} 0.7328 & 0.4296 & -0.1624 \\ -0.7036 & 1.6975 & 0.0061 \\ 0.0030 & 0.0136 & 0.9834 \end{bmatrix} \quad (1)$$

$$D = 0.3F\left[1 - \left(\frac{1}{3.6}\right) e^{\left(\frac{-(L_A - 42)}{92}\right)}\right] \quad (2)$$

$$X_c = \left[\left(X_{D65}\frac{D}{X_W}\right) + (1-D)\right] X, X = R, G, B \quad (3)$$

where D and F are the adaptation factor and surround factor, respectively. L_A is the adaptation luminance, which is 20% of the adaptation white. The adaptation white point (X_W) is obtained by operating Gaussian low-pass filter on the HDR image itself.

2. Tone compression (TC). Since the iCAM compresses RGB cone responses separately, the ratios of RGB channel are imbalanced after compression. In this method, we transform the RGB cone responses to luminance and chromatic channels, then process the luminance channel and hold the chromatic channel unchanged, and at last combine them to form the final compressed cone responses. The photographic tone reproduction operator is chosen to map the luminance channel due to its simplicity and automation [8]. The initial mapping function is expressed as Eq. (4).

$$L_d(x,y) = \frac{L(x,y)\left(1 + \frac{L(x,y)}{L_{white}}\right)}{1 + L(x,y)} \quad (4)$$

where L(x,y) is the linearly scaled luminance by anchoring the average luminance to 0.18, and L_{white} is the smallest luminance that will be mapped to pure white. To accomplish a better result, the advanced operator with automatic local dodging-and-burning technique is applied instead of this initial one.

3. Adjustments in IPT space. In order to predict the phenomenon of Hunt effect, the stage of image attribute adjustments [3] is retained in this method. The images in XYZ space should be converted to those in IPT uniform opponent color space, and P and T channels are enhanced as the function of the factor F_L and chroma value as follows.

$$P = P\left[(F_L + 1)^{0.2}\left(\frac{1.29C^2 - 0.27C + 0.42}{C^2 - 0.31C + 0.42}\right)\right] \tag{5}$$

$$T = T\left[(F_L + 1)^{0.2}\left(\frac{1.29C^2 - 0.27C + 0.42}{C^2 - 0.31C + 0.42}\right)\right] \tag{6}$$

RESULTS AND DISCUSSION

To evaluate the performance of the proposed method, it was tested and further compared with the iCAM06 algorithm. Firstly, the hue shift performance was estimated. The gradient gray stripe alone was rendered respectively by the individual operators, as shown in Fig. 2. Then, the gradient gray stripe was embedded in the common HDR images to test their performances, of which the results are presented in Fig. 3.

(a) iCAM06 **(b) The proposed method**

Fig. 2 The rendered results of gradient gray stripe alone

(a) iCAM06 **(b) The proposed method**

Fig. 3 The rendered images by embedded gradient gray stripe

As shown in Figs. 2 and 3, the reddish shift of white in iCAM06 could be viewed obviously, while the white point is corrected in the proposed method.

Secondly, a psychophysical experiment was conducted for HDR rendered images. We picked 7 images with various kinds of contents including natural scenery in day or night, people in the picture, indoor and outdoor, resulting in the testing images as shown in Fig. 4.

(a) iCAM06

(b) The proposed method

Fig. 4 The testing images rendered by different algorithms

Two rendering pictures were displayed at the same time, and a panel of 8 observers (4 male and 4 female) participating in the experiment was asked to judge which one of them were more realistic according to their experiences. To analyse the comparative visual data, the Law of Comparative Judgement was applied and their Z-scores were calculated and plotted in Fig. 5.

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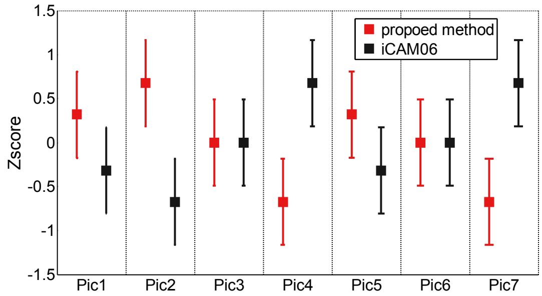

Fig. 5 The Z-scores of the two HDR image rendering methods

It can be seen from Fig. 5 that the proposed method performs better in outdoor pictures of daytime, but produces worse results of indoor or night scenery, in comparison with iCAM06. Then we carried out the additional experiments of contrast and color evaluation, which indicated that the photographic tone operator has some deficiency. Moreover, for the efficiency of the two methods, the time consuming of image processing by iCAM06 is about four times as much as that of this proposed method.

CONCLUSION

In this study, a method for HDR image rendering based on iCAM framework was proposed, of which the main three steps are demonstrated by modifying the iCAM algorithm. The evaluation experiment indicates that this method not only solves the hue shift problem of the iCAM with a preferable results, but also is more efficient. Meanwhile, the deficiency found in the tone compression would be further discussed in the future work.

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Using Color Shading for Pineapple Ripeness Classification

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Keywords: pineapple ripeness: color shading: RGB: HIS.

ABSTRACT

This paper proposes a pineapple ripeness classification in the manufacturing process based on color shading. The pineapple image that is captured in RGB format then converts to HSI format and it is manually segmented. The segmented image is passed to the feature extraction in order to classify the color shade of the pineapple. Mean intensity saturation component of the pineapple color, which is a part of HSI system, is considered as a classifier the pineapple ripeness level. The proposed method then performed testing on the pineapple samples and it can separate the ripeness into 3 levels. Finally, performing the test with pineapple slices and it is found that proposed method can separate the ripeness level of pineapple as same as human does in some degree.

INTRODUCTION

Currently, the use of machine vision system has increasingly used in the agriculture industry particularly in food processing [1] in order to increase the quality of their products while reducing waste and manual labor costs. Color is a significant quality that applies as a criterion in several applications such as fruit [1] and beef [2] grading. Also in the canned pineapple process, the color is used as a key to classify the sliced pineapples before filling into cans in which the slices need to have similar shade of the yellow color. Manual labors are employed to do this repetitive task which involves dozens of people. Color shade of the pineapple is used for classifying by human color perception. Consequently, the automated system which involves identifying a specific shade of a color in an image is required for this task. Digital camera is employed as a sensor of the machine vision system. There are two main sensor technologies: charge coupled device (CCD) and complementary metal-oxide-semiconductor (CMOS) [3] are used in the digital cameras. Both of them, however, capture red, green, and blue (RGB) values of an image. As the colors processing in RGB space, only the differences between colors can be determined but it is not easy to separated shades of the same color [4]. Due to the pineapple have the same color but difference shades therefore the RGB space is unable to do this task. The aim of this study is to investigate the application of digital image processing to measure the color shades of the pineapple slices in order to separate the ripeness level of pineapple.

COLOR MODELS AND CONVERSION

In this section, two color models: RGB and HIS (hue, saturate, intensity) models are explained and discussed. Gonzalez et al. [5] described that "RGB color model is based on a Cartesian coordinate system in which each color appears in its primary spectral components of red, green and blue. The color subspace of interest is in the cube shown in Figure 1 (a). The RGB values are at the three corners; cyan, magenta and yellow are at three other corners. Black is at the original and white is at the corner farthest from the origin. The gray scale in this model extends from black to white along the line joining these two points. Colors are points on inside the cube that defined by vectors extending from the original.”

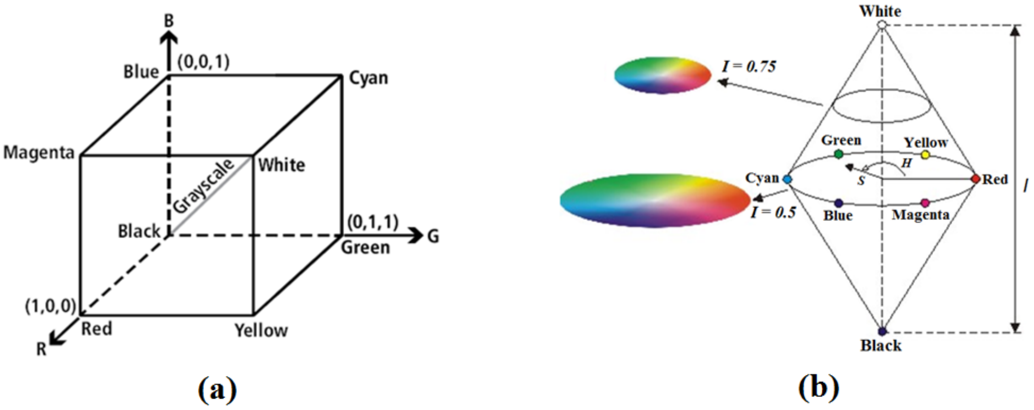

Figure 1. RGB and HIS color models [5,7]

The digital color image ***C*** obtained from the CCD or CMOS camera is in the RGB space that the value of each image pixel can be expressed as [6]:

$$C(x,y) = (R(x,y), G(x,y), B(x,y))^T = (R,G,B)^T \tag{1}$$

HSI (hue, saturation, intensity) color model [6] are used as co-ordinate axes as illustrated in Figure 1 (b). The hue ***H*** is a color attribute that describes a pure color, whereas saturation ***S*** gives a measure of the degree to which a pure color is dilutes by white light. The intensity ***I*** of the color corresponds to the relative brightness. The RGB color image obtained from the digital camera can be converted to the HSI color model for evaluating the hue ***H***, saturation ***S*** and intensity ***I*** values as the following equations [6].

$$H = \begin{cases} \delta & \text{if } B \le G \\ 360° - \delta & \text{if } B > G \end{cases} \tag{2}$$

where

$$\delta = COS^{-1}\left(\frac{(R-G)+(R-B)}{2\sqrt{(R-G)^2 + (R-B)(G-B)}} \right) \tag{3}$$

$$S = 1 - 3 \cdot \frac{\min(R,G,B)}{(R+G+B)} \tag{4}$$

$$I = \frac{1}{3}(R+G+B) \tag{5}$$

and RGB values have been normalized to the range [0,1]. These equations are employed in the next section.

EXPERIMENT

A. Sample preparation

The sliced pineapple images are taken a picture in white lighted illumination with illuminance of 5,000 lux. The RGB images are reduced size to 400×350 pixels then manually segmented the pineapple area from the background as shown in Figure 2 (b). Therefore the pineapple area of each sample image is amount the same. The total 22 samples which are 10 unripe, 9 ripe and 3 overripe samples, respectively are used in the experiments.

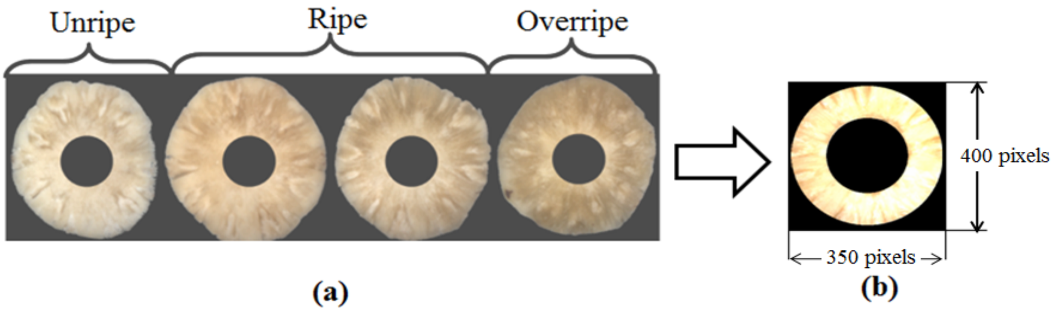

Figure 2. (a) Sliced pineapple image with ripeness stage and (b) An example of segmented sample image

B. Feature Extraction

The segmented image in RGB format is transformed to HSI color space using HALCON. The saturation S using Eq. 4 is calculated for each and every pixel area to get the average value. Background image with pixel value of zero is not included in the calculation. After the calculation, the mean value of the saturation is provided and then employed to determine the range of pineapple ripeness levels that can separate into 3 levels which are unripe, ripe and overripe, respectively.

RESULTS AND DISCUSION

As the testing results of the samples that are beforehand categorized by human as unripe, ripe and overripe. The saturation S range can be considered as color shading are established as the follows: i) unripe pineapple has mean saturation value less than 60, ii) ripe pineapple has S range from 60 to 100 and iii) overripe has S value of more than 100 as listed in Table 1.

Table 1: Ripeness level and its saturation value range

Ripeness Level	Unripe	Ripe	Overripe
Mean saturation value	<60	60 – 100	> 100

Also Table 2 shows the testing of another 18 samples results using the established range compare to the human opinion.

Table 2: Comparison between human opion and the proposed method in ripeness level of the pineapple

Samples	Human opinion	Mean Saturation value	Proposed method	Samples	Human opinion	Mean Saturation value	Proposed method
1	Unripe	56.6786	Unripe	10	Ripe	91.088	Ripe
2	Unripe	69.7164	Ripe	11	Ripe	78.2671	Ripe
3	Unripe	51.3198	Unripe	12	Ripe	80.8526	Ripe
4	Unripe	51.2022	Unripe	13	Ripe	102.042	Overripe
5	Unripe	75.0431	Ripe	14	Ripe	96.2385	Ripe
6	Unripe	57.6034	Unripe	15	Ripe	93.0435	Ripe
7	Unripe	65.3856	Ripe	16	Ripe	88.5845	Ripe
8	Unripe	88.5257	Ripe	17	Overripe	118.498	Overripe
9	Unripe	76.0188	Ripe	18	Overripe	113.742	Overripe

From the comparison results, it is found that the proposed method provide 6 contrast results to human opinion. These errors may cause from the use of unsuitable lighted illumination that effect to captured RGB color value.

CONCLUSION

The pineapple ripeness classification using HSI color model has been demonstrated and presented. It is found that the mean saturation value *S* could use as a criterion or color shading for classifying the ripeness of the pineapple in some degree. Also there are contrasts results that might cause from the lighted illumination that used direct light to the pineapple. However, this shortcoming is able to be overcame by improve the lighting system. Moreover, the other color models such as HSV (hue, saturation, value) CIE color model will be investigated and applied in the future study.

Oral paper

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Oral paper OB15

MULTICOLOR LED LIGHTING APPARATUS FABRICATED TO DEMONSTRATE METAMERISM

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Keywords: LED: lighting apparatus: metamerism

ABSTRACT

Metamerism is a phenomenon in which colors of two objects appear the same under a lighting condition while they appear different under another lighting condition. Since metamerism have caused troubles among manufacturers and consumers, it is desirable to develop lighting apparatus to produce various lighting conditions. The author reports that we can make such lighting apparatuses using LEDs. An easy way is to use power LEDs which are provided in packages easy to handle. However, they are not always sufficient due to inadequate color variety. More satisfactory apparatuses can be made using deep red, red, amber, green, cyan, blue, and purple (royal blue) chip LEDs. However, chip LEDs need to be handled with care. The author shows jigs and ways to fabricate lighting apparatus with chip LEDs, and demonstrates amazing metamerism.

INTRODUCTION

Performance of LED lighting apparatus depends on the assortment of LED colors. However, wavelength ranges of available LEDs are restricted to those of mass production. Recently, power LEDs of various colors are available in chips. So, the author fabricated multicolor lighting apparatus with chip LEDs. Fabrication with chip LEDs was a tough challenge; chip LEDs are so small that tweezers were necessary to manipulate under a magnifying glass. Another difficulty was due to the fact that chip LEDs were weak to heat; they had to be soldered with temperature under 300 degree centigrade. This paper will show how to make lighting apparatus with chip LEDs.

CHIP LEDS

The lighting apparatuses were made with Philips LUXEON Rebel chip LEDs: deep red (λ_D = 655nm at 350mA), red (λ_D = 627nm), red orange (λ_D = 617nm), amber (λ_D = 590nm), green (λ_D = 530nm), cyan (λ_D = 505nm), blue (λ_D = 470nm), and royal blue (λ_D = 448nm). Figure 1 shows their package outline. Light is emitted through the dome lens on the top sueface. There are a thermal pad and two electrical contact pads on the bottom surface.

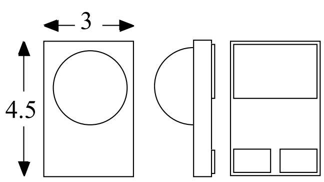

Figure 1. Package outline.

ELECTRONIC CIRCUIT

Figure 2 shows the LED lighting circuit. Power source voltage is 4.8V for a portable apparatus using nickel-hydrogen cells, and 5V for a desktop apparatus using an AC adapter. Current of each LED is around 100mA. Each resisters are 22 Ohms. To obtain adequate brightness, two LEDs are used for each color.

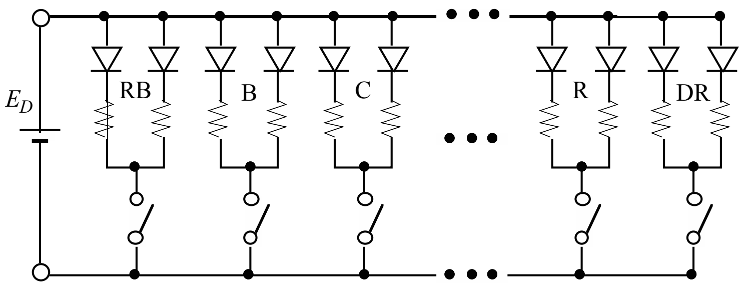

Figure 2. LED lighting circuit.

SOLDERING THERMAL PADS

Solder the thermal pads of chips to the copper radiation plate in the following procedure.

(1) Cover an end of copper radiation plate with solder on a temperature-controlled hot plate.

(2) Put a peace of double-sided adhesive tape on an end of paper card of the same thickness as the radiation plate.

(3) Stick electrical connecting pads of LED chips to the adhesive tape on the paper card so the thermal pads overhang.

(4) Stick all LED chips as above in line.

(5) Place the paper card with LED chips next to the radiation plate on the cooled hot plate so that the thermal pad of each chip is on the soldered radiation plate as shown in Figure 3.

(6) Switch on the hot plate so the solder on the radiation copper plate reflows and thermal pads of LED chips are soldered to the radiation plate.

(7) Switch off the hot plate as soon as the solder reflows and chip soldering is completed.

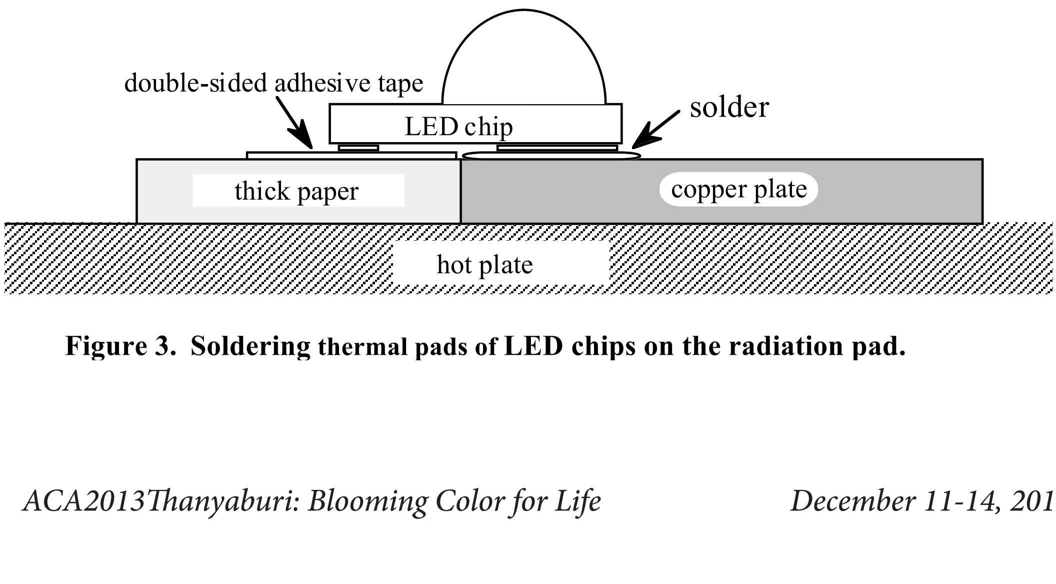

Figure 3. Soldering thermal pads of LED chips on the radiation pad.

(8) After the thermal pad soldering, LED chips are tightly fixed to the radiation plate. So, detach the paper card from the chips.

SOLDERING ELECTRICAL CONNNECTING PADS

To solder electrical connecting pads of chips, temperature-controlled soldering iron is necessary. Since the chips are cooled by the radiation plate, the temperature of soldering iron can be set around 320 degree centigrade. Figure 4 shows LED chips soldered to a radiation plate. The radiation plate has been bended round so the light is focused at the distance around 30cm. The radiation plate has been attached to an aluminum plate on which resisters has been glued and wired.

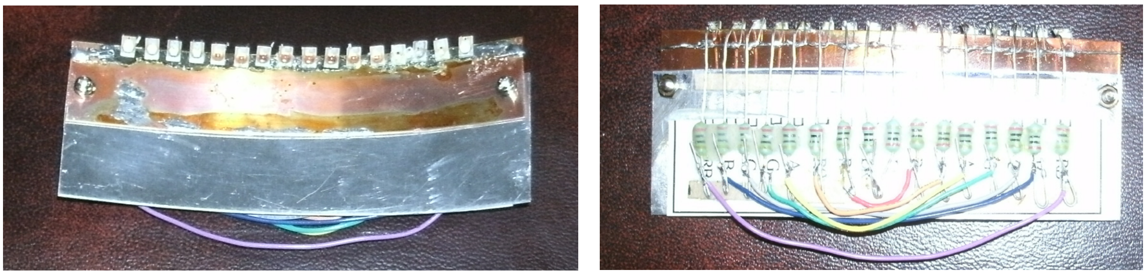

Figure 4. LED chips soldered to the radiation plate.

SAMPLES OF APPARATUS

Figure 5 shows a portable type apparatus (left) and a desktop type apparatus (right). The portable type apparatus is equipped with four battery cases each of which contains four size AA batteries.

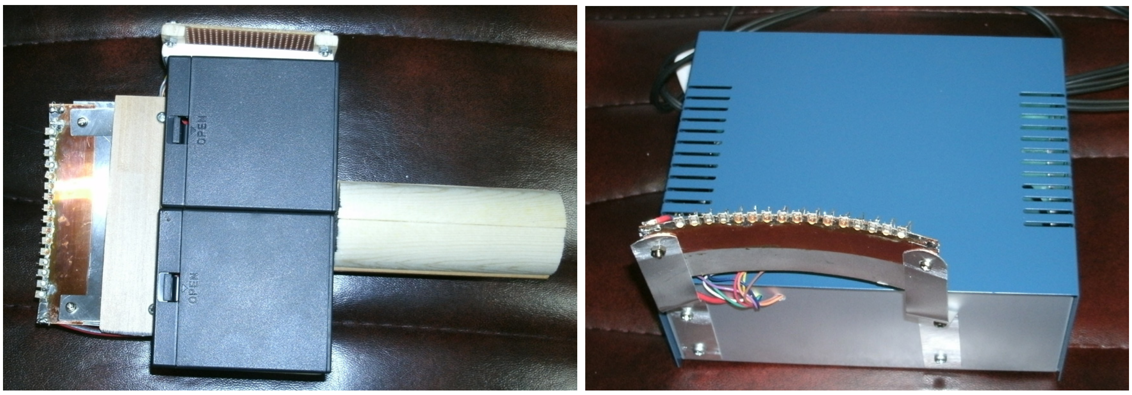

Figure 5. A portable type (left) and a desktop type (right) apparatuses.

PERFORMANCE

With 8 color LEDs, the apparatuses show satisfactory performance. For a brown pair and a green pair of metameric cards, we can observe metameric match and metameric failure.

CONCLUTION

Using chip LEDs of various colors, we can make lighting apparatus with sufficient performance to demonstrate color metamerism.

Investigating the Wrong Decision of Fashion Designers on the Creativity of Color Combination for Apparel

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Keywords: Apparel, Psychophysical Experiment, Color Imagery, Originality

Oral paper OB21

ABSTRACT

Designers usually choose a lot of color combinations to match their originality of fashion apparels in conformity with their own subjective sensations. But, it may frequently result in against what they expected. Therefore, an experiment including a semantic differential method and the color psychophysical method Magnitude Estimation Method[3] was conducted in this study to explore how a designer's error is in the selection of color to give a specific creation color-meaning to her/his new apparel works compared with what people actually respond to those works. The result shows that fashion designers would have about 20% error in the selection of colors to match their originality of fashion apparels being away from those color imageries of the observers examined. It also indicates that an effective color imagery model is needed to be a good tool for designers in creating new color fashion.

INTRODUCTION

In general, from the beginning of human in prehistoric times, there exist four major original function purposes of clothing, the modesty, immodesty, protection and adornment. But, nowadays, art-work has already gravitated from the individual "Originality" of highly expressive artists to Mass-produced vision-perceptual semiotic games that facilitate audience participation and consumption.[1] Meanwhile, the role of the ultimate consumer in the fashion business is an important one and, in the final analysis, controlling. The controlling role of the consumer is not unique to the fashion industry. Every business that serves the public has to guide its operations in the light of consumer demand. Consumer demand becomes the guide to intelligent production and merchandising. A knowledge of the fundamental facts of what consumers want and why is clearly of the first importance to those who design the product, prepare the advertising and sales promotion, sell the goods and make the collections, etc.[2]

The originality on the works created by artists, in fact, frequently cannot match with the perception and demand of consumers completely. It is a great problem for fashion industry at present to have to be solved due to the importance of the role of consumer as depicted above. And, especially, the color imagery of consumers on fashion apparel with color combination is the first important factor among all those perception and demand ones. Therefore, the authors conducted an experiment by means of a semantic differential method and a psychophysical experimental method Magnitude Estimation Method[3] to examine the wrong decision of designers on the creativity of color combination for apparel.

EXPERIMENTAL

Two types of apparel and five fashion colors were created and employed by two designers participating in this study as shown on Figure 1. The originalities of these fashion colors for those apparels were also provided and indicated in the Table 1 before they all were arranged in the psychophysical experiment of color-imagery assessment conducted in this study.[3] And, in the visual assessment of scaling color imagery, 10 color-image specimens of apparels with fashion colors respectively described above having a large size of 3×3 square inch subtending 10^0 visual angle, shown on a flat display in a dark room. Each sample was assessed twice by a panel of ten observers including five female and five male ones, within the ages of 20 and 35. And, fifty-two pairs of semantic differential words were also used. Totally, 10400 assessments were obtained.

(a) (b)

Figure 1 Two examples for two types of fashion apparels respectively were created by the designers in this study, (a) the first type and (b) the second type ones.

Table 1 The CIEL*a*b* coordinates of color samples tested and the related originalities given by the designer in this study.

Color Sample No.	CIE L*,a*,b* Coordinates	Originality of Designers
1	42, 2, 6	Elegant and Mature
2	43, 5, 2	Sweet and Lovely
3	44, 8, 5	Soft-beauty and Harmonious
4	62, 4, 1	Pure and Fresh
5	56, 2, 2	Graceful and Beautiful

Table 2 The mean results of visual color imageries are listed for five fashion colors tested respectively. The abbreviated CSN indicates Color Sample No., MV Mean Value and SDPW Semantic Differential Pair of Words. The symbol "+" indicates that the word with "+" has the positive meaning of color imagery, on the other hand, the other one the negative.

SDPW \ MV \ CSN	1	2	3	4	5
(+) Beautiful-Ugly	-15	26	21	21	19
(+) Complicated-Simple	-35	-20	-30	-31	-27
Relaxed-Tense (+)	-7	-34	-24	-29	-11
Mature-Young (+)	-33	21	35	19	-13
(+)Fashionable-Unfashionable	-16	32	27	7	11
(+) Respectable-Contemptible	-7	26	34	28	28
(+) Natural-Affected	-11	-11	-10	30	-4
(+) Perceptual-Reasonable	6	20	25	-3	-12

RESULTS and DISCUSSIONS

There were fifty-two pairs of semantic differential words being used in the psychophysical assessment experiment of color imagery as described previously. And, a normal repeatability of observers with the mean value of 79 in the unit of coefficient of variation (CV %) was obtained. According to the selected ratio value for every pair of semantic differential words obtained from visual results,[3] eight ones having the selected ratio value larger than 99% are chosen, and their mean results of visual color imageries are listed in Table 2 for five fashion colors tested respectively. The results indicate that the observers feel Relaxed, Simpler and Mature, but Ugly, Unfashionable, Contemptible, Affected and little Perceptual to the No. 1 fashion color tested as shown in Table 1, but this result is almost against the originality for the No. 1 given by the designers in this study.

For the rest four fashion colors No. 2 to No.5 examined, the visual results of color imageries may nearly completely match with those originalities by designers respectively, with the exception of the imagery sensation Affected. Finally, on the whole, it is obvious that a fashion designer would generally have about 20% wrong decision on the selection of color combination for his/her own creativity of fashion apparel. Further and more field trials may be needed to verify this finding.

Oral paper

CONCLUSIONS

Designers determine to choose a color combination to match their originality of fashion apparel usually in conformity with their own subjective sensations. But, it may frequently result in against what they expected. The wrong decision of fashion designers was examined using an experiment with the semantic differential and the psychophysical methods conducted and carried out in this study. And, two types of apparel and five fashion colors proposed by two designers and fifty-two pairs of semantic differential words were also employed. Each sample was assessed twice by a panel of ten observers. The conclusions can be obtained as follows: a normal repeatability of observers with the mean value of 79 in the unit of coefficient of variation (CV %) was obtained. Most fashion colors tested can match with those originalities by designers. But, there still exists about 20% wrong decision on their selection of color combinations for their creativity of fashion apparels. It also indicates that an effective color imagery model is needed to be a good tool for designers in creating new color fashion.

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Oral paper OB22

AN ANALYSIS ON JAPANESE PACKAGE DESIGNS FROM THE POINT OF A CHINESE DESIGNER

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Keywords: package design, consumer, color, design, food package

Abstract

The package design is an important part of measures representing the countries, nations and cultures([1], [2], [3]). The aim of this paper is to analyze Japanese package designs from the point of a Chinese designer. The Japanese package designs faces directly consumer's needs in colors, in materials, in designs and in letters. They are concerned with environment. Many of them are made from recyclable stuffs, ex. paper, wood, or hemp. Almost all milk package is made from paper. They show Japanese traditions by combinations of Japanese letters, ex. Kanji(originally produced in China), Hiragana, Katakana and so on. They also pay much attention to their affordance which they would have to let consumer pick up, open and eat easily. Their "pretty" colors are also characteristics of Japanese package designs that we, Chinese designers have to learn. Generally Japanese package designs are quite kind to consumers.

INTRODUCTION

In the rapid development of economy modern days, a plenty of products have appeared and both the artistically and practically higher request increased for the package of various products. The package design came into people's daily lives being a form of the artistic expression.

Americans regard package design as a tool to earn money, North European people feel package design as a necessity in their daily lives. Japanese people, on the other hand, assume that package design is the mean for the existence of their nation.

Two factors gave influence on Japanese package design: One was the need for the simplicity and small scale. They seem interested in design of down-sizing, standardization and of multi-functions. The second is that they think much of their traditional culture. They integrate various aspects of the race in to design.

In the present paper. the characteristics of Japanese package design, especially food package designs, were analyzed in comparison with Chinese one.

ANALYSIS

1. Japanese package designs showing their ethnicities

The package design nowadays are the expression of culture. Japanese package designs possesses prominent traditional culture. They have used a variety of means to emphasize Japanese traditional culture and evoke consumer's sympathy. For instance, they use new fonts in combinations of " Kanji" which are originally Chinese characters and Japanese characters, "Hiragana" or " Katakana" which are deformations of Kanji.

Japanese package designs inquire the traditional culture in terms of form, color, and material (Fig.1).

They try to fusion such tradition with innovation of technology. Japanese people traditionally feels good for what is expressed through natural things. They will feel the beauty of nature to see sacks made of hemp.

Based upon their tradition, Japanese people created original culture absorbing those of other countries. The diversity of Japanese culture revealed in diverse package designs in daily lives. In Japanese packages, do exist in harmony two of the forms of fashionable and convenient style and composition by Euro-American influence and that of Japanese style.

２． *Japanese food package designs*

Food is one of the most important part in our daily lives. The package designs are the total reflections of bland concept, function of products and consumer's mind etc. They have the direct influence upon consumer's purchasing desire. It can be said that the package is a strong tool to construct affiliation between the products and the consumers.

This is prominent especially in food packages. Japanese merchandise society is approaching to its maturity. Japanese consumers want higher things for merchandises. As a consequence, many companies make much of package designs. Such package designs attract consumer's attention as the one which are simple, easy to open, convenient and soft to environment.

Fig.1 The package desig using traditonal characters and figures.

Fig.2 The package of bamboo

1) Japanese food designs are the environment- protective expressions

In these modern lives, people are seeking the oasis for their lives. People want to be back to nature even when the civilization and the technology have highly developed.

Recent days many people are much interested in the protection of environment. Japanese people have formed strong mind of environmental protection due to their island nation and scarcity of resources.

Japanese designers in package automatically take the environmental protection into their works. They select the materials which would not pollute the environment and are easy to recycle. Almost

Fig. 3 The package of paper.

Fig. 4 An example of humanized design.

Fig. 5 Hot food (right) and salty food (left)

Fig. 6 Designs by shapes and styles.

all the materials of food package are now plastic through the world. Plastic materials have very bad influence on environment because they resist to be decomposed. "The white pollution" have been an issue through the world.

Japan has succeeded in this point. Many food companies have gradually destroyed the plastic packages and prefer to utilize materials which can be decomposed easily, for instance, paper, wood, and hemp cloth (Figs. 2, 3).

In Japan, many paper package have "tag" to use for opening. One of the package that is most accepted by Japanese consumers is "the paper bottle for liquid". The mouth of a paper bottle is equipped in special design for easy opening. The paper bottle is thus replacing the pet bottles.

2) Japanese food package designs are humanized designs

Through designs the impression and the feeling of the food are expressed. “Humanized design” is spreading all over the world. Japan particularly emphasizes humanized design. What humanized design shows is convenience. One instance is yogurt (Fig.4). You can drink it by straw. You can also drink it by opening its mouth. But in the latter case, you do not need to open the mouth fully; as a tag is attached at the back of the mouth, you can stop the mouth at the half position. The deadline for consumption is printed on the package. The package of vivid color attract many consumer’s attention. But as such print by vivid color may be harmful for health, Japanese packages refrain from being so colorful. They do not use harmful inks.

Also Japanese packages create psychological communications with consumers. They sometimes personify the package both in color and design. So the consumers are evoked some psychological reactions. Say, they use red color in package for hot foods. They also utilize the figure of "fire" as design. So the consumers can learn how hot is the food by its color and design. Japanese package utilizes not only color and design but the shape, material, and quality of the container to let the consumer know the taste of food (Fig. 5).

Japanese consumers are fond of something pretty, "kawaii" in Japanese, utilizing cartoons or designs something like cartoons. These figures make the consumers accept the product informations so easily. Thus Japanese package designs employ different colors, shapes, and styles to stimulate consumers' visual, tactile, and taste senses all together (Fig. 6).

CONCLUSION

Japanese package designers have spent much time for research in sincere attitude and developed humanized designs holding traditional styles. These are what we Chinese designers must learn. That they demand quality in details means that they have responsibility for their works. They also respect consumers. For good designs is important the influence of the regional culture. Without culture, there is no spirit. It seems to the author as a young Chinese designer that many Chinese package designs mimic Euro-American designs and lack original appeal with no creative work. Japanese package designs, on the other hand, posses their original styles in harmony with their tradition and modern fashions. This is the point of success in Japanese package designs and the point that Chinese design have to learn.

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Oral paper OB23

THE COLOR DESIGN OF THE BOOK SLEEVE AND THE CONSUMER'S PURCHASING BEHAVIORS

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Keywords: book design, book sleeve, consumer's purchasing behavior, image, color

ABSTRACT

This paper aims to explore which color design of the book sleeve was chosen by the consumers for purchase. 160 university students, who had paid for the book, were requested to choose a book covered by one of 16 types of the sleeve. The book was the textbook of psychology which would be used in the class. The cover of the book was largely in yellow-green with black gothic letters (Kanji). The book sleeve chosen most was the white surface with red letters of Mincho font and the black one with white letters of Mincho font. The results generally showed that the clear image of the book sleeve was critical and the Mincho font was preferred. The second experiments were conducted both in Japan and China, in which the image of the same books with 16 types of the sleeve were measured with the SD method for the students in each universities. The results show that for Chinese students the image of "heavy-light" is important for choice of book. They prefer to a book having "heavy" image. On the other hand there seems no particular image which is relevant with choice of book for Japanese students.

INTRODUCTION

The color design of the book cover and sleeve are very important for the book to be purchased [1]. The author studied the book design in a university in China and created several works shown in Fig. 1 and 2[2][3]. The conclusion of the study was that the higher the value of beauty of the book design, the more the consumers want to buy the book. But that is a theoretical prediction. There was no actual data indicating the positive correlation between them.

The present study, which was conducted after belonging in the present affiliation, tried to prove the above assumption.

Experiment 1 was carried out to explore which design and color of the book sleeve would be chosen by university students for purchase. Experiment 2 was tried to see which image of the book sleeve would be correlated with the choice of the book. This experiment was done both in Japan and China for cross- cultural comparison.

EXPERIMENT Ⅰ

METHOD

Books:

Some of the books used were shown in Figs. 3, 4, and 5. In total of 16 kinds of books with different sleeves (5 colors, 2 fonts including reverse patterns) were used. Those books were arranged at random in a way like a square on the desk.

Participants:

In total of 160 students of Kanagawa University, who would take the class and had already paid for the book, were requested to choose one of them one by one by before the class stared. The age of them ranged from 18 to around 23.

Fig. 1 A Creation by Li (2008)

Fig. 2 A Creation by Li (2008)

Fig 3 The book sleeve chosen most.

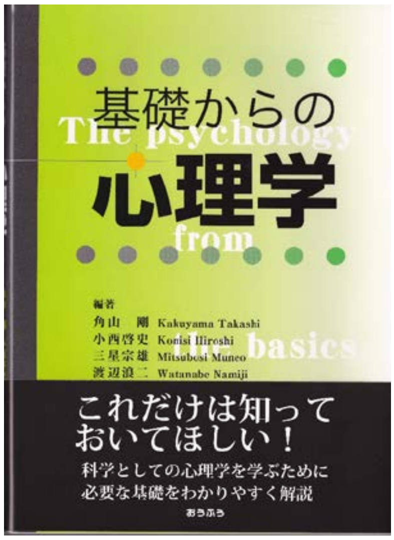

Fig. 4 The book sleeve chosen second most

RESULTS AND DISCUSSIONS

The Figs 3 and 4 show the books chosen most at the same rate (0.12). The book sleeve of Fig 3 was the one which female students chose most, and that of Fig. 4 the one which male students chose most. The books chosen second most were the one with white letter of Mincho font on the blue background and the one with white letter of Gothic font on the black background at the same rate(0.11). The book sleeve chosen least was shown in Fig. 5 at the rate 0.012.

Generally speaking, clear images of the book sleeve, white letter on the background of any colors, were preferred to the students. Fig 3 is exceptional! The font of Mincho was a favorite for them.

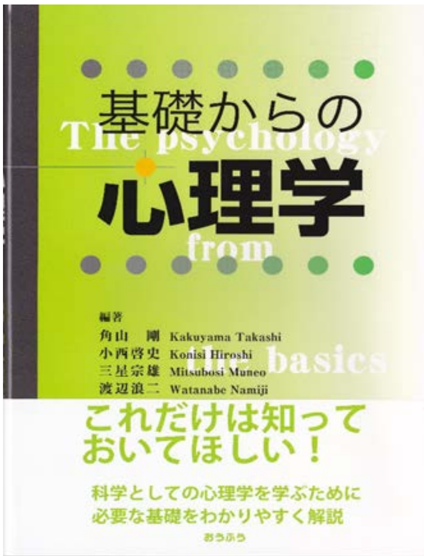

Fig.5 The book sleeve chosen least

EXPERIMENT Ⅱ

METHOD

Materials
The images of the same 16 kinds of books with different sleeves were used. The images of the front covers of the books with sleeves, just like as Figs. 3, 4, and 5, were printed and delivered to the students.

SD scales:
Twelve SD scales with 7-points were used: 1. like - dislike, 2. soft - hard, 3.thick - plain, 4. elegant - vulgar, 5.monotonous - changeful, 6. heavy - light, 7. dynamic - static, 8. simple - tedious , 9. romantic - realistic, 10. modern - ancient, 11. natural - unnatural, 12. beautiful - ugly.

Procedure
The participants evaluated the image of the book cover using 12 SD scales in their classes. Sixty-six students participated in Hunan City University, China and eighty-one students in Kanagawa University, Japan.

RESULTS AND DISCUSSION

Figs 6 shows the rate of choice of book by the students in China (left) and the most relevant image (right) judged from the similarity of the shapes of two curves. The other 11 images are totally different from the trend of Fig. 6 (left). The students in China seem to choose the book by the image of "heavy-light" as long as this data shows. They prefer to a book having heavy impression.

Fig. 7 shows the choice of rate of book by Japanese students. There is a tremendous difference between Fig 6 (left) and 7. Chinese students preferred the No. 3 book sleeve most, while Japanese students did prefer that sleeve least. Fig. 8 show the No.3 sleeve. There seems no particular image which is relevant with the choice rate for Japanese students. Thus Japanese students seem to choose book not by a single image but by multiple factors.

ACKNOWLEDGEMENT

The author would like to thank all the students of Kanagawa University and of Hunan City University, who were willing to participate in this study.

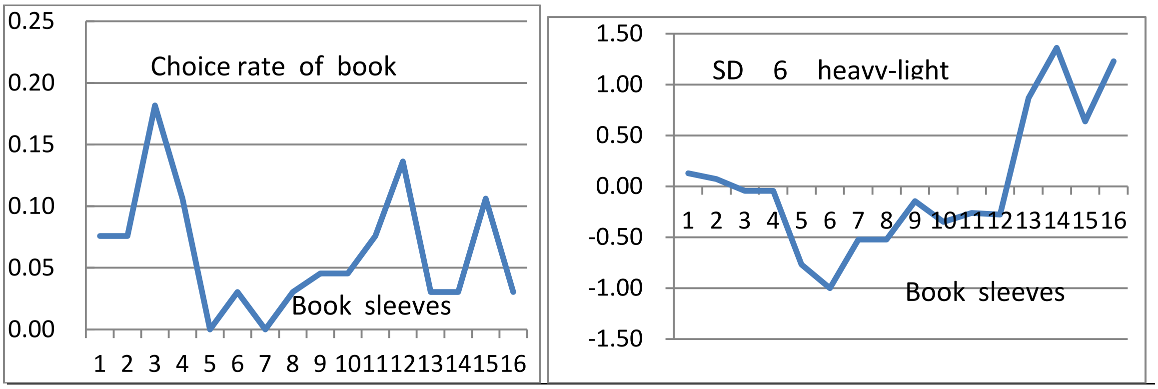

Fig 6 The choice rate of book in China (left) and the most relevant image (right) .

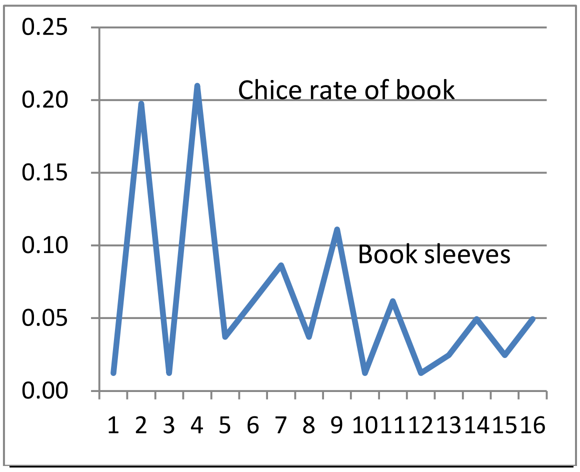

Fig 7 The choice rate of book in Japan.

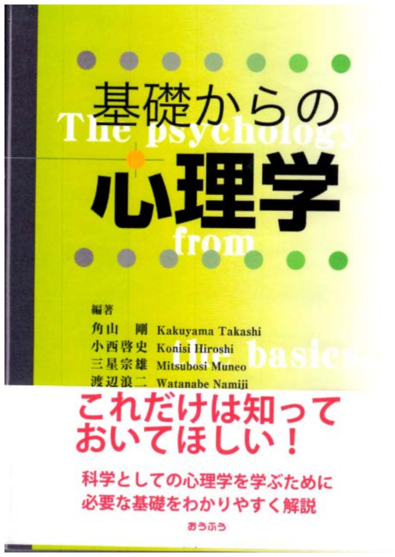

Fig.8 The book sleeve No.3.

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EFFECTS OF COLOR DECORATION ON USERS' FEELING AND OPERATIONAL PERFORMANCE ON TOUCH PANEL DEVICE

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Keywords: Interface design, color design, usability

Oral paper OB24

ABSTRACT

A novel representation model of relationship between interface color design and operation is proposed. User performance and screen impression data are used for creating the model. To evaluated users' performance, experiments have been conducted with a simple application of arithmetical calculation in which a touch panel is used. Furthermore, questionnaire approach has been used to assess the screen impressions. Finally, the proposed model has been created via analysis of Structural Equation Modeling (SEM). By using the proposed model, we can verify the effects of touch panel coloration on operator's feeling, and clarify how the feelings affect the operations.

INTRODUCTION

Touch screen technology is widely used for ATMs (Automated Teller Machines), ticket vending machines, interactive kiosks and so forth. Many personal devices such as smart phones, tablets PC, also use this technology. These devices are used in several fields e.g., health care [1]. Touch panel interfaces have some advantages, i.e., easy use, flexible design, and better performance. Therefore touch screens have become prevalent, and user-friendly touch panel interfaces are required.

Color information is one of the most influential factors which affect users' perception, physiological reaction and emotion reactions [2]. There are many studies which inquired into relationship between interface design and operation. However, user's perception for the interface is difference depend on the individual. It can be assumed that the difference might be caused from the user's feeling. Thus, this research aims to clarify the causality between effects of coloration and users' performance by considering through users' feeling perspective. Correlation between colorations and users' emotion is investigated as well as the relationship between users' emotion and operational performance is also verified and a representative model is proposed.

LITERATURE REVIEWS AND RESEARCH MODEL

Relationship between interface design and effects on users' behavior has been being discussing. Cyr et al. [3] found that website color appeal is a determining factor for website trust and satisfaction. Bonnardel et al. [4] sought the effect of website colors on users' cognitive processes and the impact of the color on the users' revisit rate was found. The results show that the user spent for longer time on web sites which have warm colors than which have cool colors. Similarly, Sakamoto et al. [5] studied relationship between impressions by looking the color designing of touch panel interfaces design and the operations, and concluded that the colors which are cool-casual scheme (i.e. mild green and mild yellow) have positive effects on users' performance. Besides, they argued that the emotional of the operator are strongly related to accuracy of the operation.

In all of above mentioned interface studies, relationships between design and user's behaviors were investigated. This scheme can be represented as Figure 1 (A). However, cognition of design varies from person to person and the relationships also may change depend on an individual. Thus, the authors have assumed another scheme represented in Fig. 1 (B): At first, an interface design is recognized by an operator, and he/she has some feelings about the design. Then, his/her operations are influenced by the feelings. In order to verify the validity of the scheme, a Structural Equation Model has been created and has been analyzed.

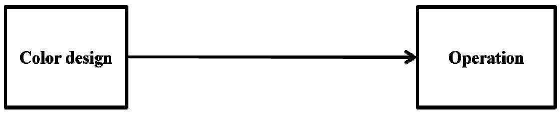

Figure 1(A). Traditional model

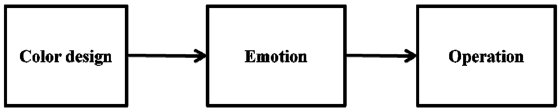

Figure 1(B). Proposed model

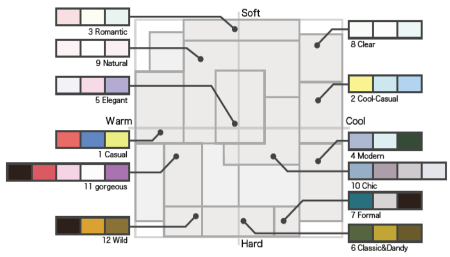

Figure 2. The twelve color schemes which were used in this experiment

CREATING PROPOSED MODEL

In this section, the methodology of creating proposed model is described. In the data gathering process, two methods are adopted: experiments and questionnaires. The relationship between user's feeling and operation are investigated through experiment. The participants are asked to work arithmetical tests (single digit ones) and questionnaires in order to examine users' feelings on each screen. Afterward, experiments data and questionnaires data were prepared in order to create proposed model. The participants were males and females student in their twenties to thirties.

Experimental equipment

To get performance data, a simple computer application which quizzes addition questions was used. The bottom of screen of the application is decorated by a color schemes. This color scheme can be chosen from the color sets on the mix color image scale [6], which is an image map which transforms color schemata into impressions. This scale has two axes, "soft-hard" and "cool-warm." Twelve major descriptive phrases were selected as representative color schemes as shown in Figure 2. The background of the windows are colored by pale gray (N8), and the push panels' color are white (N9.5). The color of characters are dark gray (N3). The colors of these components were chosen by considering visibility of characters in the screen. The three alternatives of question are placed for each problem. An example of screen which used in this experiment is shown in Figure 3. In the experiments, the decoration color scheme was chosen from representative color schemata which mentioned before. Each screen was displayed with a different color scheme without changing other components.

Tasks

In the experiments, the participants tried single-digit mental arithmetic tests. The participants were requested to select one correct answer from three alternatives by touching one of three push buttons. If a participant does not touch any buttons within 1.5 seconds, the system moved on the next problem automatically. Thirty different problems were contained in each condition. The spending time and the accuracy rate were chosen as indicators to measure operational performances, and recorded.

Evaluation of users' feeling

Questionnaires have been conducted to obtain participants' feeling data for each screen. The questionnaire comprised fifth-teen sensations query: preference, understandability, visibility, enables concentration, volition, hesitation, number of tasks, familiarity, eye strain, readability, beauty, trouble, comfortableness, impressive, and safety. Rating linear measurement method was utilized for the scoring. A part of questionnaire is shown in Figure 4.

Procedure

The experiment ran on twelve different conditions as described above. In each condition, each participant requested to do calculation tasks and answer questionnaires. Figure 5 shows the timeline of the experiments. In the beginning, each participant got the instructions and trialed a training task. The training task was conducted on a screen that had no color decoration. Then, a participant has done tasks on the twelve screens. Afterward, the participants had to answer the questionnaire to evaluate their feeling with each decorated color scheme. A two minuets break was given between each condition. Then, the proposed model has been created by using Structural Equation Modeling (SEM). SEM is technique to express a complicated statistical model by a path diagram which expressed the causation between variables in an arrowed line clearly. As SEM model, each square represents variable as well as each arrow means causation between variables. A numerical value expresses a degree of effect [7]. SEM helped us to explore the causal relation between color schemes and user's emotions along with relationship between emotions and performances. A sample model was generated from analyzing data which gained from the experiments and the questionnaires. Figure 6 shows the generated model.

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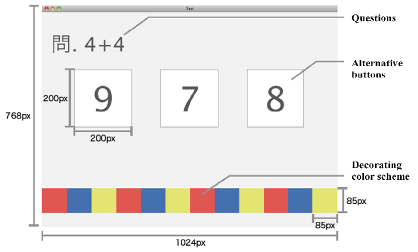

Figure 3. An example of screen which used in this experiment

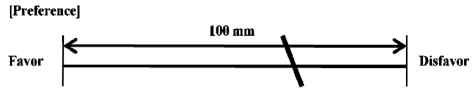

Figure 4. An example of rating linear measurement method which used in the experiment

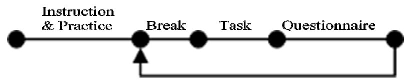

Figure 5. The procedures of the experiment

RESULTS AND DISCUSSION

In this section, the validity of proposed model was discussed. As shown in Fig. 6, there are fifth emotions which linked up the operations. Correlations between the results of the performances and the feeling on the screens are shown in Table 1. There are positive correlations between the both operations and the safety. There is also a positive correlation between the spending time and the hesitation. In addition, there is a positive correlation between the accuracy rate and the understandability. On the other hand, there are negative correlations between the performances and beauty. There is also a negative correlation between the spending time and the activeness. Hence, it can be said that the operational performances and the user's feeling have a causal association. Following, the results of evaluated feeling on each screen which used in experiments are shown in Table 2. We can notice that different colors decorating can reflect individual emotion.

CONCLUSION

A new scheme which represents relation between design and operation has been proposed. With this model, we can understand the scheme in which how an operator feels about an interface design, and how the operation gets effects from the feelings. Experiments and questionnaires have been conducted to generate an example model. Then the model has been analyzed. The results of the analysis demonstrate that each color can reflect emotion differently. Besides, the safety has been found to have positive effect on operational performances. On the contrary, the beauty has negative effect on operational performances. This avenue of research further has potential to provide interface designers with enhance knowledge for how to design capital interface through the effective use of colors.

ACKNOWLEADGEMENT

This work was supported by Grants-in-Aid for Scienctific Research from Japan Society for the Promotion of Science (NO. 23653260, 21360191, 23611025)

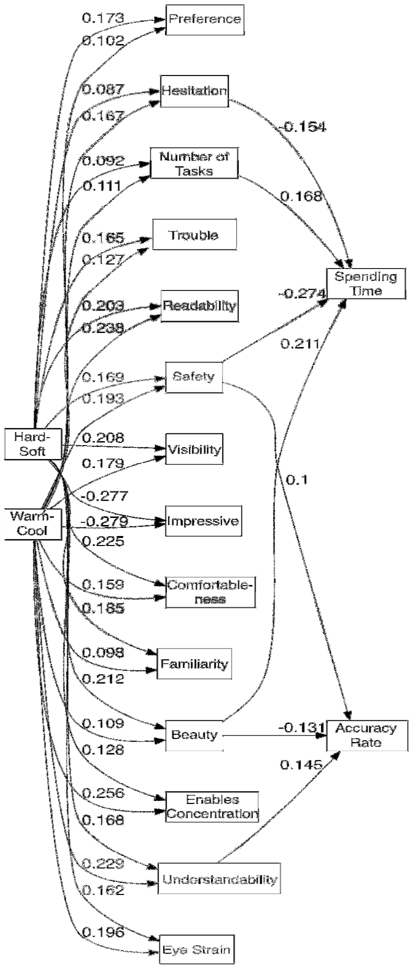

Figure 6. The results diagram from Structural Equation Modeling

Sensation	Performance	
	Spending time	Accuracy rate
Preference		
Beauty	0.211	-0.131
Comfortableness		
Familiarity		
Visibility		
Readability		
Trouble		
Hesitation	-0.154	
Concentration		
Understandability		0.145
Number of tasks	0.168	
Impressive		
Safety	-0.274	0.100
Eye strain		

Table 1. The causal relations between user's feeling and operation

	Preference	Beauty	Comfort ableness	Familiarity
Warm-Cool	0.102	0.109	0.159	0.098
Soft-Hard	0.173	0.212	0.225	0.185

	Visibility	Readability	Trouble	Hesitation
Warm-Cool	0.179	0.238	0.127	0.167
Soft-Hard	0.208	0.203	0.165	0.087

	Concentration	Understandability	Number of tasks
Warm-Cool	0.256	0.229	0.111
Soft-Hard	0.128	0.168	0.092

	Impressive	Safety	Eye strain
Warm-Cool	-0.279	0.193	0.196
Soft-Hard	-0.277	0.169	0.162

Table 2. The correlations between colorations and users' feeling

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THE CORRESPONDENCE BETWEEN MACROSCOPIC APPEARANCE AND MICROSCOPIC COLORS INVESTIGATED BY LIGHT AND ELECTRON MICROSCOPY

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Keywords: effect pigments, real structure, color, SEM, TEM, FIB

ABSTRACT

Plate-like effect pigments (with diameters between 5 – 40 µm and less than 1 µm thick) are widely used to create decorative appearance in coatings, prints, plastics and cosmetics. Thereby it is well-known that the particles of one and the same ensemble do not have the same microscopic color; the colors will deviate from particle to particle and also over the surface of individual particles itself. Since the effect pigment appearance depends on the microscopic color as well as on its local lateral distribution, it is important to elucidate the reasons for these local changes for typical interference pigments.

INTRODUCTION

The continuous work to improve the pigments' coloristic behavior requires a strong control of the properties governing interference, absorption and reflection over the ensemble of effect pigments. The trend to more saturated colors on a macroscopic level can be followed by a more homogeneous distribution of the colors on a (light) microscopic level. As an example the development of interference colors from Iriodin® 9231 to Pyrisma® T40-24 SW Green via Iriodin® 9235 and Iriodin® 97235 is shown in **fig. 1a-d** (macrographs) and **fig. 2a-d** (micrographs). Although the more homogeneous microscopic color distribution is evident, the reason for having different local colors cannot be elucidated by only using light microscope images. Therefore, the recent work deals with an investigation into the real structural changes creating the local deviation from the averaged interference condition and yielding a local change in the color. For the sake of simplicity only effect pigments are tested whose layers are composed by a substrate (transparent) and a deposit (transparent or semitransparent).

From the physical description of color creation by thin film interference (and absorption) described in standard textbooks [1] the principal reasons of local color changes can be derived as follows:

- 1 local change in the optical thickness of the substrate
  - 1.1 local change in layer thickness and/or
  - 1.2 continuous change in layer thickness and/or
  - 1.3 local change in index of refraction
    - 1.3.1 by change in material (chemical reactions) and/or
    - 1.3.2 by loss or addition of material (e.g. air filled gaps)
- 2 local change in the optical thickness of the deposit; in full analogy to 1.
- 3 local bending of the flake

Thereby it is not important whether such structural deviations result from the normal crystallographic behavior of the material itself (fig. 4 – 6) or are induced by mechanical or environmental stresses (fig. 7 – 8).

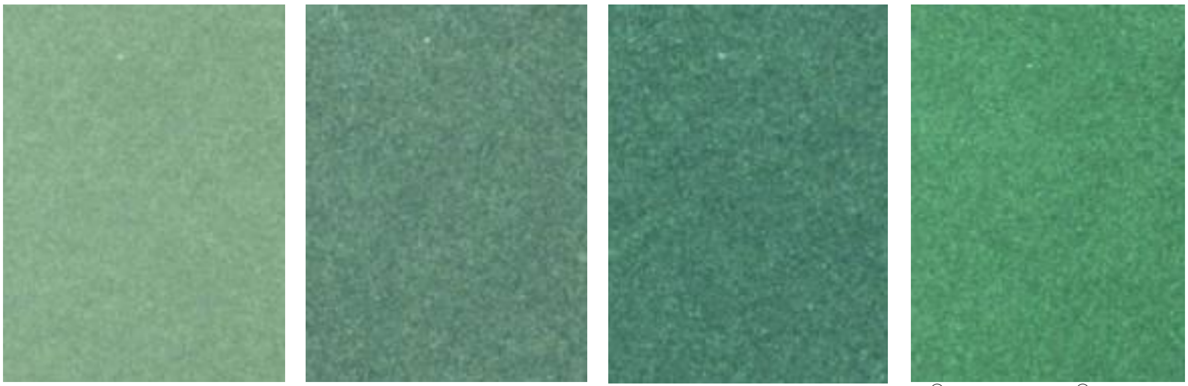


Fig. 1: Photographs of panels made of green interference pigments with rising saturation: Iriodin® 9231, Iriodin® 9235, Iriodin® 97235 and Pyrisma® T40-24 SW Green (from left to right)

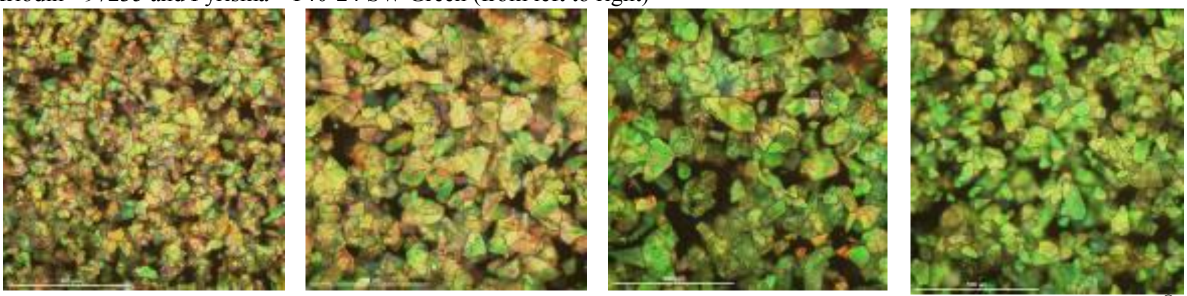
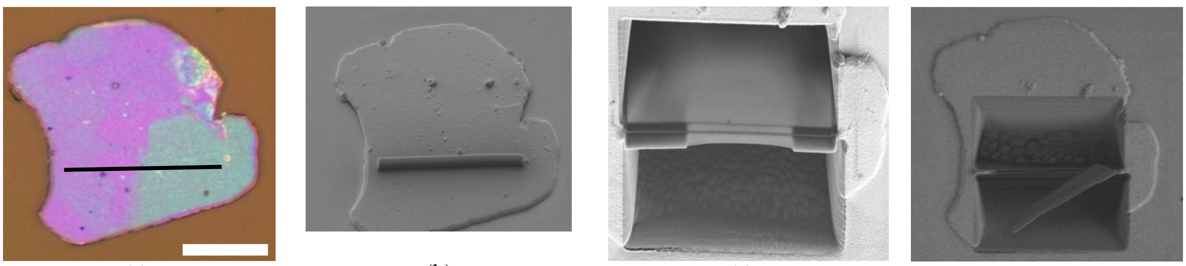


Fig. 2: Micrographs (bright field, obj. 20*, marker 100 µm) of green interference pigments with rising saturation: Iriodin® 9231, Iriodin® 9235, Iriodin® 97235 and Pyrisma® T40-24 SW Green (from left to right)

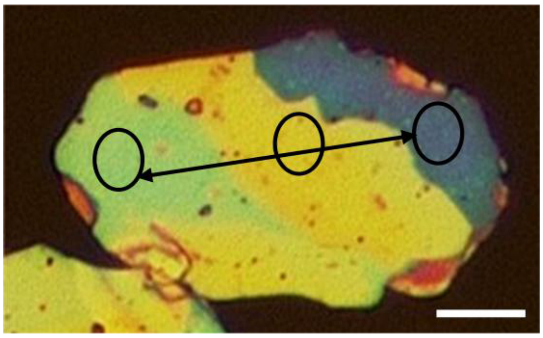
EXPERIMENTS AND RESULTS

The standard experimental procedure to analyze the real structure of effect pigments can be described as follows: **1**. Identify and mark local color deviation on selected flakes using a light microscope (**fig. 3a**), **2**. Analyze the color deviation roughly by color imaging or more accurate by micro-photo-spectrometry, **3**. Isolate and transfer this particle on a flat holder for focused ion beam (FIB) preparation, **4**. Protect the particle by depositing a metal layer (**fig. 3b**), cut the particle from both sides by an ion beam along the marked line (**fig. 3c**), lift of the lamella (**fig. 3d**), rotate and put it on a TEM grid, **5**. Analyze the geometry and the constituents by TEM imaging in diffraction contrast (**fig. 4 – 6b**) or SEM imaging in secondary electron imaging mode (**fig. 7 – 8b**) and microspot EDX. To carry out such preparations and analysis research light microscope Eclipse 90i /Nikon/Zeiss spectrometer, FIB (V600CE+/FEI), SEM (SU70 / Hitachi) and TEM (Tecnai G2 F20 STWIN/FEI) are used, respectively.

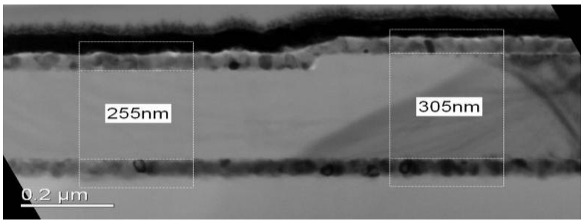


(a) (b) (c) (d)

Fig. 3: Light microscope imaging and marking of a local color deviation on a single particle (a), deposition of a metal protection stripe (b), both sided ion beam thinning of the lamella along the marked line (c) and lift of procedure of the lamella (d) [Pyrisma® T40-27 SW Indigo, marker 10 µm]

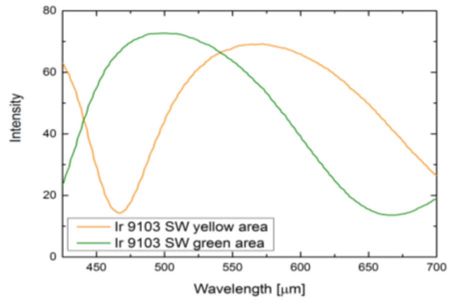


(a)

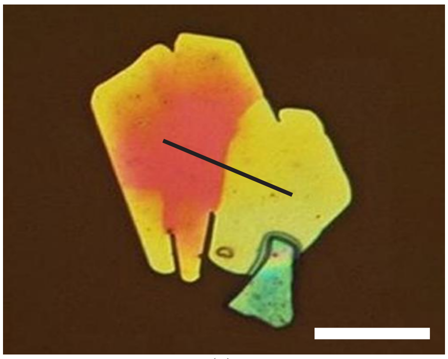


(b)

Fig. 4: Color variation on the surface of a (dielectric) silver-white particle composed of TiO_2 on mica [Iriodin® 9103 Sterling Silver SW, marker 10 µm] imaged with light microscope **(a)**. The colored patches are analyzed by their reflection spectra **(c)** and the change in the interference condition by TEM: steps on the mica surface yield different thickness of the mica layer for all color patches **(b)**. Fitting the spectral data on both sides of the step and the measured thickness of the layers with the interference formulae the local index of refraction of the deposit can be calculated.



(c)



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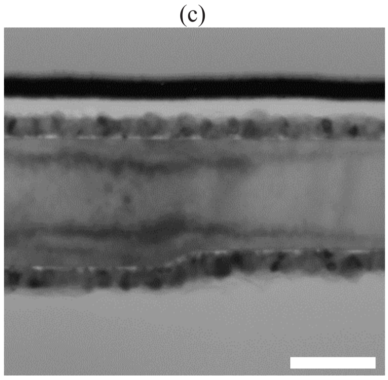
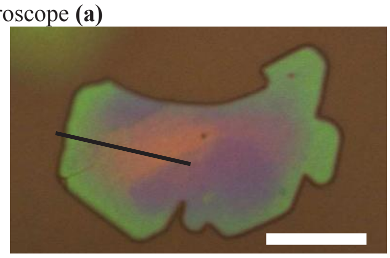


(b)

Fig.5: Color variation on the surface of a (dielectric) silver-white particle composed of TiO_2 on alumina [Xirallic® T60-10 SW Crystal Silver, marker 10 µm] imaged with light microscope **(a)** and analyzed by cross-sectioning the particle along the marked line: stepwise variation in the alumina thickness (marker 200 nm) **(b).**



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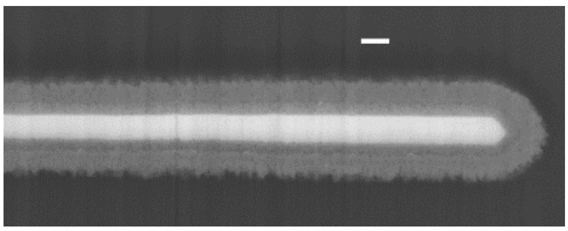
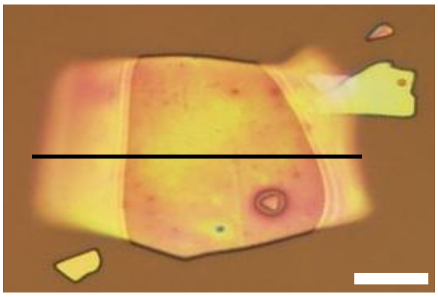


(b)

Fig.6: Continuous color variation on the surface of a (dielectric) silver particle composed of TiO_2 on alumina [Xirallic® T60-25 SW Cosmic Turquoise, marker 10 µm] imaged with light microscope (a) and analyzed by cross-sectioning the particle along the marked line: continuous variation in the alumina and titania thickness from the center to the border area **(b),** marker 200 nm.



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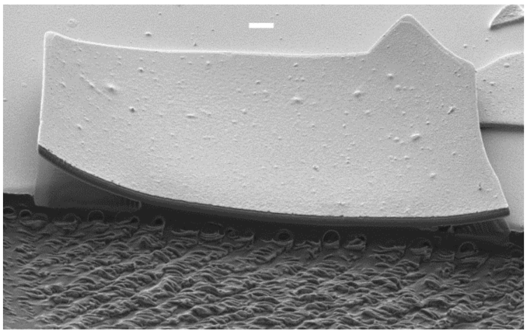
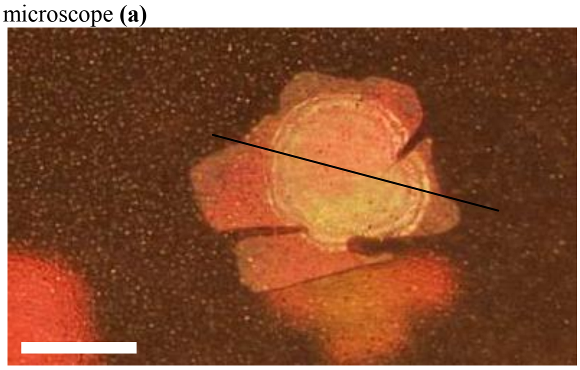


(b)

Fig.7: Continuous color variation on the surface of a particle composed of TiO_2 on silica [Colorstream® T20-01WNT Viola Fantasy, marker 10 µm] imaged with light microscope **(a)** and analyzed by cross-sectioning the particle along the marked line: continuous variation in the light incidence angle due to particle bending (marker 2 µm) **(b).**



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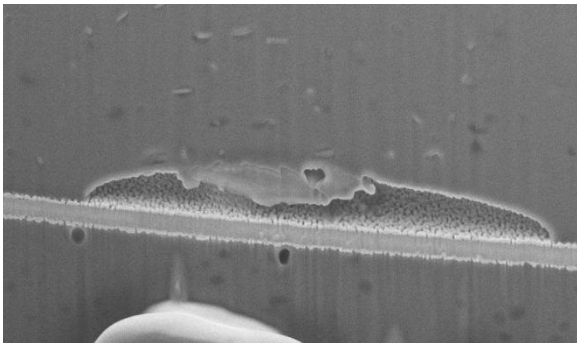

(b)

Fig.8: Distinct color patches on the surface of a particle composed of Fe_2O_3 on alumina [Xirallic® F60-51 SW Radiant Red, marker 10µm] imaged with light microscope **(a)** and analyzed by cross-sectioning the particle along the marked line: delamination course an air filled gap between the particle surface and the binder. This air filled gap acts as additional interference layer with variable thickness creating interference lines and a local change in color **(b).**

DISCUSSION

For mica based neutral or tinted silver effect pigments, the step height distribution over the particle surface control the local color distribution which cause the desired macroscopic color by additive color mixture. For chromatic interference pigments step structures and the corresponding color deviations result in a reduction of the saturation in comparison to non-stepped structures. Sometimes the change in the height between adjacent steps and their distance is so small, that even with light microscope only a continuous color change over the particle surface can be observed. For amorphous materials as silica and glass flakes continuous changes in the thickness (wedged shaped geometries) lead also to continuous color changes over the particle surface. Since for gonio-apparent pigments the light incidence on the flake surface change the spectral composition of the reflected light bended flakes show a multicolor behavior. Additional layers (having constant or variable thickness) always influence the local colors. Such cases are found as delamination cracks between the interference layers and the substrate or the polymeric media and as foreign phases produced by chemical reactions or dissolution/removal of layers previously created.

Effect of polarization to directional surface color measurement

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Key word: polarization, surface color measurement, 45:0, 0:45

Abstract

The colorimeter of 45:0 and 0:45 geometry conditions are usually utilized for color measurement of samples such as automotive parts, plastics, paint, raw materials, and packaging. The measurement result of this kind directional colorimeter is easy affected by polarization property of the measured surface. This paper shows the relationship between polarization and color measurement error. First, a preliminary theoretical analysis of the polarization effect is established basing on the Fresnel reflection equation. Then, an error model of the directional colorimeter is proposed, which include the polarization property of samples. After that, an experiment is taken on the reference colorimetry apparatus of NIM China, and the result verifies the error model. The conclusion shows that the effect of polarization should carefully treated for colorimetry, and designer need to minimize the polarization of colorimeter, and the end user should choose a fit colorimeter according to the characteristic of the test surface.

Introduction

The colorimeter of 45:0 and 0:45 geometry conditions are usually utilized for color measurement of samples such as automotive parts, plastics, paint, raw materials, and packaging.

CIE has established a series of standard illuminations, observers and geometry conditions for the color systems, such as CIEXYZ and CIELAB. According to the spectral color measuring method, the tristimulus values or L*a*b* can be obtained by the diffuse reflectance of the sample. And the measurement result of this kind directional colorimeter is easy affected by polarization property of the measured surface and the color instrument[1]:

$$R' = R_{uu} + P_{uj} P_d R_{uu} \qquad R' = R_{uu} + P_{ju} P_i R_{uu} \tag{1}$$

The equations show that the error of the color instrument is the product of P_d and P_i the polarization factor of instrument, P_{uj} and P_{ju} the polarization factor of sample, and R_{uu} the reflectance of sample. The polarization factor is a fix number for a certain instrument, so this paper mainly discusses the polarization factor of sample, and the principle of polarization.

Optic model of color sample

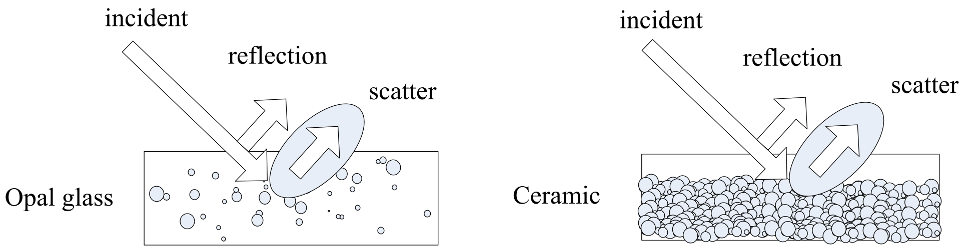
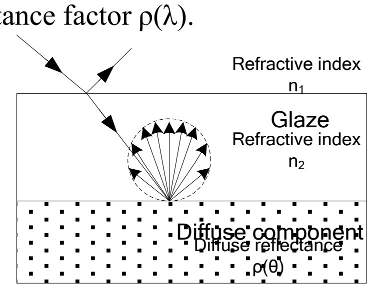


Fig.2 reflection and scatter light of sample

Most of the sample for color calibration is opal glass and ceramic tile. As Fig.2 shows, when the incident light illuminate the sample, the light is reflected and refracted at the front surface of the sample, and then the light into sample is scattered by the material inside. Normally, the first reflection light generates gloss, and the scatter light shows us the color of sample.

So an optic model for discussing the surface color is established. It has two layers, the first layer is the glaze, which has a refractive index n_2, and the second layer is a diffuse component layer, which is assumed as a perfect Lambert diffuser with reflectance factor ρ(λ).



The reflection and refraction at the first surface of glaze layer follow the Fresnel equations:

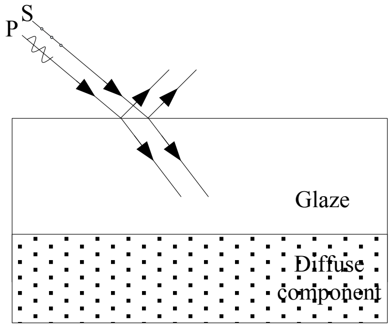


Fig.4 reflection and refraction at the first layer

The reflectance for *s*-polarized light is

$$R_s(\theta_i,n_1,n_2)=\left|\frac{n_1\cos\theta_{\mathrm{i}}-n_2\cos\theta_t}{n_1\cos\theta_{\mathrm{i}}+n_2\cos\theta_t}\right|^2=\left|\frac{n_1\cos\theta_{\mathrm{i}}-n_2\sqrt{1-\left(\frac{n_1}{n_2}\sin\theta_i\right)}}{n_1\cos\theta_{\mathrm{i}}+n_2\sqrt{1-\left(\frac{n_1}{n_2}\sin\theta_i\right)}}\right|^2 \quad (2)$$

θ_i is the incident angle. While the reflectance for *p*-polarized light is

$$R_p(\theta_i,n_1,n_2)=\left|\frac{n_1\cos\theta_t-n_2\cos\theta_i}{n_1\cos\theta_t+n_2\cos\theta_i}\right|^2=\left|\frac{n_1\sqrt{1-\left(\frac{n_1}{n_2}\sin\theta_i\right)}-n_2\cos\theta_{\mathrm{i}}}{n_1\sqrt{1-\left(\frac{n_1}{n_2}\sin\theta_i\right)}+n_2\cos\theta_{\mathrm{i}}}\right|^2 \quad (3)$$

So the transmission factor satisfies:

$$\begin{aligned}T_{si}&=T_s(\theta_i,n_1,n_2)=1-R_s(\theta_i,n_1,n_2)\\T_{pi}&=T_p(\theta_i,n_1,n_2)=1-R_p(\theta_i,n_1,n_2)\end{aligned} \quad (4)$$

If flux of the incident light: $\Phi_p=\Phi_s=\Phi/2$, and the absorption of glaze is α, the irradiance of the diffuse component is:

$$E_s=\frac{\Phi_s T_s(\theta_i,n_1,n_2)\alpha}{dS}$$

$$E_p=\frac{\Phi_p T_p(\theta_i,n_1,n_2)\alpha}{dS}$$

Where d*S* is the illuminated area on the diffuse component

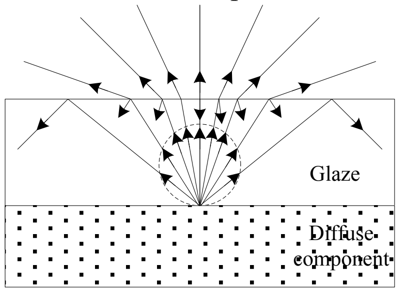


Fig.5 diffuse reflection of the diffuse component and refraction at the glaze layer

As Fig.5 shows, the light is reflected by the diffuse component, and refracted by the out surface of glaze. For the assumption of the diffuse component is a Lambertian surface and a perfect depolarizer, the radiance of the exitance light satisfies:

$$L_{ss}=\frac{\rho E_s}{\pi}T_s(\theta_e,n_1,n_2)=\frac{\rho\alpha\Phi_s T_s(\theta_i,n_1,n_2)}{2\pi dS}T_s(\theta_e,n_1,n_2)=\frac{\rho\alpha\Phi}{4\pi dS}T_{si}T_{se}$$

$$L_{sp}=\frac{\rho\alpha\Phi}{4\pi dS}T_{si}T_{pe},\quad L_{ps}=\frac{\rho\alpha\Phi}{4\pi dS}T_{pi}T_{se},\quad L_{pp}=\frac{\rho\alpha\Phi}{4\pi dS}T_{pi}T_{pe}$$

Where, the subscript of L_{ss} means the input and output polarization state, subscript *i* and *e* indicate the incident beam and exitance beam.

The diffuse reflectance factor of the directional geometry condition can be obtained by measure the ratio of the sample's radiance and the radiance of the reference plate multiplies its calibrated reflectance value, so:

$$R_{ss}=\frac{L_{ss}}{L_{ref}}R_{ref},R_{sp}=\frac{L_{sp}}{L_{ref}}R_{ref},R_{ps}=\frac{L_{ps}}{L_{ref}}R_{ref},R_{pp}=\frac{L_{pp}}{L_{ref}}R_{ref}$$

Hence, the reflectance for the uniform illumination and detection is:

$$R_{us}=\frac{L_{ss}+L_{ps}}{2L_{ref}}R_{ref},R_{su}=\frac{L_{ss}+L_{sp}}{2L_{ref}}R_{ref},R_{up}=\frac{L_{sp}+L_{pp}}{2L_{ref}}R_{ref},R_{pu}=\frac{L_{ps}+L_{pp}}{2L_{ref}}R_{ref} \tag{5}$$

Where, subscript u indicates the uniform polarization illumination or detector.

And the reflectance factor of the sample satisfies:

$$R_{uu}=\frac{L_{ss}+L_{ps}+L_{sp}+L_{pp}}{4L_{ref}}R_{ref}=\frac{\rho\alpha\Phi R_{ref}}{16\pi dSL_{ref}}\left(T_{si}+T_{pi}\right)\left(T_{se}+T_{pe}\right) \tag{6}$$

Eq.4 and 5 shows that the illumination and viewing angle θ have an effect to the reflectance property of the sample by changing the transmission factor, thereby the color result is influenced.

The polarization factor of sample can be defined by [1]:

$$P_{ju}=\frac{R_{su}-R_{pu}}{R_{su}+R_{pu}}=\frac{L_{ss}+L_{sp}-L_{ps}-L_{pp}}{L_{ss}+L_{sp}+L_{ps}+L_{pp}}=\frac{T_{si}(T_{se}+T_{pe})-T_{pi}(T_{se}+T_{pe})}{T_{si}(T_{se}+T_{pe})+T_{pi}(T_{se}+T_{pe})}=\frac{T_{si}-T_{pi}}{T_{si}+T_{pi}}$$

$$P_{uj}=\frac{R_{us}-R_{up}}{R_{us}+R_{up}}=\frac{L_{ss}+L_{ps}-L_{sp}-L_{pp}}{L_{ss}+L_{ps}+L_{sp}+L_{pp}}=\frac{T_{se}-T_{pe}}{T_{se}+T_{pe}} \tag{7}$$

where P_{uj} indicate the factor of uniform illumination, and P_{ju} indicates the uniform detection. And they are only affected by the transmit factor of the glaze layer, which is discussed in Eq.4. Hence the polarization factor can be calculated by Fresnel equation, when the light angle and refractive index of the glaze layer is obtained.

Fig.6 shows the data curves of Eq.7.

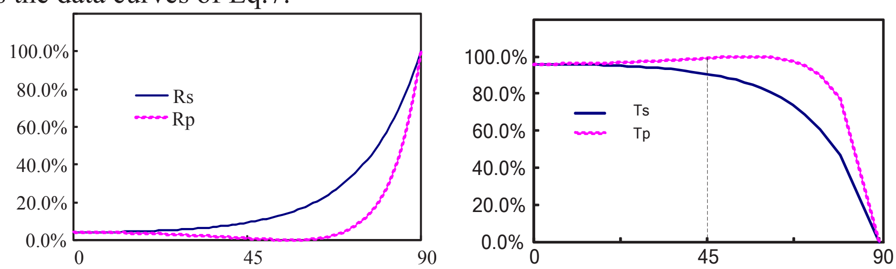


Fig.6 reflection and transmit factor of glaze layer

Experiment

A reflectance colorimetry measurement system of NIM is constructed using scanning spectrometer with array detector, and the color measurement can be achieved under 45:0 and 0:45 geometry conditions[2].

Fig.7 reflectance colorimetry measurement system and No.1 opal glass (left), No.2 high gloss ceramic (mid) and No.3 diffuse ceramic (right)

A polarizer is inserted into the illumination light path, so as to change the polarization state of the sample. And three samples is selected, No.1 opal glass, No.2 high gloss ceramic and No.3 diffuse gloss ceramic.

With opal glass in air, for example, the refractive index is about 1.55 with no anti-reflection coating. Set n_1=1, n_2=1.55, the polarization factor can be obtained for 45:0 (θ_i=45) geometry conditions by Eq.7 :

$$P_{ju-450} = \frac{T_{si45} - T_{pi45}}{T_{si45} + T_{pi45}} = \frac{89.6-98.9}{89.6+98.9} = -4.9\% \quad (8)$$

And in 0:45 (θ_i=0) geometry conditions, the polarization factor is:

$$P_{ju-045} = \frac{T_{si0} - T_{pi0}}{T_{si0} + T_{pi0}} = \frac{95.3-95.3}{95.3+95.3} = 0 \quad (9)$$

The comparison between the calculated data from Eq.7 and the measured result is shown in the table below. The result of high gloss plate consist with the theoretical result well, the deviation is below 1%, but the polarization factor result of diffuse sample No.3 is 3% less than the theoretical result. It shows the rough surface of No.3 has a depolarizing ability, the random microstructure of the glaze surface reduces the polarization effect, and the optic model is not fit for this kind of samples.

Table 1 Comparison between Theoretical and Measured

		bl3	7000A	bl6
45/0	Theoretical	-4.9%	-4.9%	-4.9%
$P_{ju\text{-}450}$	Measured	-5.2%	-5.1%	-1.8%
0/45	Theoretical	0%	0%	0%
$P_{ju\text{-}045}$	Measured	-0.7%	-0.9%	0.3%

Also the data shows the polarization factor is changing with the angle of the light in and out. When the incident angle is decreased from 45 to zero degree, the polarization factor is decreased too. According to Eq.1, the measurement error is the product of polarization factor of the sample and instrument. So the factor of sample is 5%, and limits the color error to 0.5%, the polarization factor of instrument should be less than 10%.

Conclusion

The theoretical analysis of the polarization effect is established basing on the optic model and Fresnel reflection equation. An experiment of the sample is taken on the reference colorimetry apparatus of NIM China, and the result verifies the error model. The analysis and experiment shows the relationship between polarization and color measurement result: the illumination and viewing angle have an effect to the polarization property and the color result. The effect of polarization should carefully treated for colorimetry, and designer need to minimize the polarization of colorimeter, and the end user should choose a fit colorimeter according to the characteristic of the test surface.

Acknowledgment

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RESEARCH ON THE IMPACT OF LIGHT SOURCE SPECTRUM ON COLOR VISION

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Keywords: Light Source Spectrum, Color Vision, Color Brightness Difference

ABSTRACT

This paper studies the impact of light source spectrum on color vision using indoor simulation experiments. Under the same condition of illuminance, a test participant observed different color pictures under light sources in black boxes respectively. The impact is studied by the distance that a test participant distinguishes the color brightness difference in each picture. It has been found that there's impact of light source spectrum on distinguishing the brightness difference of some colors. And color rendering index can be an important factor in the distinguishing process.

1. INTRODUCTION

Vision is the most important sense, and visual performance can be affected by the environment. In addition to the brightness factor, there may be some other impact of light source on human visual function [1]. There are many kinds of light sources, different light source spectrum result in different color temperature, color rendering index and other factors, which may also cause some impact on color vision. By learning previous studies, we didn't get a unified conclusion of the impact of light source spectrum on color vision [2] [3]. This paper presents experiment studying the impact of light source spectrum on distinguishing the brightness difference of some colors.

2. TEST METHOD

The experiment was carried out indoors. Black boxes were used for the experiment, and each box was 1.5m high with a square cross section of 0.5*0.5 m^2. Each light source was set at the top of each box, and picture was placed at the bottom of the box so that it was illuminated by the light source. Under the same condition of vertical illuminance on the picture, a test participant observed different color pictures under light sources in black boxes respectively. There's color brightness difference in each picture.

For each of the light source, let the participant walk towards the box, and measure the distance between participant's eyes and the picture at which the color brightness difference in the picture was distinguished. Results of the distinguishing process under different light sources can be reflected by measured distances. A greater distance implies better lighting for distinguishing. Figure 1 shows one of the boxes in the experiment.

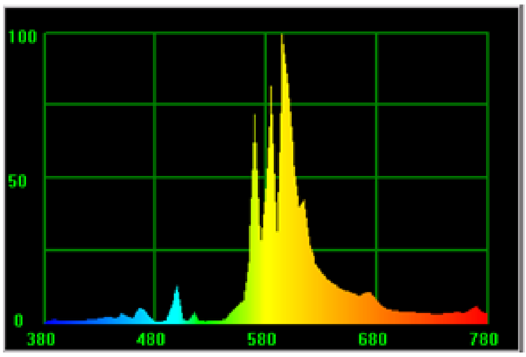
Figure 1. Black Box

2.1 Light Sources

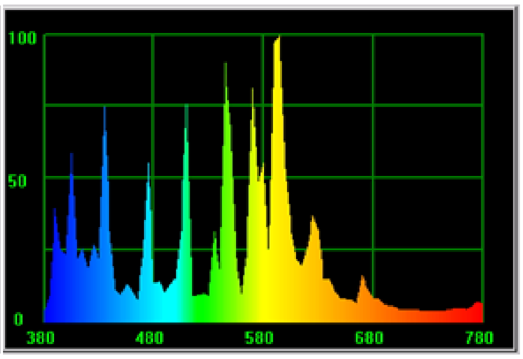
Four kinds of typical light sources are selected for the experiment. They are high pressure sodium lamp(HPS), quartz metal halide lamp(MH), compact fluorescent light(CFL) and LED. The lighting characteristics are shown in Table 1 and Figure 2.

Table 1: Basic Parameters of Light Sources

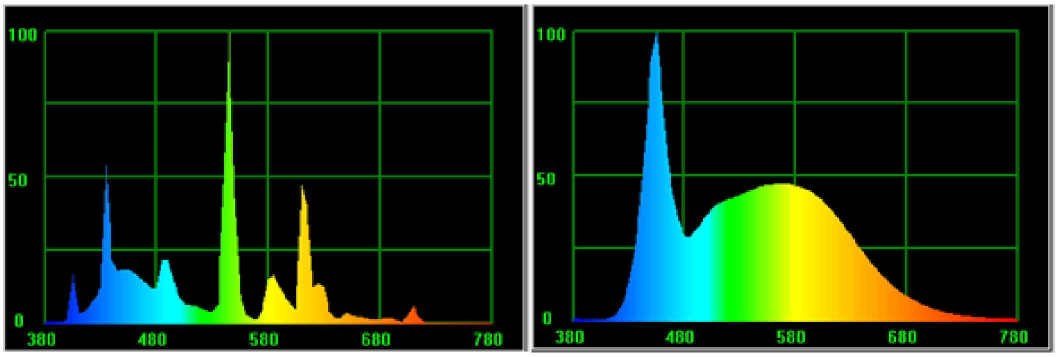
Light Source	Color Rendering Index(CRI)	Correlated Color Temperature(CCT)	Chromaticity Coordinates
HPS	26	1815K	x=0.5468 y=0.4079
MH	65	4044K	x=0.0632 y=0.3830
CFL	81	6644K	x=0.3158 y=0.0574
LED	86	6481K	x=0.7832 y=0.0498



HPS



MH



CFL LED

Figure 2. Light Source Spectral Power Distributions

The power and some other parameters of the lights are very different. We use transparent light shielding plates and other methods to control the vertical illuminance on pictures to the same. In this experiment, appropriate illuminance of 60 lx was chosen, much more than the illuminance of the indoor environment.

2.2 Experiment Settings

In this experiment, the test participants of similar age and background are chosen. No one of the participants has color blindness or other eye diseases. Eventually the number of participants is 12, including 6 men and 6 women, aged between 22 to 25 years old. Within-subjects design was used and we took measures to diminish the influence of the experimental sequence on the experiment. We also give the participants some time to adapt to the changed environment.

Each picture was mainly in blue, yellow, red or green, and there's color brightness difference in each picture, thus constitute some pattern. We can easily distinguish the color brightness difference in daylight, but the difficulty will increase to varying degrees under different light sources respectively. Each picture was illuminated by each light source, and participants observed each of the matchups. Measure the distance at which the color brightness difference in the picture was distinguished. Then we decide whether light source spectrum has impact on the distinguishing process or not of each kind of color by measured distances.

3. RESULTS

The mean value and standard deviation of the critical distance measured are shown in Table 2.

Oral paper

Table 2: Mean value and standard deviation of the distances measured

Color	Blue				Yellow			
Light Source	HPS	MH	CFL	LED	HPS	MH	CFL	LED
Mean Value(m)	1.545	2.018	2.233	2.634	1.359	1.965	2.159	2.364
Standard Deviation	0.598	0.429	0.436	0.730	0.364	0.646	0.690	0.684
Color	Red				Green			
Light Source	HPS	MH	CFL	LED	HPS	MH	CFL	LED
Mean Value(m)	1.284	2.010	2.431	2.466	1.804	1.982	2.261	2.220
Standard Deviation	0.346	0.570	0.191	0.379	0.616	0.492	0.282	0.453

By statistical data analysis, there's a significant effect of light source ($p<0.05$) on the distinguishing distance when observing blue, yellow and red pictures. But there's no significant effect of light source ($p>0.05$) on the distinguishing distance when observing green picture. The selection of light sources in the experiment may have effect on the results. In consideration of all the four colors and the mean values of distance, HPS is the most unfavorable light source for distinguishing color brightness differences, and LED is the most favorable one, CFL is better than MH.

4. CONCLUSIONS

This paper studies the impact of light source spectrum on color vision. Color brightness difference distinguishing is the method used in this experiment. It has been found that there's impact of light source spectrum on distinguishing the brightness difference of some colors. In this experiment, those colors are blue, yellow and red. And color rendering index can be an important factor in the distinguishing process. Generally speaking, the measured distance is positively correlated with color rendering index, and it may be an important factor in the distinguishing process. In our opinion, in addition to the illuminance, light source spectrum also has some impact on color vision.

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RELATIONSHIP BETWEEN COLOR APPEARANCE MODE AND COLOR APPEARANCE SHIFT

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Keywords: Color appearance, color appearance mode, elementary color naming, illuminance

ABSTRACT

This research investigates the effect of color appearance mode on color appearance shift, 11 Munsell patches with eight different hues and three different levels of gray were used as test stimuli. Each individual patch was shown, in a test room, to a subject sitting in subject room. The subject was asked to look at the test stimulus through a small window that is filled by the test stimulus. Thirty six illuminance combinations of the subject room and the test room were prepared, so that the subject perceived three different color appearance modes: the object color mode, unnatural object color mode and light source color mode. The subject described the color appearance of the test stimuli using the elementary color naming method and the color appearance mode for each condition. The results showed that the amount of whiteness increased while both the chromaticness and the blackness decreased with the increase of test room illuminance. However, the hue did not change when the color appearance modes changed.

INTRODUCTION

The color appearance is result of visual perception. Different interpretations of color are due to different visual perception, which depends on age and other factors. Attributes of color perception, use for explaining the color of objects, are: brightness, hue and colorfulness [1]. The color appearance of objects depends on three components: the interaction of light sources, object and the human visual system [2].

The color appearance mode can be changed when the illuminance of environmental changes. Increasing illuminance changes the color appearance from object color mode to unnatural object color mode and to the light source color mode.[3] In the study of the color appearance mode some researchers investigated the relationship between color appearance mode and color preference. Their results showed that the perceived chromaticness, whiteness and blackness play a role for the determination of color preference for different color appearance modes [4][5].

Our experiment investigated the relationship between color appearance mode and color appearance shift.

EXPERIMENT

Apparatus and laboratory conditions

The laboratory was separated into two rooms there were the subject room and the test room as shown in Figure 1.

The subject room was 1 × 1.5 × 2.4 m^3 (W × L × H). The wall inside was covered with white wallpaper. At the ceiling, there was a daylight fluorescent lamp (FL_S) which could be adjusted to six-level intensity: 0, 0.5, 3, 15, 80 and 240 lx. The room illuminance was measured by a Konica Minolta CL-200 illuminance meter (I_S) that was put down on the shelf that was lower than 2 × 2 cm^2 aperture square (T) to a visual angle of 1° from the subject at a distance of 1.1 meter as shown in Figure 2. A picture frame, a clock, key rings, artificial flowers, a shopping basket, cans, dolls, a flowerpot, a Rubic's Cube and books were decorated into this room to simulate a normal room of the subject as shown in Figure 3.

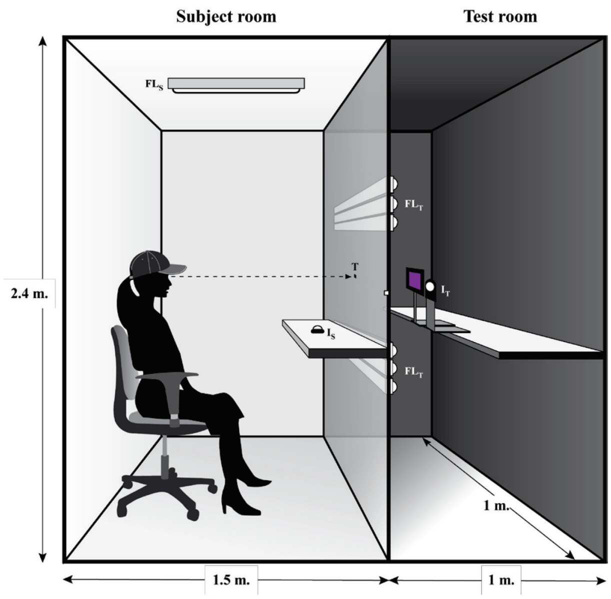

Figure 1. Laboratory and position of apparatus
FL_S : a daylight fluorescent lamp of the subject room
FL_T : 6 daylight fluorescent lamps of the test room
I_S : the illuminance meter of the subject room
I_T : the illuminance meter of the test room
T : the 2 × 2 cm^2 aperture square

Table 1: 11 Munsell patches that choose from the Munsell color notation

Hue	Value/Chroma	Hue	Value/Chroma
5R	6/14	5BG	5/8
5YR	7/12	10B	6/10
5Y	8.5/12	5P	3/8
5GY	8/10	N	2/, 5/, 8/
5G	6/10		

The test room was 1 × 1 × 2.4 m^3 (W × L × H). Inside this room there were 11 Munsell patches which were eight different hues and three different levels of gray used as test stimuli, as show in Table 1. The six daylight fluorescent lamps (FL_T) adjustable at six intensity levels: 80, 120, 250, 500, 1000 and 2400 lx were attached to the wall. The room illuminance was measured by a Konica Minolta CL-200 illuminance meter (I_T) that was near the test patch.

Thirty six illuminance conditions (six subject room illuminance levels and six test room illuminance levels) were controlled by the experimenter.

Subject

Five subjects with normal color visual acuity were selected: SN (female, 24 years old), PY (female, 24 years old), NP (male, 27 years old), OB (female, 28 years old) and PC (female, 36 years old).

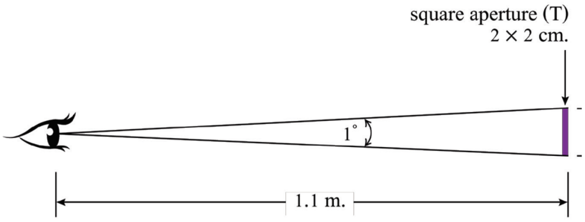

Figure 2. A visual angle of 1° from the subject at a distance of 1.1 meter

Figure 3. The position of many objects inside the subject room

Procedure

The experimental procedure was divided in two pasts: the elementary color naming method and the color appearance mode.

1. **The elementary color naming method**

The illuminance condition was chosen by the experimenter from 36 prepared conditions. The subject adapted to the test room for two minutes and was told not fix the eyes on the test stimulus, but to look around the room at fixed times. When each individual test patch was shown in a test room, to a subject sitting in a subject room, the subject was asked to estimate the amount of chromaticness, whiteness and blackness in the test stimulus. If the test stimulus show the amount of chromaticness, the subject was asked to estimate the amount of hues: red, yellow, green and blue. One or two hues: red-yellow, red-blue, green-yellow and green-blue, were named and proportionated to the total of 100.

2. **The color appearance mode**

After finishing the elementary color naming, the subject was asked to judge the color appearance modes of the test stimulus: the object color mode, unnatural object color mode and light source color mode.

Afterwards, the next illuminance condition was selected and the subject adapted to the illumination of the room again. The selection of the condition was in a random order. Within each session, 11 Munsell patches were randomly presented under 36 illuminance conditions. Each subject repeat five sessions per condition.

RESULTS

Chromaticness, whiteness and blackness of test stimuli

The averaged data of chromaticness, whiteness and blackness of chromatic test patches 10B 6/10 are shown in Figure 4. The results of six illuminance of the subject room are shown in six plots.

The border illuminance of the test room between two color appearance modes is shown in the plots by vertical dot line if any. Under some conditions the subjects perceived only one color appearance mode (the condition of 0 lx the subject room). At the border line, there is only rapid change of chromaticness, whiteness and blackness when the illuminance of subject room is 240 lx.

Chromaticness and blackness decreased when the illuminance of test room increased from 80 to 2400 lx.

Whiteness increased when the test room illuminance increased from 80 to 2400 lx

All chromatic test patches: 5R 6/14, 5YR 7/12, 5Y 8.5/12, 5GY 8/10, 5G 6/10, 5BG 5/8 and 5P 3/8 shown the same pattern of results as 10B 6/10.

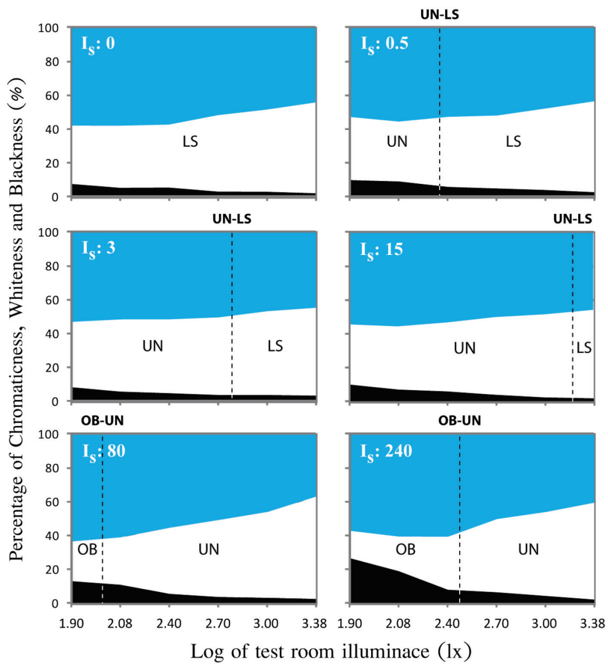

Figure 4. Percentage of Chromaticness (■),Whiteness (□) and Blackness (■) of the Munsell patch 10B 6/10.

WORKING MEMORY IN COLOR: AN fMRI STUDY

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Keywords: working memory, color, Stroop effect, color perception, word recognition

ABSTRACT

Verbal names of colors used in daily life are essentially categorical in nature rather than a reference to the particular color of the object. Colors that cross the borders of color hue categories could be verbally coded, whereas colors within a single color category are likely difficult to be verbally coded due to the involvement of slight hue differences. A brain imaging study focused on colors in working memory in a domain-dependent dissociable brain has not been well known. Current study investigated the specific dissociated brain areas responsible for color memory under both verbal and visual coding, using functional magnetic resonance imaging (fMRI). Using n-back working memory paradigm, we hypothesized that colors that cross different categories would activate phonological loop more easily because colors having large hue differences could be more easily coded verbally, as in the case of color words, than colors within the same category with slight hue differences in which memory for adjacent colors could not rely on phonological loop. We found left- and right-frontoparietal network activations under cross-color/color-word conditions, and within condition, respectively.

INTRODUCTION

Working memory is a limited capacity system that temporarily retains and manipulates information and working memory involves two domain-specific subsystems: the phonological loop (PL) that is responsible for language processing involving color names, and the visuospatial sketchpad that is responsible for visuospatial processing involving perceptual colors [1-3]. On the basis of current neuroimaging studies on working memory, phonological loop is thought to be localized in the inferior parietal region in the left hemisphere in connection with Broca's area in the inferior frontal gyrus (IFG), whereas visuospatial sketchpad is known to be located in the right hemisphere as visual working memory. When the observer asked to decide two color patches, whether current patch is the same or different as compared with patch presented n-trial back to the current one. The observer has to retrieve (remember) the color shown in n-back before and compare it with current color using visual color working memory. As *n* increases the observer has to maintain color information longer time, thus need use of efficient coding strategy.

We hypothesized that colors that cross different color categories would activate phonological loop (verbal coding of color names) more easily because colors having large hue differences could be more easily coded verbally, as in the case of color words [4]. While, colors within the same category with slight hue differences in which memory for adjacent colors could not rely on phonological loop could be perceptually coded (not in the phonological loop but in visuospatial sketchpad region of the brain). Our assumption is that color coding in the brain's working memory could be divided into dual system. One is specific to colors that could be easily coded in verbal domain because of their large color difference The other is specific to colors that is difficult to code verbally because of their small color difference (no unique category names due to subtle difference).

METHOD

Procedure

We used n-back working memory reporting procedure which asked the observer to compare current color and that of n-back presented before. We used a block design in this fMRI study. Nine stimuli was presented on the screen in (36.5 s. Each stimulus was presented for 0.5 s followed by a 4 s interstimulus interval. Participants (n=9) asked to press a key with the left/ right thumb as instructed. A single block had a color group consisting of three stimuli, from which one was selected as the specified color (red, yellow, green or blue). Under the cross-condition, the stimuli were presented as a colored square of a specified color along with two typical colors of adjacent hue categories (e.g. red group: purple, red and orange), whereas under the within-condition, the stimuli were a specified color along with two adjacent colors in the same category to minimize possible verbal labeling. Under the word-condition, stimuli were color names printed in Japanese.

Materials

Stimuli for the color-word condition are specified with color names (e.g., red, orange, purple…) and stimuli for the cross/within-color conditions are presented with corresponding perceptual colors (the size of the background was 15 x 11 deg and the color stimulus was 2 x 2 deg). Averaged color differences (DEuv*) were 46 in the Cross condition and19 in the Within condition.

fMRI data acquisition and analysis

Whole brain imaging data were acquired on a 1.5-T fMRI scanner using a head coil. Head motion was minimized with a forehead strap. For functional imaging, we used a gradient-echo echo-planer imaging sequence with the following parameters(TR. 2.5 s, TE. 49 ms, flip angle. 801, 6mm slice thickness,FOV. 256mm_256mm, and pixel matrix. 64 x 64). We employed SPM2 software. All functional images were realigned to correct for head movement, which were less than 1mm within runs. The functional images were normalized and spatially smoothed with an isotropic Gaussian filter). Data were modeled using a box-car regressor corresponding to a single block convolved with HRF. Group data were analyzed using a random effects model. We specified activation areas of all conditions at the threshold Po0.05, corrected for multiple comparisons (false discovery rate, FDR).

RESULTS and DISCUSSION

The data were analyzed in one-way repeated measures analysis of variance and we found no main effect which indicates the performances among three conditions were mostly the same. Regarding activated brain areas, we found bilateral inferior frontal gyrus (IFG) , premotor(PM) , supplementary motor area (SMA), left inferior parietal lobule (IPL), and right intraparietal sulcus (IPS). We also calculated the percentages of signal change in each region of interest across the three conditions. On the basis of analysis of the interaction, significant difference among the three conditions were found in the bilateral IFG, left PM, left IPL, and right IPS ($p<0.05$). In Addition, we found that the left hemisphere was strongly activated under the word-condition whereas the right hemisphere under the within-condition. Under the cross-condition, the signal intensity was intermediate between the word- and the within-condition. Under the word-condition, we found

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activation in the left IFG–IPL, which suggests that PL is possibly employed when memorizing colors. Considerable evidence of PL from neuroimaging studies and neurological patients has suggested that IPL, specifically the left supramarginal gyrus, subserving as a passive storage buffer, and frontal areas such as IFG and PM comprise the active rehearsal circuit, which is known to be

involved in the preparation of active subvocal rehearsal.The right IFG activation uniquely observed under the within-condition might plausibly be considered recruitment of that area, instead of a verbal strategy in the left IFG, to retrieve visual colors under the within condition. On comparison of the cross-condition to the within-condition, memorizing colors across several categories strongly employed the left IFG and the left IPL, respectively. This suggests that an implicit verbal strategy was very effective when executing the 2-back task under the cross-condition. Colors within the same category, however, activated the right IFG instead of the left IFG and the left IPL, indicating that a visual strategy is more useful than a verbal strategy to achieve a good performance under the within-condition

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Color and luminance affect perceptual transparency of human skin

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Keywords: skin, transparency, luminance, chromaticity

ABSTRACT

Transparent skin has recently been one of the most important keyword in developing cosmetic products in Japan. Perceptual transparency must be related to colorimetric parameters, such as chromaticity and luminance. Therefore, we conducted psychophysical experiments to examine the effects of colorimetric parameters on the perceptual transparency.

In Experiment 1, we examined whether luminance information has an effect on the perceptual transparency. A small patch of the cheek was clipped from a face image of a Japanese woman. Based on that image, we generated four kinds of stimulus corresponding to four levels of average luminance. Participant's task was to choose the skin with higher perceived transparency using a 2AFC paradigm. The results showed that the skin with higher luminance values was perceived as more transparent.

In Experiment 2, we examined whether chromatic information affects the perceptual transparency of skin. We asked participants to choose the color so that they can maximize their perceived transparency by adjusting the a*b*- chromaticities of the skin patch. The results showed that each participant has an ideal chromaticity so as to perceive transparency of skin though there are quite large individual differences among the participants. In addition, we found that redder skin looks more transparent.

1. INTRODUCTION

Transparent skin has recently been one of the most important keywords in developing cosmetic products. If transparent perception of skin can be controlled by some parameters, it must be applied to makeup, designs and developments of cosmetics products. The term "transparent perception" is originally used in expressing skin perception in Japan. However, "transparency of skin" is an ambiguous expression because it is influenced by individual subjectivity and individual experience in practice. In addition, visual factors which determine the transparent perception of skin are still unknown.

Human skin has a complicated structure which consists of multilayers called an epidermis, dermis and subcutaneous tissue. The light which entered from the outer skin is repeatedly reflected, decreased and absorbed in each inner layer. As a result, the mixed light of a diffuse reflection ingredient and a specular reflection ingredient comes out from the skin [1]. The reflection characteristic of skin influences largely skin appearance. It was clearly shown by previous researches [2] that the higher rate of a specular reflection ingredient, in other words, the higher rate of the transmitted light to incident radiation makes the skin more transparency.

In addition, skin perception depends on colorimetrical parameters such as chromaticity, brightness, and luminosity. However, it is unclear what contributes to transparency of skin and how it is determined. Therefore, we conducted psychophysical experiments to examine the effects of colorimetric parameters on the perceptual transparency of the human skin.

2. EXPERIMENT 1

Previous research [3] indicated that the luminance distribution of human skin affects the skin age perception. However, it is unknown how luminance level of skin influences transparency of skin. First, we chose the image of the woman with uniform skin color out of 100 images of Japanese females. The woman did not have any makeup when the picture was taken. The small patch of the cheek was clipped from the face image of the female. The patch was a square and both length and width were 200 pixels. The RGB values of the image were converted to the XYZ values using the calibration data of the LC-display. The XYZ values of all the pixels were multiplied by four kinds of gain 0.5, 0.75, 1.0, and 1.25, while the xy-chromaticities were kept intact. Four stimuli had four levels of average luminance; 20.3, 30.4, 40.6 and 50.7[cd/m^2]. Stimulus conditions and the image stimuli are shown in Table 1 and Fig.1, respectively.

Table 1. Stimulus conditions

Luminance level	1	2	3	4
average luminance [cd/m^2]	20.3	30.4	40.6	50.7

(a) level 1 (b) level 2 (c) level 3 (d) level 4

Figure 1. Stimulus images

Five young Japanese university students (21-29 yrs) participated in the psychophysical experiment. In fact, the participants chose the skin with higher transparency along a 2AFC paradigm. The image stimuli were shown randomly for 3 trials. The experiment was conducted in a darkroom, and the participant face was fixed to the position away from the display 90 cm. The stimuli were displayed on the carefully calibrated LCD-monitor (ColorEdge CG245W: EIZO). The results shows that the higher luminance skin appears more transparent (Fig. 2).

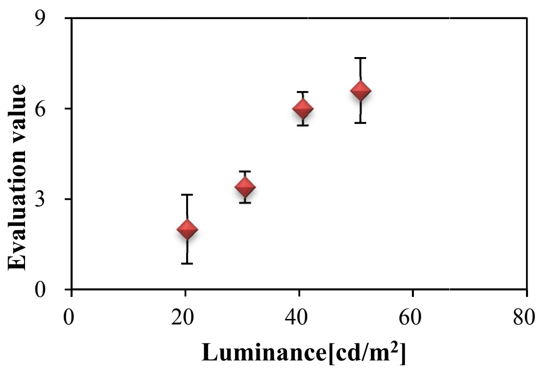

Figure 2. Results of Experiment 1

Moreover, in order to analyze the influence of the luminance level in the transparent estimation of human skin, an analysis of variance was conducted within one factor (participants). As a result, there was a significant difference among luminance level conditions, suggesting that luminance information strongly affects perceptual transparency of skin.

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3. EXPERIMENT 2

We conducted Experiment 2 to examine whether chromatic information affects to the translucent perception of skin. We measured chromaticity values of the bare face of a Japanese female by using a 2D luminance colorimeter (UA1000:Topcon), and clipped the part of cheek from the measurement data. The skin patch was a square and both length and width were 160 pixels, respectively. We converted XYZ values of the image into L*a*b* values. We increased or decreased the a* and b* values by one each, and made 2601 (51x51) image stimuli in total.

Five subjects participated in the experiment. The participants chose the skin with the highest perceptual transparency from all stimuli in five trials [4]. Participants chose the stimulus of the cheek that appeared the highest transparency in real time with the interface we developed. The experiment environment was the same as Experiment 1.

We plotted all the optimal chromaticities of the skin patch on the a*-b* plane (Fig.3). In addition, we calculated the average values of five trials for every subject, and plotted the average optimal chromaticities in the a*-b* plane shown in Fig. 4.

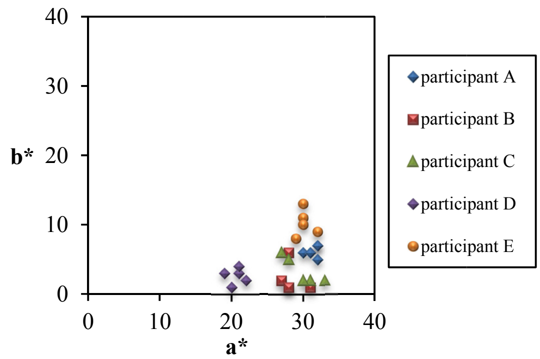

Figure 3. The optimal chromaticities of transparent skin for each participant

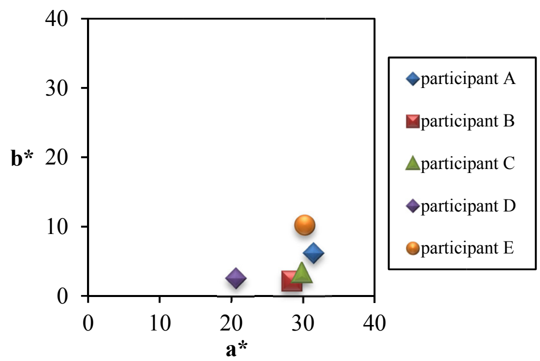

Figure 4. Average optimal chromaticities of transparent skin for each participant

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Figures 3 and 4 show that both optimal a*and b* values exist in the first quadrant in all subjects. Although there are large individual differences among subjects, few differences in each participant. These facts suggest that each subject has an individual ideal color for transparent skin. In addition, the results indicate that the redder skin appears more transparent.

4. CONCLUSION

Higher luminance induces more perceptual transparency of human skin. In addition, an individual ideal color exists for transparent skin in each participant. Finally, it was found that redder skin looks more transparent. These results suggest that we can control transparency of skin by adjusting luminance level and color of skin though there are large individual differences between observers.

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EVALUATION OF THE EFFECT OF DAYLIGHT ON ROOM BRIGHTNESS

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Keywords: Brightness, Daylight, Window, Reference Matching Method

ABSTRACT

The purpose of present study is to investigate effects of daylight on room brightness using a reference matching method. Participants observed two scale models simulating a room. One was a test room with a window through which artificial daylight entered and the other was a reference room without a window. Participants made brightness match by adjusting illuminance of the reference room with various illuminance levels (from ceiling luminaires) of the test room and window sizes. The results showed that, at the illuminance levels below 300 lx, the illuminance adjusted by participants was low even if the daylight increased the total illumiance of the test room. However, the adjusted illuminance increased efficiently with the daylight at the 1000 lx illuminance level. These results suggest that effects of daylight on brightness change with illumiance levels. The results were also discussed in terms of those of previous study using a magnitude estimation method.

INTRODUCTION

Recent development of lighting design and technology has enabled us to create various visual environments easily. Consequently, however, many designers and researchers have been faced with problems, not usually considered in previous studies. For example, although illuminance is used as an index of room brightness, a low illuminance room sometimes appears brighter than a high illuminace one. This fact not only indicates that illuminance does not always reflect room brightness accurately, but it also leads researchers to investigate factors which causes discrepancies between illuminance and brightness. One of such factors is daylight coming from windows. A few studies examined effects of daylight on room brightness [1] and found that increases in illumiannce by daylight did not sufficiently enhance room brightness, as compared with that by a ceiling light, particularly in the low illumianance room condition. In the present study, we further investigated the effects of daylight on room brightness by using a reference matching method. In this method, participants were asked to adjust illuminance of the reference room with various illuminance levels (from ceiling luminaires) of the test room and window sizes.

EXPERIMENTAL METHOD

In the present study, two 1/8 scale models simulating an office room were used (width; 800 mm, length; 1,200 mm, height; 340 mm). Figures 1 and 2 illustrate experimental apparatus and interior appearance. One room had no window and served as a reference room. Another room had a window and served as a test room. In both rooms, achromatic furniture and interior were arranged. To simulate daylight, we used 8 fluorescent lamps attached outside the test room. By changing the number of lamps turning on, the intensity of simulated daylight was manipulated: High (8 lights), Middle (4 lights), Low (2 lights), and Very Low (1 light). The illuminance of test room from ceiling luminaires and the window size were also manipulated. The Illuminance of the test room was either 100, 300 or 1000 lx. The window size was either full-window, 1/2, 1/4 or 1/8. The participant's task was to compare the brightness of the two models and to made brightness match by adjusting the illuminance of the reference room. Participants were able to repeatedly view each room and adjust the illuminance of the reference room.

In addition to the daylight conditions, we conducted a no daylight condition (control condition) in which participants viewed the test room with no daylight. The task was identical to that in the daylight conditions. There were 8 blocks of 16 trials. The order of conditions was randomized across participants. Before an experimental session, participants practiced the task for several times until they familiarized with the task. Four participants participated in the present experiment. All of them had experience of brightness experiments before.

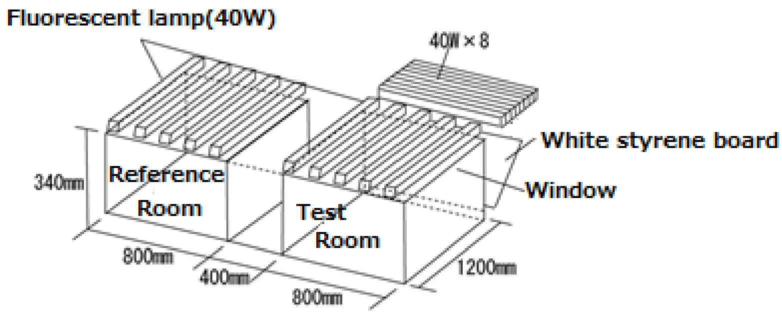

Figure 1. Experimental apparatuses

Figure 2. Interior appearance

RESULTS

Figure 3 shows the mean illuminance of reference room adjusted by participants. Note that horizontal axis represents the total illuminance from the ceiling luminaires and daylight. The white markers indicate the mean illuminance set by participants in the High, Middle, Low and Very Low conditions (in order from right to left). The black markers indicate the mean illuminance set by participants in a no daylight condition. As shown in the figure, the white markers shifted to upper right from the black markers as the illuminance of test room increased by daylight coming. The adjusted illuminance of test room also rose with the test room illuminance. The results indicated that the adjusted illuminance tended to increase as illuminance of test room increased. From the results of 100lx and 300lx conditions, it is obvious that white markers were located below the dotted line. From the result of 1000lx condition, most white markers were located on it.

DISCUSSION

From the results of 100lx and 300lx conditions in Figure 3, compared with the illuminance of test room, the adjusted illuminance of reference room was low. This means both test room illuminance and room brightness increased by daylight coming, but the increase in the brightness was lower than that induced by ceiling luminaire. From the results of condition 1000lx of Figure 3, daylight had almost the same effects as those of ceiling luminaire when interior brightness was enough.

Next, we will discuss the results of the present study in terms of those of the previous study. Figure 4 shows the results of subject RT in the previous study. Note that horizontal axis represents the total illuminance from the ceiling luminaires and daylight, and vertical axis represents brightness values that participants responded. Conditions were the same as the present study. Similar tendency was seen in the most results. However, in some conditions the results showed different tendency from those in the present study. From condition 100lx and 1000lx, the increase was seen, similar to the present study, but from condition 300lx, most white markers were located above the dotted line.

CONCLUSION

Although the illuminance increased by daylight coming, room brightness did not always increase effectively as expected from the illumiance increases by the illuminaires. However, such effects of daylight on brightness changed with illumiance levels. Under the conditions as the illuminance level was low, interior brightness increased as daylight came, but it was lower than before daylight came. Room brightness raised as the illuminance increased, but such effects of daylight became weak. Furthermore, some results differed from the findings measured by using a different method. Therefore, we need to investigate this point in future study.

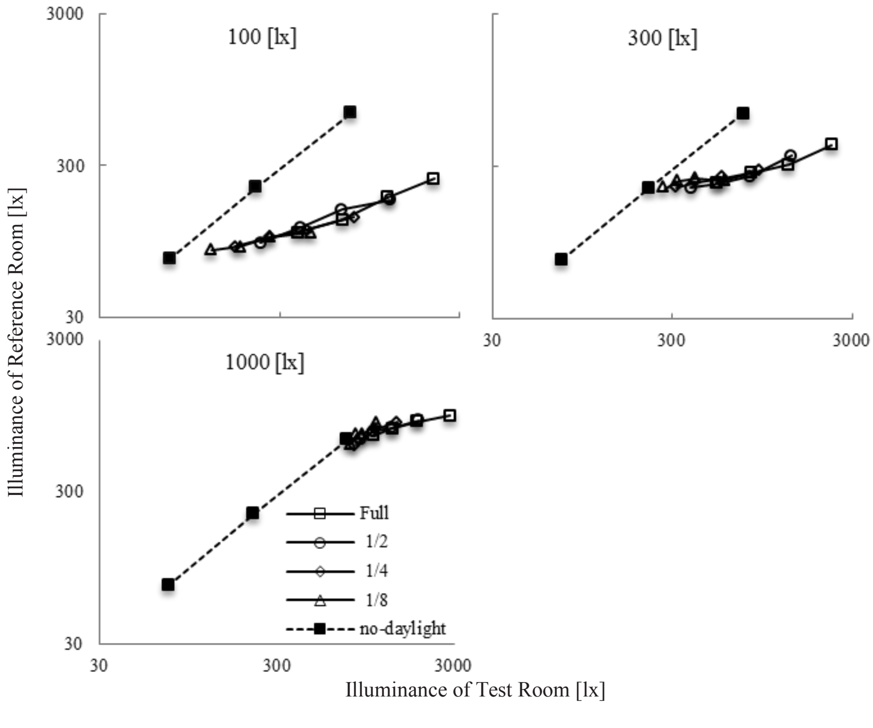

Figure 3. Brightness matching (Average)

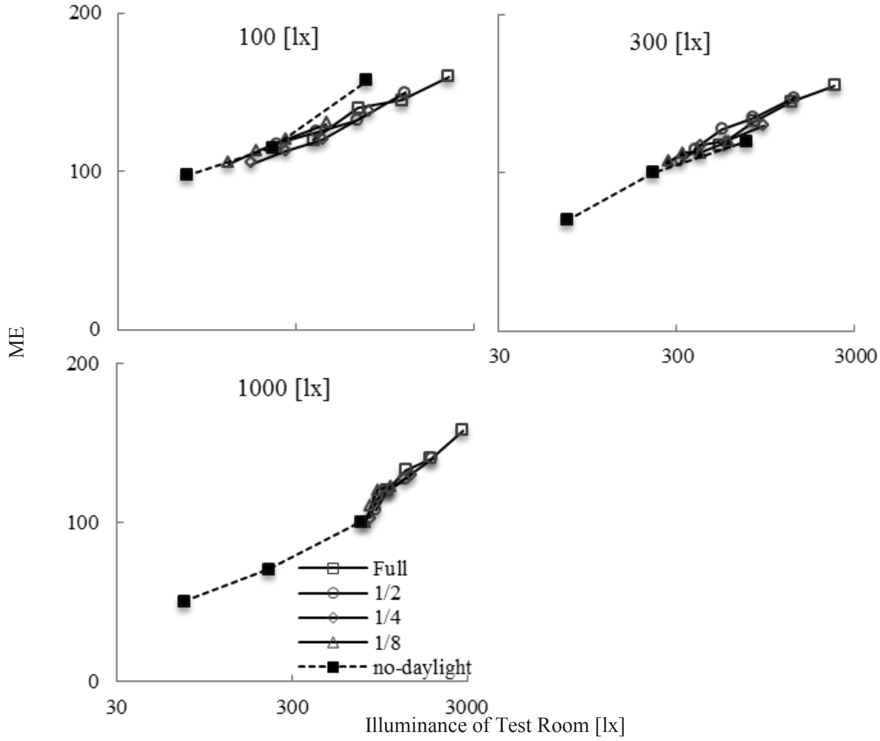

Figure 4. Previous results (RT)

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BLACKNESS JUDGMENT OF LACQUER WARE BY EXPERT AND NAÏVE GROUPS

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Keywords: lacquer, expert, material, paint, blackness

ABSTRACT

In this study, we examined the degree of observer's ability to identify the test bowls of the same shape but composed of different materials that are painted by lacquer or cashew, with or without glossiness. Performance of expert and non-expert groups is compared in relation to the luminance distribution of test bowls.

1. INTRODUCTION

Lacquer ware has been used for a long time since ancient era in a wide area of eastern and south-eastern Asia because wooden ware painted by lacquer becomes impermeable and durable. Also, many different ways of decoration can be added to lacquer ware, such as gold work, gold-embedded work, or mother-of pearl work, etc., and thus lacquer painting is used for interior finishing of religious buildings. However, due to the distinctive decrease of plants after the world war II, and the cost-cutting stream of modern industry, industrial production of Japanese lacquer ware has become extremely small. Instead of natural lacquer, cashew oil mixed with a resin is often used for a painting material that mimics Japanese lacquer ware. Quality of appearance of cashew ware is fairly high and it is difficult for people who do not have special interest in lacquer ware to discriminate it from natural lacquer ware. It is said that lacquer craftspeople can distinguish the appearance of real natural lacquer ware from 'fake' lacquer ware. To seek the perspective of expert in identification of real Japanese lacquer is an interesting issue for the study of recognition of material appearance [1].

Therefore, in this study, we examined the degree of observer's ability to identify the test bowls of the same shape but composed of different materials that are painted by lacquer or cashew, with or without glossiness. Performance of expert and non-expert groups is compared in relation to the luminance distribution of test bowls.

2. EXPERIMENT

2.1. Test bowls

We prepared 12 bowls of the same shape. They are composed of wood, bonded wood, or plastic, and painted by Japanese lacquer, cashew, or urethane with or without glossiness. Cashew and urethane are mixed with resin. Among them, the test bowls painted by Japanese lacquer and cashew were used as test stimuli. Table 1 shows the property of the test bowls employed in the experiment.

Table 1: Property of test bowls used in the experiment

Paint	Material	Gloss or matte	Weight[g]
Japanese lacquer	Wood	Glossy	95
		matte	108
	Bonded wood	Glossy	116
		matte	116
Cashew	Bonded wood	Glossy	110
		matte	114
	Plastic	Glossy	82
		matte	90

2.2 Identification experiment

Eight test bowls were placed on the table at the north window. To examine the effect of some non-uniformity of diffused sun light, 2 kinds of paper curtains were installed, one was with thin horizontal bamboos and the other was a uniform paper. They are called with and without stripes, respectively. Settings of the test bowls are shown in Figures 1 and 2.

One session is composed of 2 blocks, and 1 block includes 2 runs. At the beginning of the first block, the observer was handed 8 small cards in which the property of test bowl is written. Then, the observer was instructed to place each card in front of the corresponding test bowl without touching them. Observer could spend a time as long as they became satisfiable. When this task was done, the experimenter checked whether each card was placed at the correct test bowl. We call the first run 'observation only'. After the first run, the experimenter changed the position of test bowls randomly. Then in the second run, observer was handed 8 cards again, and he/she was given the same instruction as the first run, except that he/she could not only see, but also touch, hold, or smell test bowls freely. After the placement of 8 cards, the experimenter's check was done in the same way as the first run. We call the second run 'observation with touch'. These are the tasks performed in the first block. Between the blocks, the leaning period was given to the observer. He/she was taught the property of each test bowl and could see and touch them freely to memorize which was which. Duration of learning period is not limited, but usually within ten minutes. Then, the second block was carried out in the same way as the first run.

For each of with and without stripes condition, one session was conducted for each observer. The order of with and without stripes session was counterbalanced among observers in each group. Seven experts and 20 naïve observers participated the experiment.

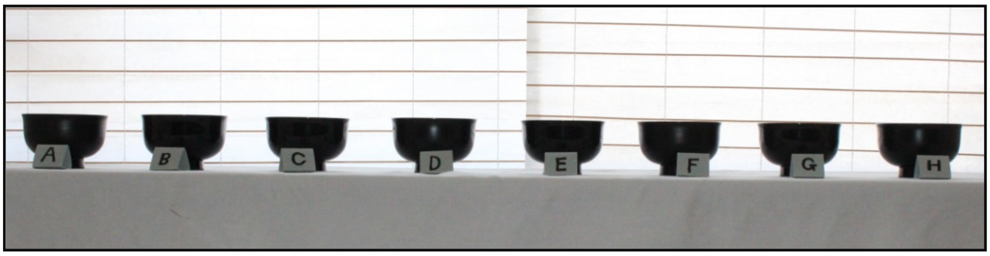

Figure1. Test bowls placed at the north window with stripes session

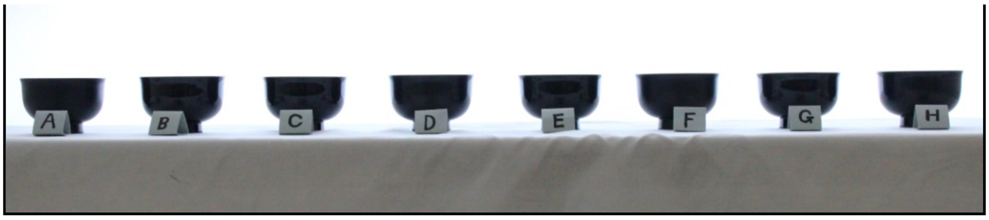

Figure2. Test bowls placed at the north window without stripes session

3. RESULTS OF IDENTIFICTION EXPERIMENT

Figure 3 (a) and (b) show the percentage of correct identification in the first block of with and without stripe conditions, respectively. As shown in the figures, performance of expert group is higher than that of naïve group for all runs. Performance of the second run, 'observation with touch' is higher than that of the first run, 'observation only'. Performance of 'observation with touch' in the with stripes condition is higher than that in the without stripes condition, while that of 'observation only' is vice versa in the expert group.

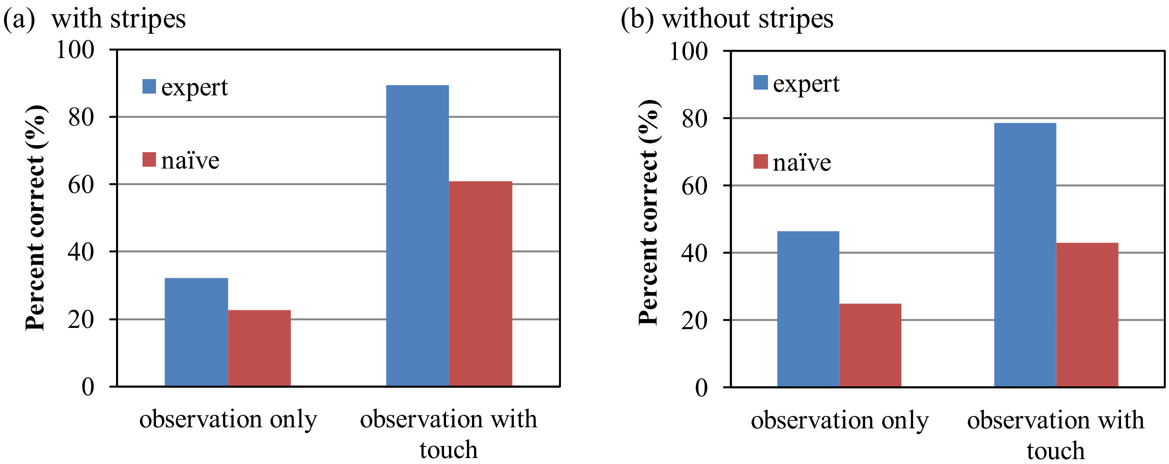

Figure 3. Results of identification experiment. (a): with stripes, (b):without stripes conditions

4. DISCUSSION

To seek visual cue by which experts can identify each of 8 test bowls, we measured the luminance distribution of test bowls in various settings. Lee et al., measured angular reflectance property of lacquer and synthetic resins, and reported that one of the difference between Japanese lacquer and cashew with resin is the reflectance change with tilted angle [2]. During the observation with touch run, most of expert observers looked at the inside of bowl carefully with changing the viewing angle. Therefore, we compared the luminance distribution of the bottom of the test bowl at the tilt angles of 0, 3, and 5 degrees. Results of the measurement for the two test bowls, painted by Japanese lacquer or cashew with gloss are shown in Figure 4. Both of them are composed of bonded wood, and thus the weight of the bowls is the same.

Luminance distributions of the inside bottom of the bowl in with stripes condition show slight difference between Japanese lacquer and cashew. Also, Japanese lacquer bowl shows subtle change between the tilt angles of 0 deg and 3 deg, whereas cashew bowl does not show such a change. In our previous study, we found that perceived blackness of lacquer plates correlates with the luminance measured from observer's eye position [3]. Thus, difference or change of luminance distribution may induce variation of perceived blackness for the expert observers. At the present, we consider that the expert observers in this study utilize this kind of subtle change and/or difference of luminance information and combine other sensory information such as sense of touch and smell, to identify the test bowls.

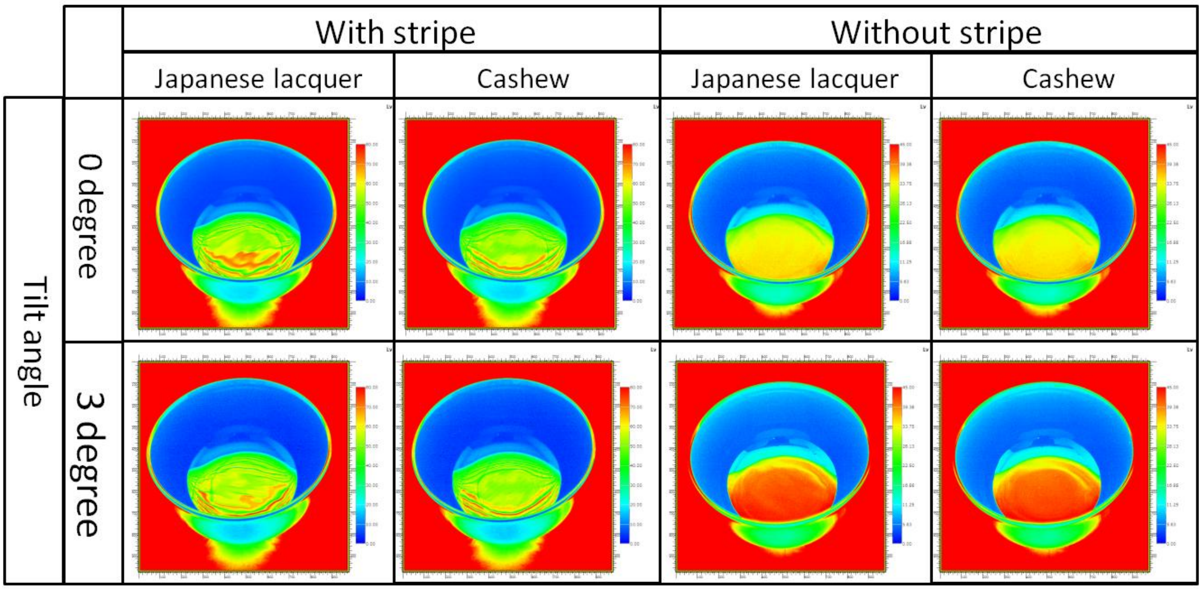

Figure 4. Luminance distribution of two test bowls, painted by Japanese lacquer or cashew, with gloss. Both are composed by bonded wood

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Keywords: colour, colour study, colour design, education

ABSTRACT

The pioneer course in colour study and design at the Faculty of Architecture, Chulalongkorn University was originated from the fact that colour design and study was only a small part of Design Fundamental module, which was not able to provide the Architecture students enough fundamental knowledge about colours. The pioneer colour study and design was thus established in 2005 as an elective course. The aim of the course is to provide students with solid fundamental knowledge about colour usage in terms of functional and aesthetical senses. The students should also understand changes and gimmicks, which could help creatively design colours that serve functions. The course employs the interdisciplinary concept, which combines Science with Arts and Sociology. Its structure is built up from scientific facts regarding colour perception namely colour seeing, colour interpretation, combined with aesthetics knowledge regarding colour harmony and contrast. After completing the course, the students are able to integrate knowledge attained by the "learning by seeing, touching, feeling and creating good colour design" method as well as able to show good progress in applying the theory into colour design concept creation in a short period of time. They also show interests in colour design and use colours in designing architectures. The success of this course also reflects in the number of students enrolled, from 15 students in 2005 to 52 in 2012, which proves the increase interests in colour among students.

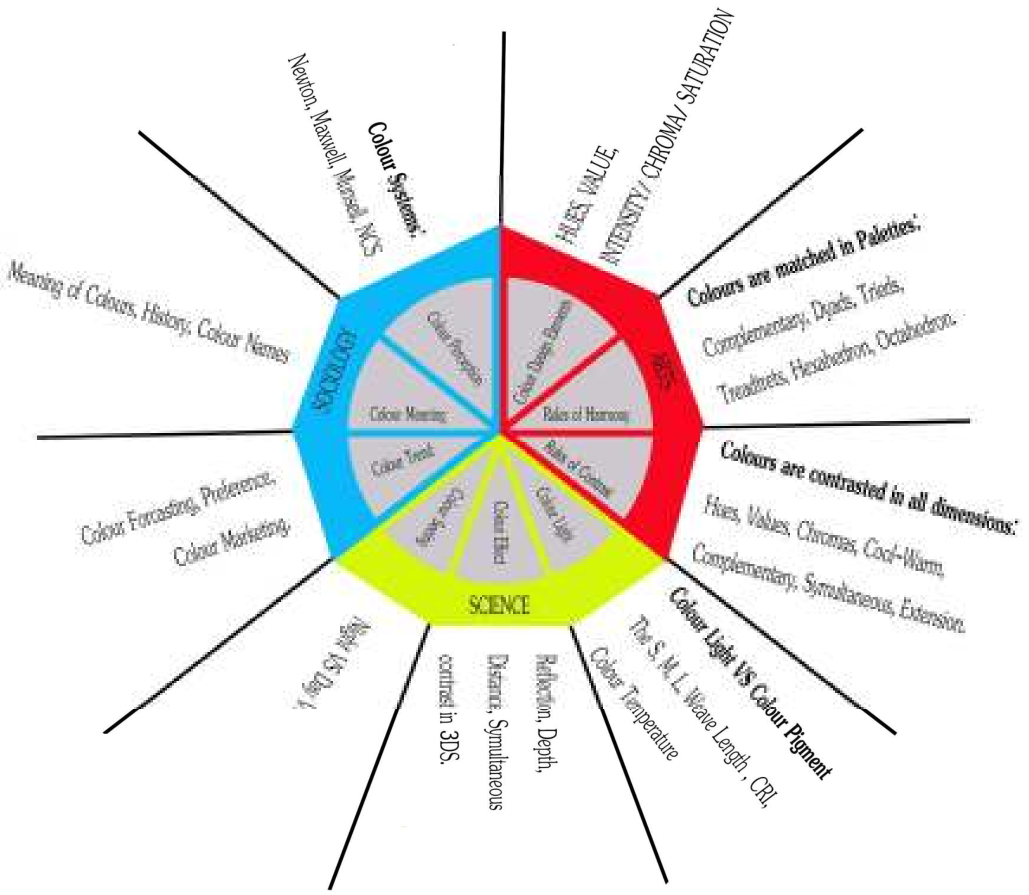
INTRODUCTION

The Colour Study and Design course is the first course at the Faculty of Architecture, Chulalongkorn University that dedicates the full course teaching about "colours". Rather than conventionally regarding colours as one of the less important design elements, this course aims at demonstrating how important colours are in designs and the impacts of the colours on designs that are beyond aesthetical impact.

To demonstrate the point, the class teaching method was to unconventionally argue that the knowledge about colours does not belong purely to the Arts. Rather, the knowledge about colours is the Arts, Science and Sociology combined.

The course, thus, provided the students with colour knowledge on three aspects. Firstly, the course continued to explore the Arts aspect of colours by continuing to teach about fundamental theory about colour scheme in order to create mood and feeling which matches with design objectives.

Knowledge about Arts applied in colour studies, thus, concerns Harmony and Contrast, focusing on aesthetical sense. Secondly, the course took the students to explore colours scientifically. Colour Study and Design is the pioneer course that aware of the scientific consequences from the use of colours. For example, the course explored the change of colours in different light, different environment and different seeing ability. This is considered the study of Science which contributes to better understanding of colour usage. Lastly, the Colour Study and Design took the Sociology approach by exploring human feelings through the study of colour system organisation, colour awareness, trends and colour meanings.



In exploring the the Arts, Sceince and Sociology aspects of colours, the course was structured by alternatively performing lecture topics and studio practices which were a 3-4 hour-individual task. As Colour Study and Design was an elective subject for 4th and 5th year architectures students who had somewhat good background knowledge about architecture in various natures, which was their major subject, the focus of the course was on “designing colours” rather than on designing structure or form.

Students were taught by the "Learning by Seeing" approach. They would learn to mix colours by themselves and learn about the change of hues and nuances.

The lectures and assignments given in this course start from a simple task to more complicated ones. The first lectures and assignments were dedicated to colour palette introduction. Topping up from the fundamental 12 colour palette studied in their first year, students learned about 40 colour palette in Natural Colour System (NCS) which can be mixed and create many nuances. The aim was to provide the students with the opportunity to experience the more complicated colour palette and be able to use it to create more complicated colour designs.

After the first three weeks when students were familiar with the hues and nuances, the course proposed the first studio practice—a design project, encouraging the students to design colours, based on colour theory, colour harmony and colour contrast. From the seeing practice through the first projects, the course then proceeded to the more complicated design projects. The students would learn about colour & meaning and colour perception for each colour and group of colours. They were assigned to design colours for the design project of their choice, such as colour renovation that portrayed identity suited with functions and reflected beauty. The work were assigned be done both in 2Ds and 3 Ds.

In terms of lighting, the course provided knowledge about colour pigment and colour light by considering from the appeared wavelength, which is a basic theory but provides effects for the students to analyse before choosing colours.

Moreover, the students learned about effects which enable design's colour changing, for example, reflection, simultaneous contrast both on 2Ds and 3Ds. These effects would be learnt while the students explored colours on their design projects. For the design projects that required the decision from more than one person, those projects would be assigned as group projects such as "Painted by Reflection" project, the project initiated by the instructor which provided students the opportunity to witness colour changing by different kinds of colour reflection.

In terms of 2Ds colour design, the students were required to use knowledge gained from colour perception and colour effect lectures in creating colour story board. Other design elements were reduced such as details of forms, structural lines so as to demonstrate the impact of colours on story-telling. After the story board has been critiqued and developed to a certain point, the students were then allowed to design 3Ds works. Through designing the 3Ds works, the students' ability and precision in choosing colours that creates beauty, function and at the same time, expresses feelings and communicates sizes and distance were shown.

The last assignment was the final project, which was subjected to each student or each group of students' interest. The students were required to choose their topics of study and design colours for the topics. The project would be presented in every process, from methodology, theories applied, analysis and synthesis.

The final project was the indicator of students' interests. The topics chosen varied from colours for food display, packaging and dessert colour design, colours for nail liquor, lighting and colour design for restaurant, colour changing for hard scape to separate daytime and nighttime activities, colour design for MRT station to colours with other senses (Synesthesia) such as CD cover design for jazz music and packaging design that convey the taste of the food etc. Each project showed the students' understanding and ability in combining and applying the Arts, Science and Sociology aspects of colours.

Oral paper

In terms of course assessment, the assessment of the course is part of the motivation for students to excel colour design as for every project, should the students be unsatisfied with the work or grades, the students are encouraged to resubmit the project as many times as they wish until the end of the course. The records show that more than 50 per cent of the students resubmitted the works which encouraged them to learn from the mistakes and to make better understanding with each colour topic.

The practices from 9 projects during the first weeks to the 13th week enabled the students to design colours with confidence and to apply knowledge to their final projects in only three weeks. For each assignment, the limited amount of time encouraged the students to pull their resources quickly. Especially the final projects, they demonstrated very well that the students had good understanding and were able to integrate and apply the Arts, Science and Sociology aspects of colours into their works.

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THE COLOR IDENTITY IN TRADITIONAL THAI BUDDHIST TEMPLES

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Keywords : Thailand, Color, Buddhist temple, Color Identity, Color Themes, Adobe Kuler

ABSTRACT

Thailand has been a land of Buddhism for over a thousand years. Buddhist temples spread across 2,000 kilometers from the north to the south of the kingdom. This research aims to identify the colors that represent Thai Buddhist temples and to create colors themes that represent the similarities and the differences of all the regions of Thailand. The method used was the collection of outdoor and indoor images of major temples in five different regions: north, northeast, center, east and south; then processing the average value by using additive color theory from major design elements of the temples. Five color sets per theme will be created, each from indoor and outdoor photos. Each theme will be compatible with Adobe Kuler design environment. The color themes can also be utilized in different design applications.

INTRODUCTION

Over one thousand years ago, when Buddhism came to this region of Asia, it developed unique characteristics and created a genuine identity over time. Buddhist temples have become parts of the Thai way of life and distinguished themselves from other neighboring countries.

Color is an important part of the architecture. This study examines the colors of Thai temples: what tints make Thai Buddhist temples so unique? Can colors of Thai temples define Thai identity? How this set of colors is distributed across the kingdom? Do they remain the same schemes from north to south? Can we apply the color themes from Thai temples to other applications and recognize them as Thai?

OBJECTIVE

1. To study and extract color sets from Thai temples that can represent Thai identity and the uniqueness of Thai temples.

2. To find the differences and similarities of color sets in each region of Thailand.

3. To design color themes that can be applied to other design tools or applications and maintain Thai characteristics.

METHODOLOGY

Step 1

We analyzed color patterns from five selected well known Thai temples in each region throughout the kingdom. The selection is based on the principle of similarity, principle of proximity, principle of closure and principle of constancy.

Step 2

We classified temples in three categories for color data collection:

1. Outdoor Category: the colors of the main chapel.
2. Indoor Category: the interior Buddha image of the main chapel.
3. Overall Category: the pagoda and overall temple look and feel.

Step 3

We used digital single lens reflex camera (DSLR) as a tool to collect the color data by photographing each part of the temples in additive (RGB) color model.

Using image editing software such as Adobe Photoshop, we sampled down to determine elements of the photographs into single RGB value: five colors per category for each temple.

Data value was averaged by using Adobe Photoshop, which is not only averaged by values of colors mathematically, but also accumulated from the portion amounts of colors as well. The method applied to find out the representation colors of each regions as well as final overall colors of Thailand.

RESULTS

The total sampling of temples from five regions found that most colors are on the warm side of color wheel, regardless if it was indoor or outdoor. There are some differences on the color themes between the different regions. The north utilized more darker colors in general: rooftop, indoor and outdoor. The north-east uses more saturated vivid colors overall, especially rooftop and outdoor. The central region has brighter color on the rooftop and exterior. The east and south display similar color moods and tones.

The result chart **(Table 1: Results chart)** below display result of each region in to roll of five colors set per theme. Each column display category from outdoor, indoor and overall. The last roll shown the result of final Thai temples theme that averaged from each regions.

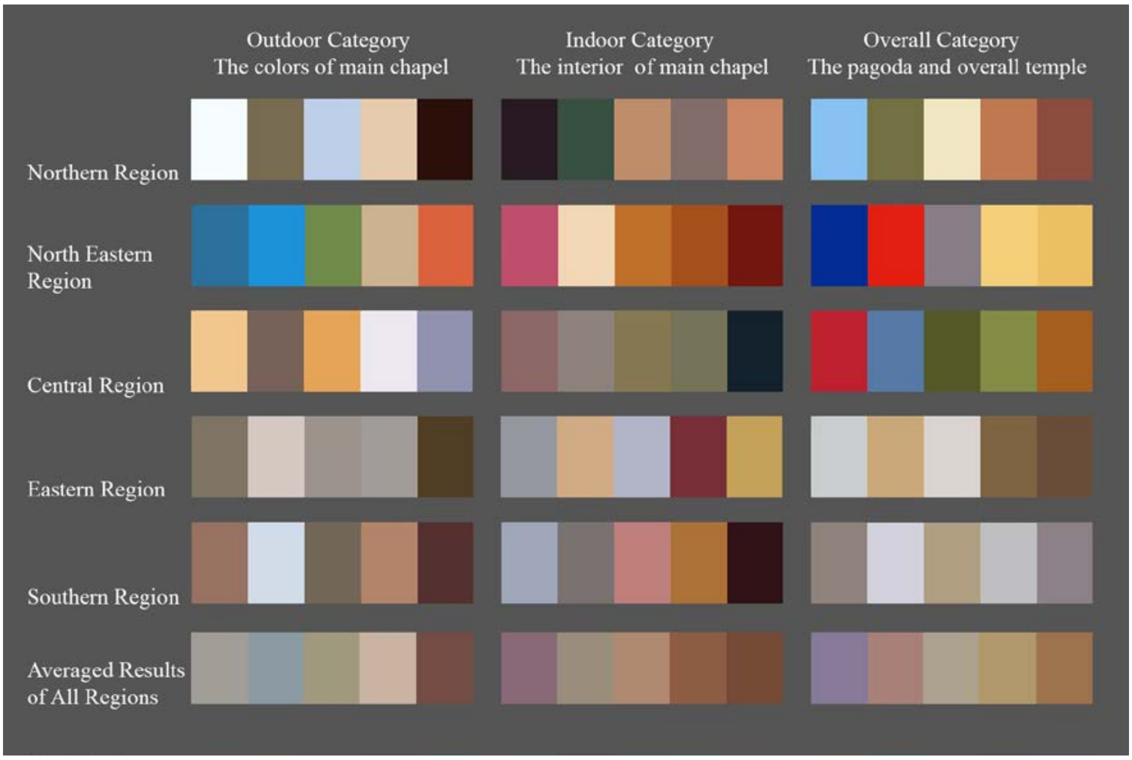

Table 1: Results chart

Since Thai temples are so colorful, it is difficult to sample colors of the temples without aesthetic consideration. These methods have to be selected by visual artists and are very time consuming. It also generated overwhelming data. Therefore, in order to create a successful set of color themes, a mixed method approach seems more appropriate. Moreover, there could be more than one theme representing the colors of Thai temples in each region.

These color sets can be used traditionally as a color reference and digitally as RGB values. In addition, in our digital, this research was conducted based on color sets that can be applied as popular Adobe Kuler themes, digital designers and artists can download and use these themes via Adobe's website and use them with Adobe Kuler compatible applications as color theme template.

ACKNOWLEDGEMENT

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COLOR SEMIOTICS IN SHORT FILM ECLIPSE

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Keywords: Color Semiotics, Short Film, Eclipse, ACA2013,Thailand

ABSTRACT

The following study examines the usage of color semiotics in producing the short film 'Eclipse', which was awarded the Grand Prize Winners of "Young Thai Artist Award 2011" in the feature film category. The film was also invited to be screened at the prestigious "Official Selection 10th World Film Festival of Bangkok" from 16 to 25 November 2012 at Esplanade Cineplex Ratchada. The primal inspiration behind the film was to implement color semiotics as a sole element to narrate the story in terms of its meaning of giving hope, reflecting sadness and tragedy, which this will subsequently mirror society of individuals in need of hope, being faced with adversity and are in a state of despair. Furthermore, these factors mentioned may even lead to commit suicide cases and individuals being in a wrath towards their parents, cousins and relatives.

Using the basis of this film's dialogue, characters and the different dimensions of them; this study's primary objective is to: 1) Use color semiotics in the film as a way to reflect hope, faith, sadness, love and death; 2) Use color semiotics as a way to reflect the film's meaning in the psychoanalytical thriller genre.

THE PROJECT'S STRUCTURE

This short film was conceptualized creatively for the purpose to produce a psychoanalytical thriller in which it doesn't follow the traditional sequence in timing, location and the color semiotic. The length of the film is expected to be at around 30 minutes with using a High Definition (HD) camera to film it.

THE PROJECT FRAMEWORK

1. Planning the film's script for a psychoanalytical thriller in which color semiotics are used to narrate the story in around 30 minutes
2. Producing the film with a length approximately at 30 minutes

OBJECTIVES

1. To produce a film that presents viewpoints towards the issue of commit suicide and revenge that then follows for the victim's relatives.
2. To produce a psychoanalytical thriller by using semiotics.
3. To produce a film that does not follow the traditional sequence in story telling, time and place.

CONCEPTS AND RELATED THEORIES

The integral motive in producing this film was to reflect the core concepts behind psychoanalysis theories and how it relates to the psychology of human beings. Subsequently, this concept can be examined through four main ideas, as follows: (1) Semiotic Concept (2) Color Usage Concept

1) Semiotic Concepts

"Semiotics" or also known as "Semiology" both come from the Greek word "Semeion" which means signs. The customs of Semiotics dates back to American philosopher Charles S. Peirce (1839-1914), where he expansively introduced this concept in his academic field. As for Semiology, it's a study first familiarized by renowned Swiss linguist Ferdinand de Saussure (1857-1913) and received popularity in many European academicians (SoraneeWongsebiasuj, 2001). With many explanations given towards the study of Semiotic, Ferdinand de Saussure describe it as a science that studies the foundation of signs and symbols in a social context and how it widely affects the way people lives. Therefore, we learn how these signs are initiated, developed, changes and are eliminated. This field also studies the laws behind semiotics and how humans handle them when being affected, which 8 Mark Gottidiener once explained that Semiology is a framework that helps people understand the relationships found in the world where signs and symbols are the foundation or the nature of representation. The Italian scholar Umberto Eco also divulged the boundaries found in Semiology and how everything can be cogitated as signs and represents something else. Hence, the study of Semiotics is based on communication concepts that are naturally delicate, which means that not every sign can be explicitly explained into words. This is where the social context and traditional customs then must be factored into getting a better understanding of semiology. KanjanaKaewthep (2001: 2-3) has then concluded that semiotics should carry these three attributes, as follows:

1. Semiotics should have concrete characteristics that can be perceived by the human's five senses

2. Each semiotic should mean more than its obvious physical state

3. People using semiotic should be able to rationalize and understand that these are just signs and symbols

2. Color Usage Concept

In the film ECLIPSE, the color usage is able to expose different feelings for viewers that ranges from happiness, love to sadness. Furthermore, each color has the ability to become signs and symbols that evokes different emotions. For example, using the color black and white in the dressing form for certain culture means death, sadness and sorrow. Not only can color usage help arouse different emotions for viewers; it can also help the idea of distance and motion in film. In the past till present, many scholar have tried to find the linkage between color usage and emotional response of viewers in watching a film, where it can be explain as in the following factors:

1. Feelings and Emotions

Colors have the innate ability to powerfully arouse viewers' emotions; so therefore many designers have played with this tool. However, each person's response will vary depending on his or her knowledge and experience. For example, hot tone colors may emit an ecstatic and lively feeling, while cool tone colors reflect a soothing and calm feeling.

Furthermore, each color are used specifically to evoke different feelings as follow:

Red Color

The color red is the hottest tone because of its ability to quickly grasp people's attention for associating to power and aggressive feelings.

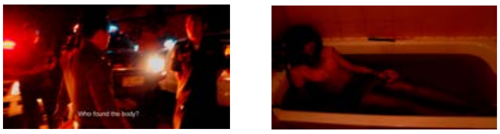

Figure 1. Red Color Example Screenshots from the Film

Additionally, the color red can also be a sign of love that vitally contradicts to the prior notion that the color is associated to negative factors such as disagreements, fighting and danger.

Blue Color

Blue is a vivid color tone that radiates coolness and a soothing sensation for viewers.

Figure 2. Blue Color Example Screenshots from the Film

Yellow Color

A highly vivid color tone, that with its vibrancy, it's usually associated with sunlight, warmth and giving hope.

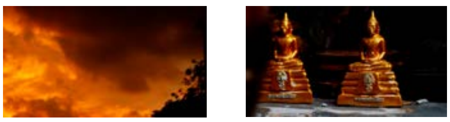

Figure 3. Yellow Color Example Screenshots from the Film

Purple Color

A color tone that is created by the mixture of red and blue, which therefore purple holds both of the primary color's feeling with the power notions of red and morality of blue. Purple is also usually associated with feeling elated, lavishness and good impressions, but it can also include sadness.

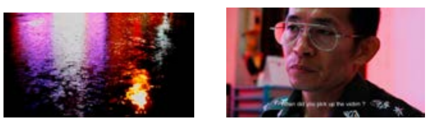

Figure 4. Purple Color Example Screenshots from the Film

White Color

Considered to be the brightest tone, the color emits a feeling of lightness, purity, goodness, fairness and also a sense of sadness and being seperated.

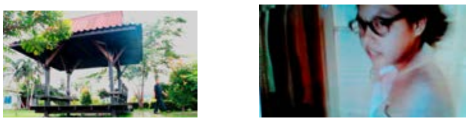

Figure 5. White Color Example Screenshots from the Film

Black Color

Considered to be the darkest tone of all colors, it reflects feeling dismal, dark, mysterious, terrifying, evilness, immortality, sadness and also death

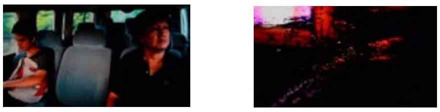

Figure 6. Black Color Example Screenshots from the Film

Color can also be a key principle in designing space and help the soul render and work towards being affected by different emotions. Because not only can color usage help give objects a livelier and more charming exterior, but it also helps in the context of emotions, feeling, size and motions in a correct suitable manner. So from this notion, we can then integrate it into analyzing each character's personality with the help of the film's color tone, the setting and the color of the clothing.

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Poster paper

in order of presentation

EVALUATION OF EFFECT PIGMENT ORIENTATION USING COMBINED SEM, TEM, AND X-RAY CT ANALYSIS AND CONCLUSION FOR INTERPRETING GONIOSPECTRO-PHOTOMETRIC DATA OF EFFECT COATINGS

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Keywords: SEM, TEM, FIB, X-ray CT, effect pigments orientation

ABSTRACT

Plate-like effect pigments (with diameters between 5-40µm and less than 1µm thick) are widely used to create decorative appearance in coatings, prints, plastics and cosmetics. Thereby the color and texture do not only depend strongly on type and concentration of the effect pigment, but also on their orientation distribution in the corresponding medium. In order to predict the appearance of a given effect pigment, its orientation distribution obtained using a specific method of application (spray application, roller blade application, offset printing, brushing, etc.) should be measured. This is usually done by preparing mechanical cross sections and obtaining the 2D particle inclination distribution N(d) by semiautomatic image processing of microscope images.

INTRODUCTION

The appearance of a golden effect pigments applied with spray application (narrow orientation distribution) and powder coating application (broad orientation distribution) is shown in **Fig. 1** and **2**. The differences are obvious and to predict such differences the orientation distribution of the effect pigments should be measured with a high statistical accuracy. Mechanical cross sections allow in insight into the orientation behavior of the effect pigments, but the statistical evaluation of the data is quite troublesome and sometime not accurate enough.

The present poster describes the method of X-ray tomography (SkyScan model 2011 nano-CT) as a noncontact, nondestructive and fast method to examine the 2D and 3D particle orientation in effect coatings. In comparison to X-ray CT a step-by-step ion beam slicing using a FIB V600 CE+ (FEI) was utilised for the same coatings volume. These cross-sections were inspected to find the identical particles already seen in the tomogram and to evaluate them with respect to inclination, thickness and inter-particle distances by SEM (SU70 / Hitachi) and TEM imaging (Tecnai G2 F20 S TWIN / FEI).

EXPERIMENTAL AND DISCUSSION

Although the lateral resolution of all methods is quite different a good correlation could be found for individual particles as well as for big ensembles. In case of adding disorienter particles to the effect pigments this data were used successfully to interpret high resolution macroscopic goniospectrophotometric measurements (Murakami GCMS-4 Gonio-Photospectrometer).

In order to follow the logical way of this research figures on the next page are shown consecutively: **Fig. 3** gives the accustomed view of an ensemble of effect pigments as generated by (BF) light microscopy. The effect pigments are seen as platelets from the top to estimate particle areas and equivalent diameters. **Fig. 4** represents a mechanical cross-section through the effect coating imaged by SEM. Here we get the side view of the particles in order to estimate the thicknesses and more importantly the two-dimensional angular particle inclination δ with respect to the surface normal. N(δ) is close to a Gaussian with a standard deviation of less than 10°. **Fig. 5a** depicts the SEM view of the marked coatings area (volume enclosed between both crosses under the metal protection bar) to be analyzed by X-ray CT. The crosses are identified then in the X-ray CT images as shown in **fig. 5b** (for X-ray CT principles see the scheme in **fig. 6**). The measured and reconstructed ensemble of the effect particles in the volume is given in **fig. 5**. Along the line between both crosses a TEM lamella was prepared using FIB technique. One of the cross-sections is shown in **fig. 8a** as an X-ray CT section, in **fig. 8b** as a SEM – and in **fig. 8c** as a TEM – cross-section image. There is not a full correspondence between the pictures due to the different depth of analyzing, which is much bigger in X-ray CT than in TEM.

Identical volumes are marked by squares and the particles are evaluated with respect to inclination d and thickness. Due to the fact that TEM analysis need thin electron transparent sections of the volume (prepared from both sides of the lamella) a continuous transversal shift of the interface was followed by SEM imaging and correlated with X-ray CT images for a large volume. The Xray CT – SEM - TEM correlation in **fig. 8a, b, c** was carried out only at the final stage, having a thin lamellar residue suitable for TEM. The usage of X-ray CT evaluation of particle inclinations in correspondence to measured goniometric lightness distributions (here light incidence is 45° and the detection angle varies from +75° to -75°, corresponding to an aspecular angle φ from 30° to -120°) is demonstrated in **fig. 9a** – for a series of different effect pigment concentrations, where the lightness curves are shifted to higher values and **fig. 9b** – for a series of effect coatings with rising disorienter concentration, with a “rotation” of the lightness curves: less lightness in direction close to the specular and more lightness in strong aspecular directions. The behavior of log(L*)=f(φ) in both cases fits well with the Xray CT data of particle inclinations as given in the captures. Therefore the gonio-spectrophotometric approach and the X-ray CT data are best suited to study the effect particle orientation distribution in a sufficient large coatings volume and SEM /TEM analysis can be used to investigate detectability of the pigments, resolution and local peculiarities of the methods.

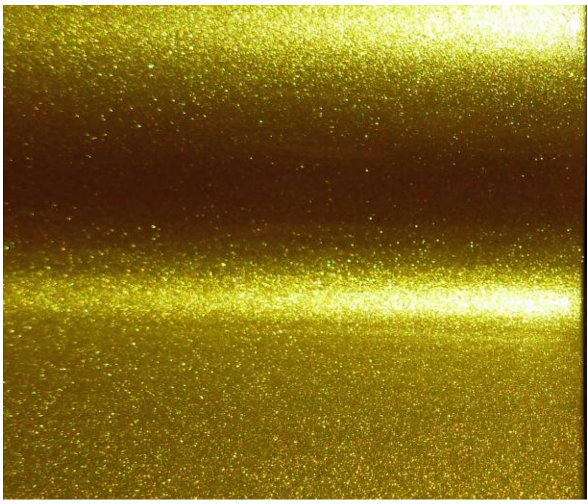

Fig. 1: Photograph of gold effect coatings produced by spray application method on a bended plate yielding strongly oriented effect pigments

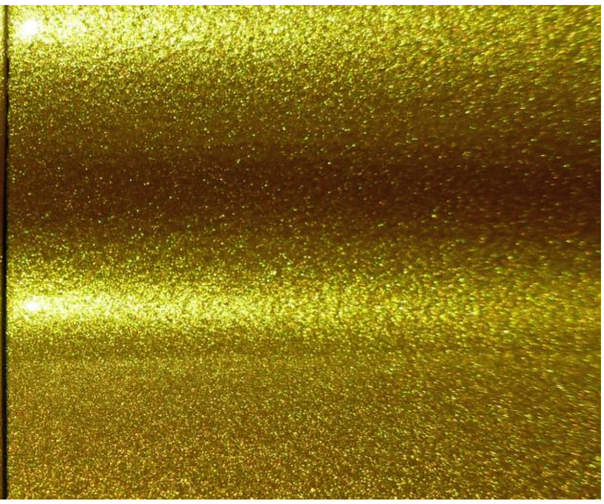

Fig. 2: Photograph of gold effect coatings produced by powder coating method on a bended plate yielding strongly disoriented effect pigments

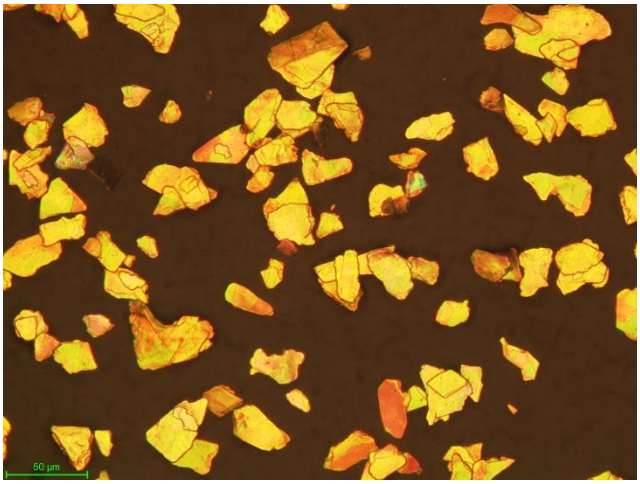

Fig. 3: Light microscope bright field image of the paint film

(1)air, (2)clear coat, (3)base coat (15 µm thick), (4)filler layers and (5)substrate

Fig. 4: Mechanical cross-section of the paint film imaged by SEM

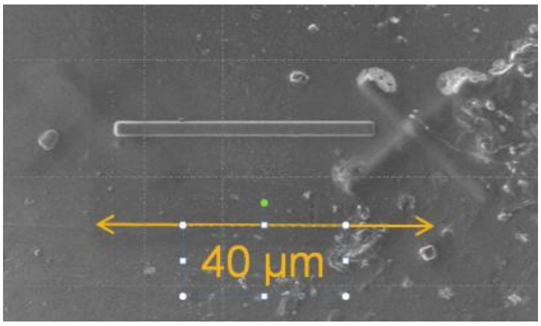

Fig. 5a: Paint surface area marked by crosses in the FIB and imaged by SEM

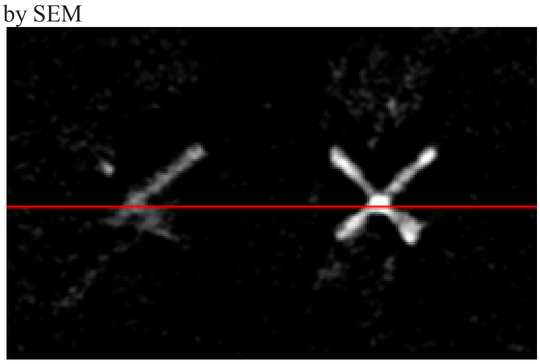

Fig. 5b: X-ray CT identification of the sample by finding the cross-markers

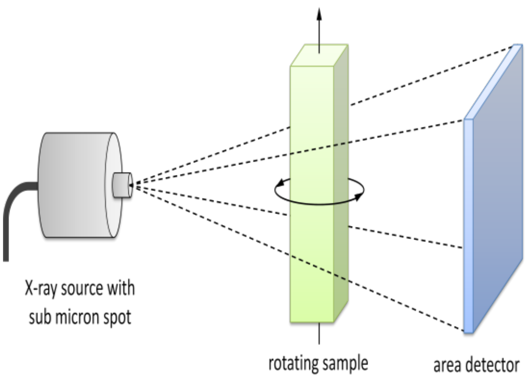

Fig. 6: Scheme of the X-ray CT imaging method

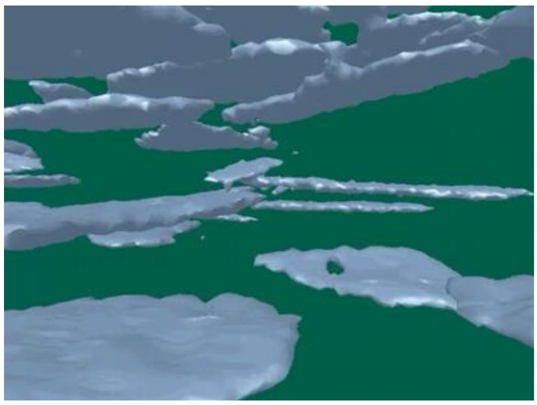

Fig. 7: Still picture of a movie showing the 3D particle ensemble

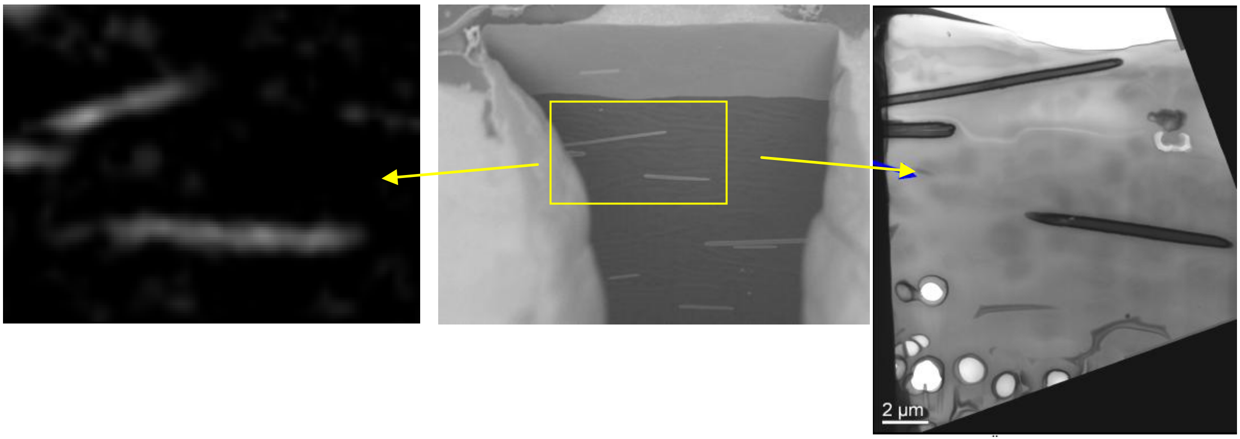

Fig. 8a, b and c: Identical location imaged by X-ray CT cross-section, by SEM of the FIB lamella and by TEM image of FIB lamella.

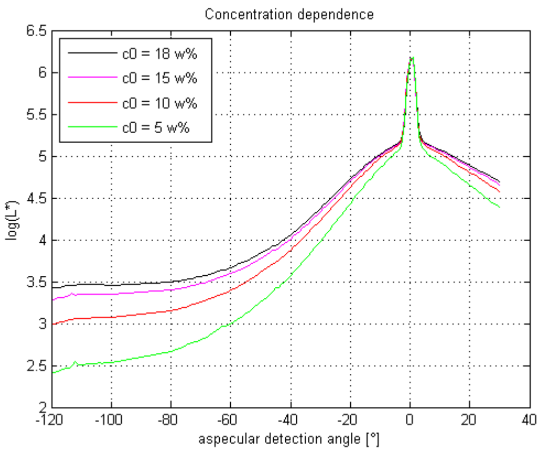

Fig. 9a: Log(L*) =f(φ) for different effect pigment concentration c0: the disorientation measured by X-ray CT is always δ=9.2° ± 0.5°.

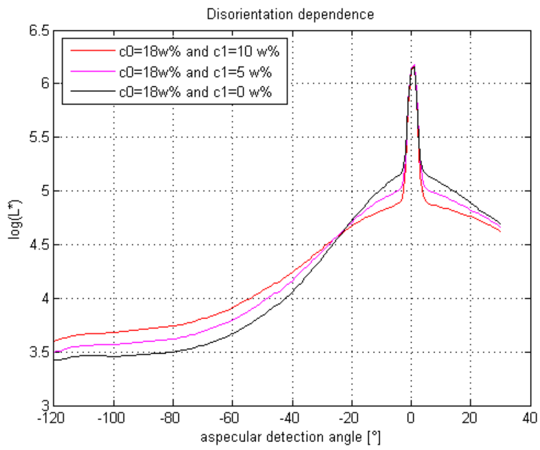

Fig. 9b: Log(L*) =f(φ) for 18w% effect pigment and different concentration of a disorienter c1: the disorientation measured by X-ray CT rises from 9.2°, via 10.5° to 13.1°.

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TEXT-BACKGROUND COLOR COMBINATION OF DIGITAL MEDIA FOR LEGIBILITY AND VISUAL QUALITY

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Keywords: computer screen, legibility, digital media, text-background color, visual quality

ABSTRACT

The purposes of this study were to find out the popular colors for using as text and background of digital media on the computer screen and to determine the text-background color combination affecting the legibility and visual quality. The popular colors were chosen by graphic designers and the optimum text-background color combinations were selected from the sampling group of undergraduate students. The samples of 55 colors included of 10 hues with 5 values each and neutral color with 5 values, referring to Munsell color system. The results revealed that 10 favorite colors applied for text and background design were yellow, red, reddish purple, black, blue, light reddish purple, greenish yellow, orange, bluish green and white, respectively. Male and female had slightly different satisfaction on the background colors of red, reddish purple and blue. The black texts on the light background or the white texts on the dark background were the best in legibility but not attractive. The warm color of texts; yellow, red, and reddish purple, on the contrast background were better in legibility and vision quality than did the cool color of texts on the warm color of background.

INTRODUCTION

Today, all new media in the form of digital media is accessed by the computer or electronic display devices. It is popularly created to distribute the information, present the slide, entertain the users, and other purposes of communication. The digital media is also easily approached by using internet, electronic storage medium and other information technologies on computer, laptop or smart phone. The design of media content on the screen is important to motivate the target group of users [1]. The simple method is to create optimum text and background color combinations that enhance the legibility and visual quality of the media. This means that the text content should be understandable or recognizable based on appearance, relate to the ability to distinguish one letter from the other in entire words, sentences, and paragraphs. It is generally true that a strong contrast leads to more readable texts [2] however the text-background color combinations of media should be designed for aesthetic enhancement and visual quality concern. The researchers then studied the impact of text-background color combination on the legibility and visual quality of readers for further design application.

METHODOLOGY

The target group for popular color choosing was 40 graphic designers, sampling from 10 graphic houses with 4 persons each. The target group of observers for text-background color combination was 80 undergraduate students in the Department of Printing and Packaging Technology, Faculty of Industrial Education and Technology, King Mongkut's University of Technology Thonburi. The color vision of target groups was prior tested using the Ishihara test to select the observers who have normal color vision or no color blindness.

The color samples were created using the Munsell color system with 5 principal hues; red (R), purple (P), blue (B), green (G) and yellow (Y), and 5 intermediate hues between principal hues (RP, PB, BG, GY and YR). Ten chromatic hues at step of 5 in Munsell model were then used as main hues in the middle; 5R, 5P, 5B, 5G, 5Y, 5RP, 5PB, 5BG, 5GY, 5YR, and the other hues were obtained by varying to 2 levels of lighter and 2 levels of darker, as shown in Fig. 1.

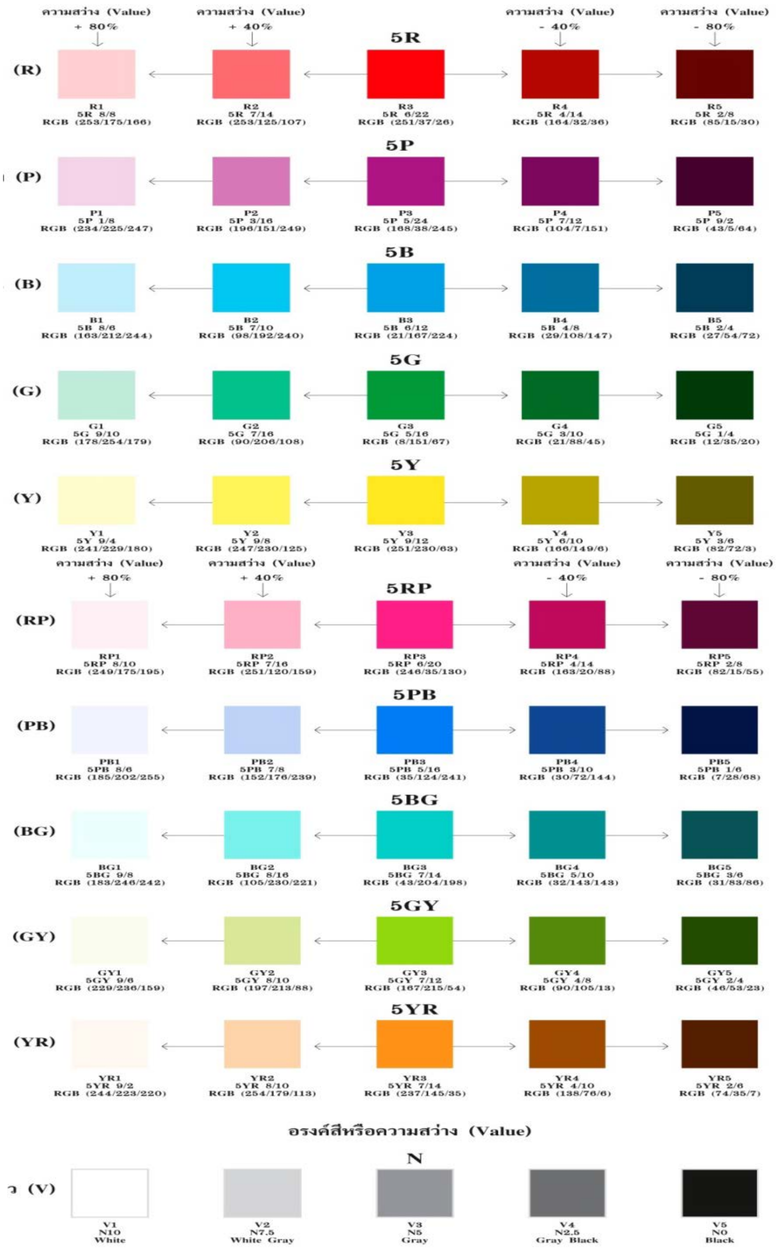

Figure 1. Principal hues, intermediate hues and achromatic hue with 5 lightness levels

Poster paper

The neutral colors (N) varied with 5 values were also used for this testing. Total 55 color samples were then converted to the color space of Adobe RGB (1998) by using a graphic design program of Virtual Colour Systems, Ltd. The color samples were displayed on the computer monitor using a file format which embeds the color profile of Adobe RGB (1998). Each graphic designer chose 10 color samples in priority by marking the list of satisfied colors in a questionnaire. The score of the first priority was set at 10 and the score of the last priority was set at 1. The top 10 colors in order of the high scores were selected to be created for text color and background color. The test form was designed by using 10 text colors on a background color and there were 10 sets of background colors. The text of Thai phrase was designed in 2 sizes; 36-points and 16-point, using TH Sarabun font as Thai standard font in the frame of colored background. There were 90 text-background color combinations for evaluation in next study. The samples of test form for text-background color combinations were shown in Figure 2.

Figure 2. Samples of test form for evaluation of text-background color combinations

The Macintosh version iMac with 21.5-inch 16:9 LED Backlit display was used for this evaluation. The resolution of screen display was set at 1920 x 1080 pixels and the color value was set by Display Calibrator. The test form was prepared in the software file to show the images with a color profile on the display using a program. Each student sat in front of the monitor at a distance around 0.5 metres. The period for looking at a set of test form was around 2 minutes. An observer evaluated each set and marked the list in the questionnaire for the priority (1-10) of satisfaction in term of legibility and visual quality. After that, the score of the first priority was set at 10 and the score of the last priority was set at 1. Total score of each text-background color combination was then calculated and the top 3 in order of high scores were present.

RESULTS AND DISCUSSION

Almost designers were 31-40 years old and have working experience about 5-10 years. After the designers see the color samples from the program, they chose 10 popular colors by their own opinion. The researchers calculated the scores of each color and showed the total scores of top 10 colors in order of high scores. Almost graphic designers like the colors in the middle level of lightness or bright color due to their good attraction and motivation. In addition, saturation or lightness of these colors could be easily adjusted when apply for the digital media design. However, the popular colors may be changed by the trend, event and personal opinion. The colors with very low scores were light purple, dark purple, light greenish yellow and dark greenish yellow. The students of 38 males and 42 females selected their favorite colors of texts on background in term of legibility and visual quality and the score was calculated to get the highest score of 1^{st}, 2^{nd} and 3^{rd}, as shown in Fig. 3. The results indicated that the optimum text color should be black, white, yellow, red and reddish purple, respectively. The black texts were the best for all background colors while the white texts were not appropriated on yellow background. The yellow texts were good for visual quality but not good on greenish yellow background. The red texts were suitable for the backgrounds of yellow, black and greenish yellow while the reddish purple texts were suitable on yellow background. Male and female had slightly different satisfaction for the background colors of red, reddish purple and blue.

Figure 3. The optimum text colors of 1st, 2nd and 3rd on 10 popular background colors

CONCLUSION

In fact, the black texts on light background colors and the white texts on dark background colors were the most popular for application in design because of their best readability or legibility [3]. However, the colorful texts on the colorful background had a high trend to be applied. The popular colors in this study were the bright colors without lighter or darker. The texts of warm color such as yellow, red, and reddish purple enhanced legibility and visual quality on the contrast background. The cool-color texts on the warm-color background were not suitable because this reduced visual quality and made vision blur or fatigue after looking for a short period [4]. Since the background area is generally much more than the area of texts, the cool-color background should be applied to preserve the users' eyes. Therefore, texts of warm-color on background of cool-color should be applied for the digital media.

ACKNOWLEDGEMENT

The authors would like to thanks to the graphic designers at Oriflame Cosmetics (Thailand) Co., ltd. and Integrated Communication Co., ltd. for their helpful in the selection of popular color application.

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COMPARISONS OF COLOR PREFERENCE BETWEEN MOTHER AND CHILD — IS COLOR PREFERENCE INHERITABLE FROM MOTHER AND CHILD? —

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Keywords: color preference, color combination, comparison between mother and child

ABSTRACT

In the present study, the effects of rearing environment on color preference were investigated by comparing color preference between mother and child. A psychological survey was carried out with 53 pairs of mothers and children, inquiring color preference/color avoidance against various samples (e.g., single color patch, bi-color combination, scenic picture). There is no systematic relationship between mother and child concerning color preference/avoidance against simple and abstract targets (single color patch or bi-color combination). On the other hand, in the case of color preference against a more complicated and specific visual object (e.g. picture), patterns of preferred color can be significantly inherited from mother to child.

INTRODUCTION

Color preference, e.g., psychological characteristic in which each individual person prefers (or avoid) particular color, has been of course one of the major interests in the color research for long years, and many researchers have been dedicated their efforts in order to understand various fundamental attributes concerning it. These include, mass inspection measuring variation of color preference in particular group across ages, comparisons between various cultures which attempt to consider socio-cultural background for color preference, analyses of visual stimulus attributes which can determine observer's evaluation for color preference, and so on.

It can be assumed that one of the biggest questions in assessing color preference would be "why does individual person become to prefer/avoid particular color?" The question is of course very hard to answer, because individual color preference would be accomplished based on a personal life history, and it would be impossible to describe every event happed upon one's life. Thus, in this study, comparisons of color preference between mother and child were carried out. In their early childhood, children would mainly wear clothes and use everyday items bought by their parents, and also spend most of their time under environment designed by their parents (Furthermore, it is said that contribution of mother would be much important as compared with father, in arranging child-rearing environment in Japan). If children's color references are affected by their growing environment, there would be some relationship between color preferences between children and their mother, because mothers owe responsibilities in arranging environment caring their children. In other words, we can investigate the effects of growing environment in establishing individual color preference, by simultaneously measuring mothers' and children's preferred/avoided colors.

METHODS

Mother and her child were asked to select their most favorite/unfavorite colors from color samples printed as a catalog on a white printing paper. Inquiries for mother and child were executed separately under natural daylight in an autumn afternoon (environmental luminance was enough to evaluate color samples). 53 pairs of mother and child were participated in the investigation. Ages of the mothers were ranged between 27 and 46, and children were between 4 and 10 years old. Participated children were 20 boys and 33 girls. After answering a set of fundamental personal questions (e.g, age, sex, location and so on), the participants were asked to examine catalogs of the color samples and select three favorite colors and three unfavarite colors from each catalog. There were three different color catalogs: 1) *single color patch,* 2) *bi-color combination* and 3) *scenic picture.*

In the catalog of the single color patches, 21 different color patches (rectangle, 3cm in height and 3cm in width each), which were randomly selected from PCCS (Practical Color Co-ordinate System) chart book (Japan color research institute), were arranged on a white paper (3 rows and 7 columns). Favorite/unfavarite items selected by the mothers and children were categorized by the following procedure. The colors of the patches were classified in accordance with their hue into one of the three categories; *warm* (e.g., red, orange), *cool* (e.g., blue, bluish green) or neutral color (e.g., yellow, purple). The patches were also categorized by "color tone", and classified into light (lt; high brightness and middle saturation), dark (dk; low brightness and middle saturation) or vivid (v; high brightness and high saturation). In the bi-color combinations, two color patches (rectangle, 3cm in height and 3cm in width for each), which were also selected from PCCS chart, were located side-by-side on a white paper. There were 36 different bi-color combinations, displayed in 3 rows, 4 columns and 3 pages. Participant's selections were classified into three categories, i.e., *hue contrast*, *tone contrast* and *hue and tone contrast* combinations. In the scenic pictures, 18 photos of amusement park (6cm in height and width), which were characterized by their usage of color, were displayed in 2 rows and 3 columns and 3 pages. The photos were classified according to their dominant tone (vivid or light) and color usage (number of colors appeared in the photo; colorful or conservative). The classifications of the photos were executed four students who had specialized knowledge about color science and naïve for the purpose of the investigation.

RESULTS

Participants selected three items respectively as favorite and unfavorite colors in each of three catalogs (single color patch, bi-color combination and scenic picture). According to their selections, mothers and children were given their attribute concerning color preference. For example, participant who mainly selected warm color as favorite color in the catalog of single color patch was classified as "warm-color liker". In a case where participant's selections were equally distributed across multiple categories, they were classified as "indeterminate" concerning such attribute. There were two attributes for the single color (hue and tone), one for the bi-color combination and two for the scenic pictures (dominant tone and color usage). Thus, in total, each participant had 10 different attributions for color preference (favorite or unfavorite colors for five different aspects).

Cross tabulation between mothers and children was executed for each attribute of color preference. Figures 1-4 indicate mother-children relationship of the color preference expressed in the single color patches (favorite hue, unfavorite hue, favorite tone and unfavorite tone, respectively). There were no significant biases of frequency distributions (Fisher's exact test: p= 0.82, 0.18, 0.61 and 0.28, respectively). This result indicates that there would be no relationship between color preferences of mothers and children obtained in the single color patch catalog; e.g., children of "cool-color liking" mother would be not always like cool color. In figure 5-6, color preference measured by the bi-color combination catalog was presented. There were also no significant relationship between mothers and children (p=0.36 and 0.22, for favorite and unfavorite color combinations, respectively). In the scenic picture catalog, there were also no significant relationship between mothers and children for unfavorite dominant tone and favorite and unfavorite color usages ($\chi^2(1)$=2.10, 0.82 and 0.20, *n.s.*), while favorite dominant tone exhibits significant relationship between mothers and children's color preference (figures 7-10); children of "light-tone liking" mother had a significantly greater tendency to prefer light tone photo as compared with children of "vivid-tone liking" mother ($\chi^2(1)$=10.07, p<.01, φ=.44).

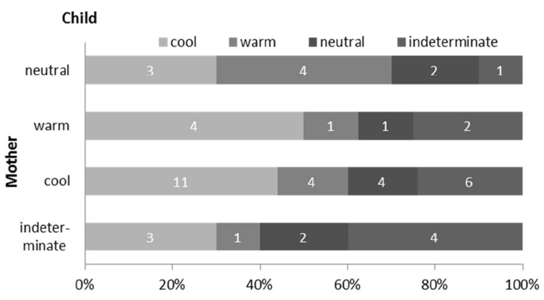

Figure 1 Hue preference

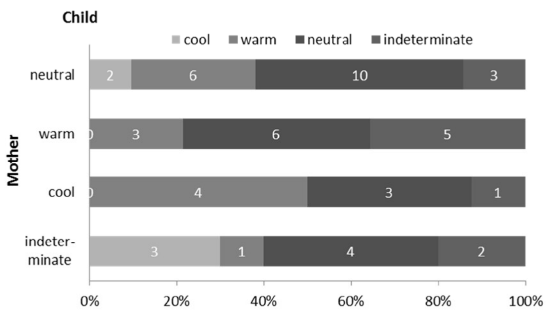

Figure 2 Hue avoidance

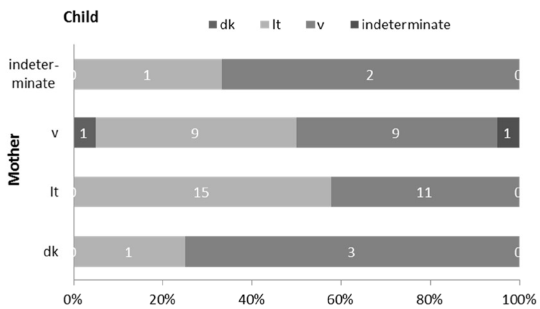

Figure 3 Tone preference

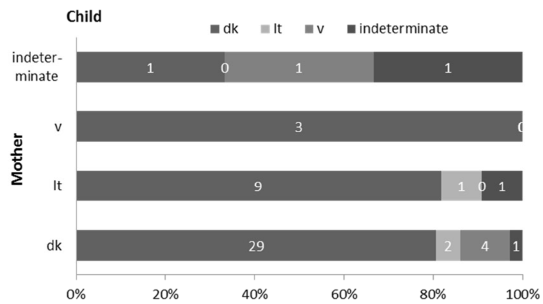

Figure 4 Tone avoidance

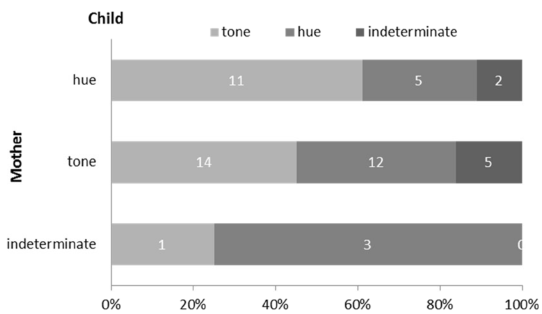

Figure 5 bi-color combination preference

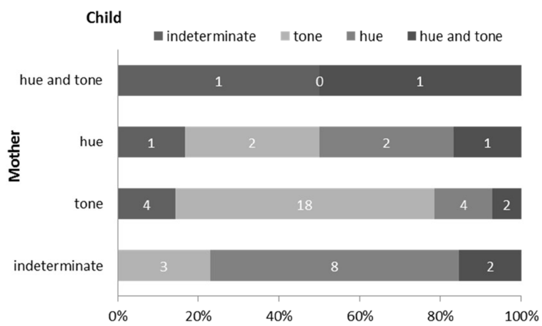

Figure 6 bi-color combination avoidance

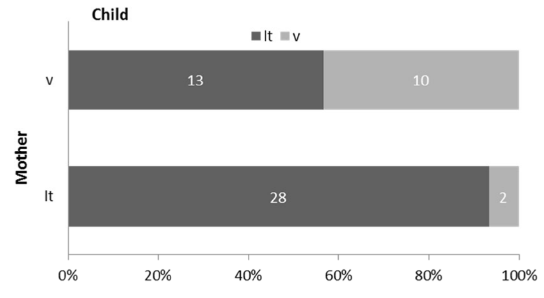

Figure 7 dominant tone preference

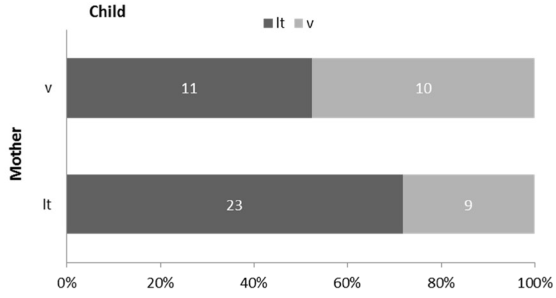

Figure 8 dominant avoidance

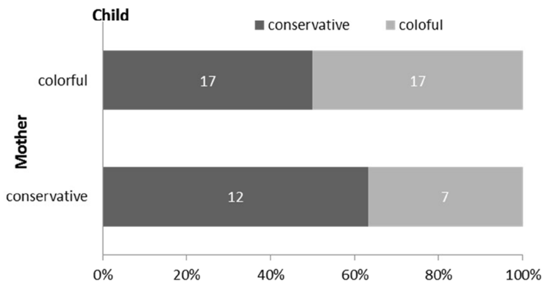

Figure 9 color usage preference

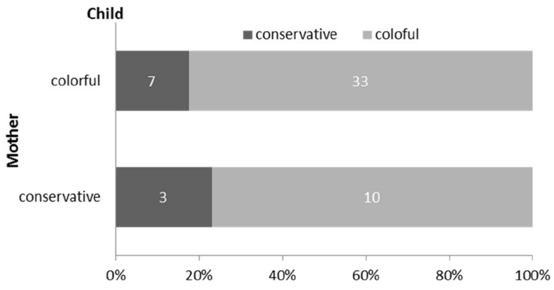

Figure 10 color usage avoidance

CONCLUSION

Psychological investigation concerning color preference participated by 53 pairs of mothers and children revealed that color preference would be inheritable from mother to child only in the case where target of evaluation is complicated and realistic (e.g., photo of a real scene), but not in the case of simple and abstract target (e.g., single color patch or bi-color combination). It can be assumed that mother's color preference affects children's cognitive tendencies of preferring/avoiding specific colors via their growing environment which would be designed by their mothers. The present research revealed that there is no significant relationship concerning abstract color preference between mothers and children. Children's abstract color preference exhibited against simple color sample may be highly dissociable from their mother's in more early developmental stage. In order to consider mothers-children's relationship more deeply, future study must be needed using larger samples of widely spreading ages.

THE EFFECT OF COLOR DIFFERENCE ON THE FUNCTIONAL VISUAL FIELD

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Keywords: color difference, functional visual field, target, background noise

ABSTRACT

Previous research has revealed that the functional visual field is affected by the difference in color between the target and the background, however, few studies have been conducted on this relationship. The aim of this study is to clarify these effects. An experiment in which a subject distinguished a target from background noise was conducted. The color patterns used were red, green and blue. The target and the noise were the same color, i.e., of the same dominant wavelength, but differed in purity. The results show that the functional visual field increases as color difference increases, and then it reaches an upper limit in the normal functional visual field. The results also show that the recognition of an object is easy when the color difference is more than 80 in the CIE 1976 L*u*v* color space.

1. INTRODUCTION

Previous research has revealed that the breadth of the functional visual field is affected by the extent of the difference in color between the target and the background[1],[2]. Fuchida[1] studied color matching properties from the view point of the practical use of complex background, and expressed conspicuity quantitatively in terms of visual search time and the color difference between the target and the background. The results showed that the visual search time became negligible when the color difference between the target and the background was over 20. However, at present, few studies have been conducted on the relationship between color difference and functional visual field. It is hypothesized that while driving, distinction of color is important for identifying road signs and potential hazards in the functional visual field. Therefore, in this study, an experiment in which a subject distinguishes a target from background noise was conducted to clarify the effect of the color difference on the functional visual field.

2. EXPERIMENT

In this experiment, a computer screen was used to display an image. The image consisted of a background black and 28 circles (each with a visual angle of 0.43 °), 27 of which contributed to the background noise while one was the target. The images were shown for 0.2 seconds. The luminance of the target and noise was the same in each color. The target and noise circles were arranged so the density was the same in every quadrant without overlapping. 12 directions of presentation were used with an angular separation of 30 ° around the fixation point, and the visual angles were 2 ° 4 ° 6 ° 8 ° 10 ° 12 °. The presentation position of the target was a combination of these directions. Figure 1 shows the example of experimental image. The color patterns used were red, green and blue. The target and the noise were the same color, i.e., of the same dominant wavelength, but differed in purity. In this study, the color difference was calculated in the CIE 1976 L*u*v* color space. Table 1 shows the color differences between the targets and the noises in this experiment.

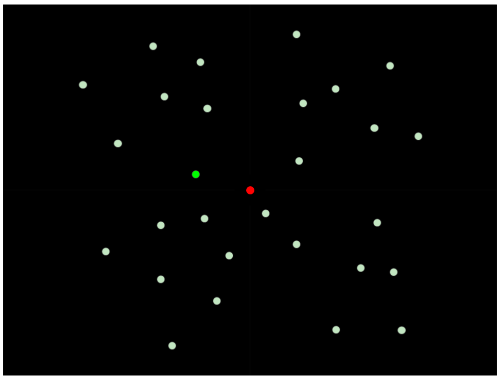


Figure 1. Example of experimental image.

Table 1: Color difference of target and noise.

	color difference level (noise)								
	1	2	3	4	5	6	7	8	9
Green	9.429	21.73	30.63	42.88	55.75	69.76	85.62	102.13	121.35
Red	17.61	32.23	48.79	64.70	79.00	92.21	107.22	121.42	133.39
Blue	18.83	35.85	50.06	62.79	73.14	82.16	91.22	98.46	105.15

In this experiment the subjects were seven males in their twenties.

The following procedure was used:

(1) Each subject adapts to the darkness for 10 minutes in a dark room.

(2) A black background image is displayed on a screen.

(3) A fixation point and an axis are displayed with a click sound, and each subject observes the fixation point.

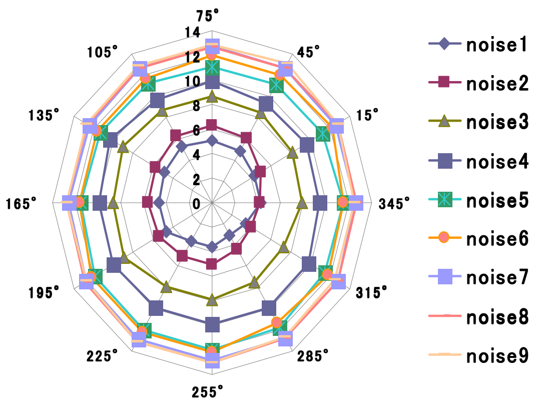
(4) Each subject replies orally the position of the target by saying the number of the quadrant the target is in when the target and noises are shown. If a subject does not identify a target, the answer is indistinguishable.

(5) Steps (2) to (4) are repeated for all presentation positions and color differences.

(6) The whole experiment is repeated for each color (green, red, and blue) on separate days.

3. RESULTS AND DISCUSSION

Figure 1, Figure 2 and Figure 3 show the average functional visual field in each color. For any color condition, the functional visual field increased with color difference up to a limit of around 13 °, which is the normal functional visual field. Figure 4 shows the relationship between color difference and the functional visual field. The functional visual field increased in the order of red, green, and blue until a color difference of 50. Given that the dominant wavelength of blue is the shortest and red is the longest, it is hypothesized that for equal color difference, the shorter the dominant wavelength, the broader the functional visual field. Furthermore, it was found that the functional visual field for every color reaches the normal functional visual field when the color difference is more than 80. In short, the recognition of an object is easy when the color difference is more than 80.



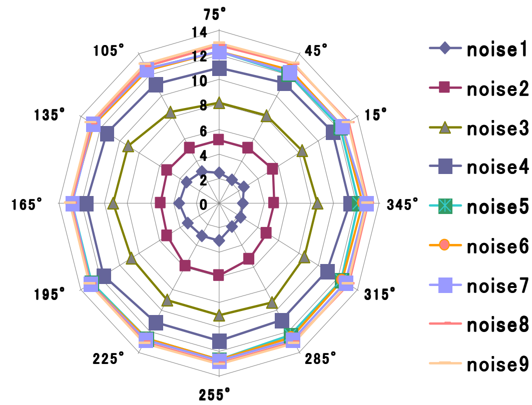


Figure2. Average of the functional visual field. (Green)

Figure3. Average of the functional visual field. (Red)

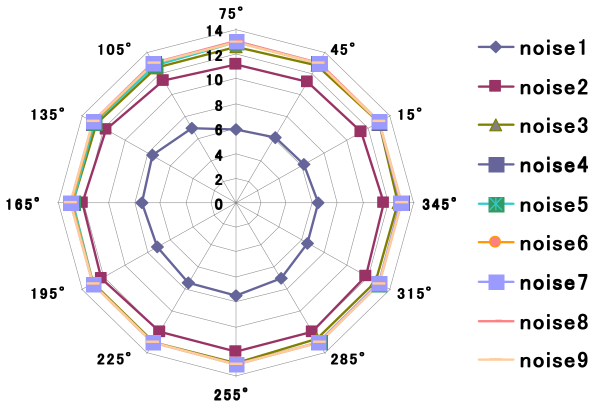


Figure 4. Average of the functional visual field. (Blue)

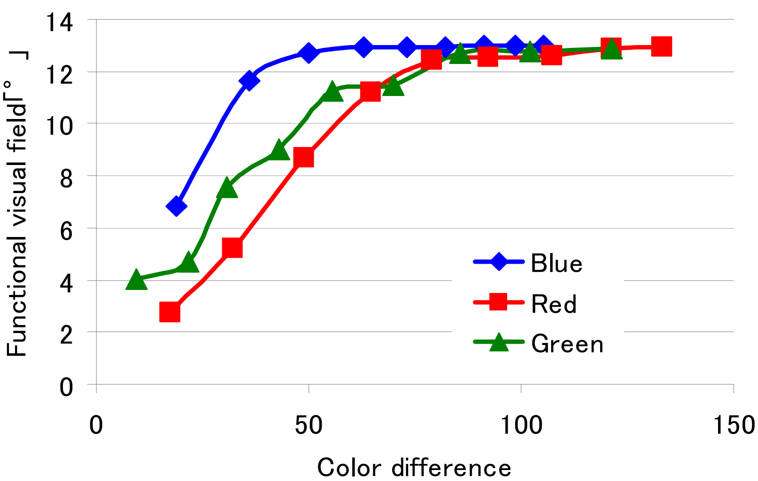


Figure 5. Relationship between color difference and the functional visual field.

4. CONCLUSION

The effect of color difference on the functional visual field was investigated by conducting a visual experiment in which subjects distinguished targets from background noise. The results are summarized as follows:

(1) The functional visual field increases as color difference increases, and then it reaches an upper limit in the normal functional visual field.

(2) The recognition of an object is easy when the color difference is more than 80.

Poster paper

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Poster paper PA05

TIME COURSE OF CHROMATIC ADAPTATION STUDIED BY COLOR APPEARANCE OF ACHROMATIC PATCH

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Keywords: Chromatic adaptation, Time course, Color appearance, Illumination

ABSTRACT

The aim of this research was to investigate the time course of chromatic adaptation in a 3D space. The two room technique was used to carry out the experiment. A subject looked at an achromatic test patch placed in the test room through a small window opened on a separating wall between the test room and the subject room. The subject room was illuminated white and changed to a red light. The window was opened for certain duration from that changing point to control the adaptation time and a subject reported the color of the test patch by the elementary color naming at the end of the duration. The color appearance changed rapidly at short adaptation time and eventually stopped. The color appearance change reached 90 % of the entire change at 33 seconds in the averaged of five subjects.

INTRODUCTION

Chromatic adaptation is an important mechanism of color vision. When we look at a white object under daylight it appears white but when we move the white object to a room illuminated with red light we still perceive the white object as white because the eyes adapt to the red illumination [1]. The adaptation takes place almost instantly. Many researchers have investigated the time courses of the chromatic adaptation by using a 2D display as an adapting field. They found that the chromatic adaptation was achieved more than 90% at 60 seconds and completed at 120 seconds [2]. Fairchild and Reniff [3] used achromatic appearance method for test patches of various chromaticities presented on a computer-controlled CRT display. The result implied that two stages of adaptation existed; the first rapid few seconds and the second slow approximately 1 min.

In the real world we always perceive and see color in 3D space and we believe it necessary to investigate the chromatic adaptation by using a 3D space as pointed out by Ikeda et al. [4] and Pungrassamee et al. [5]. In the present research we used a real room which was illuminated by colored light and measured time course of the chromatic adaptation.

APPARATUS AND PROCEDURE

The experimental room had a size of 120 cm wide, 310 cm long and 200 cm high. The room was divided to two rooms, subject room and test room as shown in Fig. 1. There was opened a small window W of the size 5x5 cm on the separating wall at the subject eye level when he/she sat on a chair. In the test room side a shutter Sh was placed on the window to control the exposure of the test patch to the subject. The visual angle of the window W was 1.3^{o} x 1.3^{o} when it was viewed at the distance 215 cm. A test patch T of Munsell Value N6 was put at the test room on the shelf.

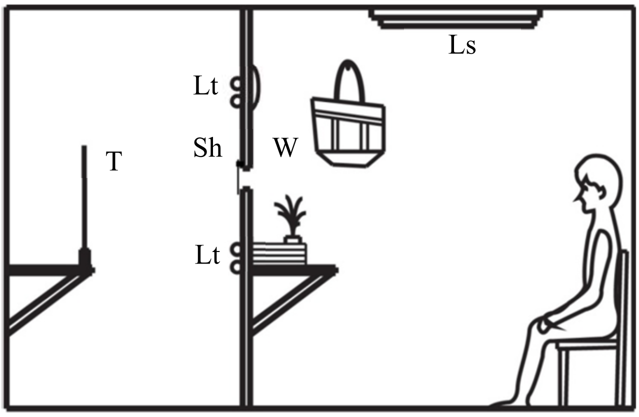

Fig. 1 Scheme of experimental room.

When the subject looked at T through the window W it appeared to be pasted on the window and he/she recognized it as an object in the subject room. The subject room was illuminated by five fluorescent lamps Ls of the daylight type at the ceiling. The central lamp was covered by a red film to give red light of chromaticity x = 0.509 and y = 0.301 when measured at the front white wall by a color luminometer. The illumination of the red light was kept at 87 lx on the front shelf of the subject room. White illumination was provided for the subject room by using four fluorescent lamps on the ceiling and it gave 576 lx. The test room was illuminated by the fluorescent lamps Lt of the same type as the subject room. The vertical plane illuminance at the test patch T was 25 lx to give its appearance an object color mode to the subject.

The subject's task was to judge the color of the test patch by means of the elementary color naming method, that is, the amounts of chromaticness, whiteness, blackness, and hues for the chromaticness in percentage. The subject entered the subject room lit with the white light and sat down on a chair for a minute or so. The shutter Sh of the window was closed. Then the experimenter switched the white light to the red light and opened the shutter. At a certain adaptation time for the red light the shutter was closed and the subject was asked to report the color of the test patch at just before the shutter was closed by his/her memory. After the subject response the red light was changed to the white light and the subject adapted to the white light for about 10 sec or longer depending on the readiness of the subject. Again the white light was changed to the red light for the measurement of the time course of the color adaptation. The time course of the color appearance of the test patch was thus investigated, which should tell the time course of the chromatic adaptation to the red illumination. Adaptation time from 1 s to 30 s was investigated at every second in the order starting from 1 s. The color appearance at 60 s was also measured to represent a long time for adaptation. When 31 judgments were conducted one session was over. Five sessions were carried out for each subject. Five subjects with the normal color vision as tested by the 100 hues test participated in the experiment.

RESULTS

In Fig. 2 results of hue appearance are shown for all the five subjects by polar diagram of which outer circle represents 100% of chromaticness. Five responses were averaged at each adaptation time in each subject. All the subjects perceived test patch of N6 as bluish green. The outermost point was obtained at 60 s, long enough to adapt to the red illumination. Ikeda et al. [6] did a similar experiment but for the steady adaptation of 8 different colors. Present hue appearance at 60 s confirms their results. The innermost points in Fig. 2 were obtained at 1 s and we see that the amount of chromaticness, which is shown by the distance from the center, increased as the adaptation time increased.

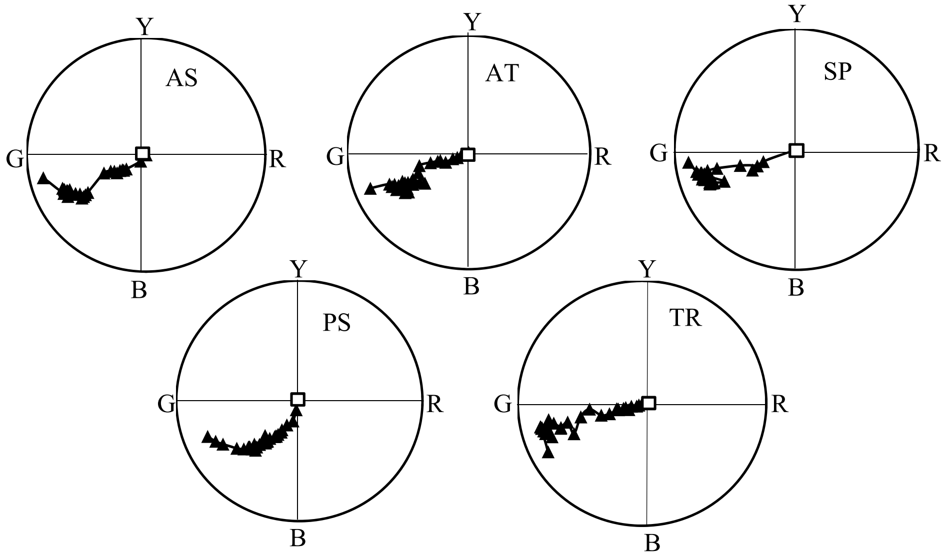

Fig. 2 Color appearance change for adaptation time shown for five subjects.

To see the increase more clearly the amount of chromaticness is plotted for the adaptation time as shown in Fig. 3 for five subjects. The abscissa shows the adaptation time from 1 to 30 s, and at 60 s and the ordinate the percentage of chromaticness. There are five curves in each figure to represent five sessions. Five curves from a subject are almost same to show consistent response of each subject. But there is difference among subjects. The subject SP shows a very rapid adaptation while the subject PS a rather slow adaptation.

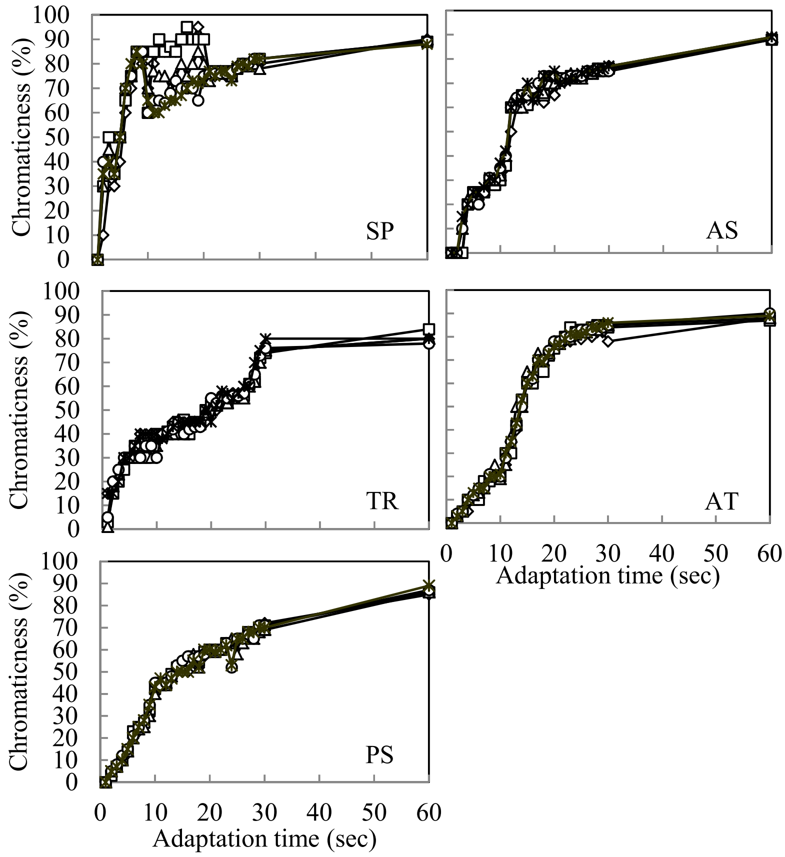

Fig. 3 Chromaticness change for adaptation time shown for five subjects.

The average of five subjects was taken at each adaptation time and is shown in Fig. 4. The chromaticness increased rapidly in the beginning of the adaptation and then more gradually in the latter time. If we assume the chromaticness at 60 s shows the completely adapted state of the eyes the adaptation time of 11 s was needed to recover to 50 %. The adaptation time for 90 % recovery was 33 s. This is much shorter than 120 s obtained by Fairchild and Reniff [3].

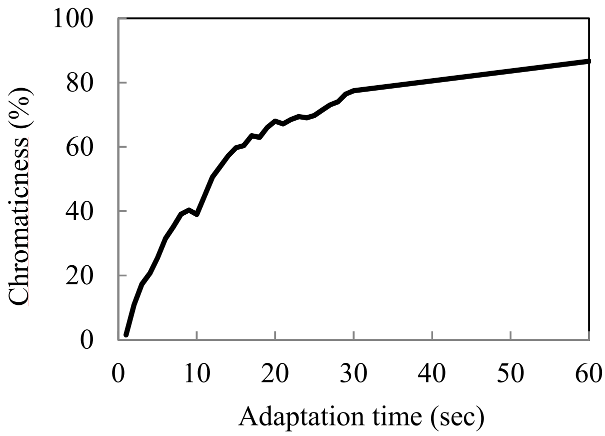

Fig. 4 Averaged chromatic change of five subjects for adaptation time.

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Poster paper

Poster paper PA06

PRODUCING DATABASE OF IMAGES FOR THE STUDY OF WATER LILY'S VARIETY

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Keywords: image, water lily

ABSTRACT

This research aims to produce and estimate the efficiency of photo database to study the water lily of 70 breeds. The study is to produce photos of water lily and bring to assess the efficiency in details through questionnaires and sample groups of 302 visitors at the lotus museum of Rajamangala University of Technology Thanyaburi.

The result indicated that controlled factors, such as the distorted photos by using a long focus lens similar to a standard lens, the color balance by estimating the color temperature of photo-recording devices as same as the light-color temperature, the light not differing from taking photos in the morning, the disordered background by using the black scene, using the eye-level angle to a 20-degree-high angle to show the dimension of blooming flowers, using a 20-degree-low angle to a 20-degree-high angle to portray the budding flower shapes, using a high-angle camera to a 60-degree-high-angle camera to show the lotus petal shape, using the high-angle camera to show the leaf shapes, designating the direction of front light and side light to show the water lily leaf and branch surfaces, and using the color-checker sheet to check the color correctness to display the flower leave and branch colors can produce the photos applying the study of the water lily breeds to grow them as garden trees in the very good level.

INTRODUCTION

The water lily is a plant that has long history along with Thai people for more than 700 years as Thais have grown the water lily as decorating trees. Moreover, Thai people have used the lotus as a food, a fragrant, medicines, and sacrificing to the image of Buddha. In the present, the lotus is used as a resource base of Thailand. There has been water lily grown in the project of reserving heredity plants, according to the statement of Her Royal Highness Princess Maha Chakri Sirindhorn, such as the Lotus Museum of Rajamangala University of Technology Thanyaburi (RMUTT). If there is a widespread growing of the lotus as the decorating trees in houses, it will be a means to reserve the heredity plants.

The water lily is a kind of lotus which is popular for growing as a decorating tree. There is a wide range of water lily breeds which give colorful flowers, various shapes and surfaces, and different types of leaves. Giving knowledge of water lily breeds regarding the significant physical qualities; for example, colors, shapes, surfaces of lotus branches, and shapes and colors of lotus leaves, will be helpful to choose the breeds of decorating trees. On the other hand, the description of the lotus in writing can explain the botany qualities of water lily, relating to the human vision naturally, in specific names such as a shallow concave leaf edge, tapering flower form, and tapering forms of flower base and edge [1]. This is relatively hard for the real perception of lotus.

As the feature of photos stated that “A picture is worth a thousand words,” photos were used as the supporting media to explain in the learning. Photos can describe the water lily breeds in order for growing the water lily as a decorating tree. The photos should be able to show the physical details of flower and leaves such as colors, shapes, surface of water lily branches, and shapes and colors of water lily leaves corresponding with the explanation.

THE RESEARCH OBJECTIVES

1. To produce the photo data base for learning the breeds of lotus
2. To evaluate the efficiency of photos to learn of water lily breeds

RESEARCH METHODOLOGY

In this research, the researchers determined the methodology as follows

1. Studying the data of flower photos, photo taking techniques to portray shapes, colors, and details of surfaces, and physical features of the water lily and particular data of each breeds including collecting the physical features of water lily breeds to plan in taking photos by using the data of original water lily breeds created by Dr.Sermlarp Wasuwat.

2. Taking photos of 70 water lily breeds by using the devices and specifying the photo taking methods as bellows:

- Use 35 mm digital single lens reflex with full frame CCDs
- Use 75 mm telephoto lens which is the short narrow angle lens to make the flowers look bigger and not result in the photos distorted apparently
- Set the color temperature of digital camera at daylight mode with sensitivity (ISO) of 200
- Use the color checker as a tool to evaluate the color correctness which photos of color checker are taken every time of taking photos of water lily breeds or changing the camera angles

Figure 1. Using the color-checker sheet

- Set the time of taking photos at 6.30-9.30 am to control the light source out of the family angle and get the light containing low contrast
- Use the black background to cut off the disordered background
- Take photos of the water lilies and other compositions of water lilies in a real location and use the natural light at the Lotus Museum of RMUTT

3. Making the original photos and adjusting colors of all photo files by applying the Color checker sheet as a criterion to develop, expand, select, and categorize photos following the water lily breeds. Then, the photos were brought to three lotus specialists of Thailand to detect the accuracy of the photos in terms of showing colors, surfaces of water lily branches, shapes and color of water lily leaves of all 70 water lily breeds.

4. Generating a tool to collect the data by building a questionnaire to measure the efficiency of the photo data base to learn the water lily breeds in the ratio of five level approximately (Cronbach’s Alphavalue of .831)

5. Collecting the data of May-July 2010 from the accidental samples which are the Lotus Museum of RMUTT visitors or once visitors, and are not color-blinded in the number of 333 people (5 percent error) calculating from 2,000 RMUTT lotus museum visitors in 2009.

6. Analyzing the data from each question in questionnaires which the mean value must be more than or equal to 3.50 and the standard deviation must be lower or equal 1.50. The researchers, later, brought the photos to make the original manuscript of the lotus photo data base in the form of photo books.

The Research Result and Criticism

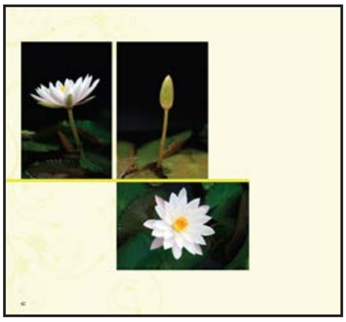

Figure 2. Photo Samples of Lotus Physical Quality

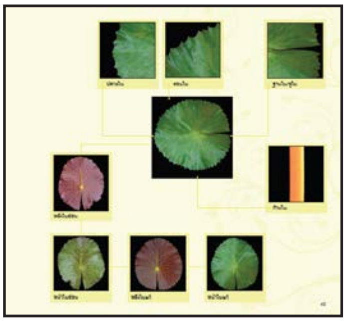

Figure 3. Photo Samples of Physical Quality of Lotus Leaves and Branches

According to the study, the produced photos could be used to learn the lotus breeds in order to grow as garden trees by showing the details of the photos corresponding to photo description in a good level. The study results showed that using 75 mm focus lens, which is short narrow angle lens and has a little focus length difference comparing with a standard lens, could be applied for taking photos to show water lily shapes and dimensions excellently. That is, using a narrow angle lens, which has the focus length similar to a standard lens, would not distort the photos to be concave enough, in the perspective of the human eyesight, to consider that shapes and dimensions of the subject was distorted. [2] Moreover, taking photos without specifying the closest focus length may be a cause of the invisible concave distort, or showing obvious unnatural dimensions or noticeable unnatural shapes [3].

To take photos showing the lotus shapes by setting camera angle in the eye level can show the best shapes of the lotus. That is because the camera angle paralleling to the subject would not change the subject distance. Conversely, taking photos in the low and high angle would change the shapes of the subject and was a reason of distorting the vision dimension [4][5]. Nevertheless, taking photos in the high camera angle (the camera

Poster paper PA07

Haze estimation of crystalline lens by spatial resolution as a function of light scattering intensity

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Keywords: Cataract, Spatial Resolution, Haze, Light scattering, Glare

ABSTRACT

Cataract is one of the most typical age-related eye diseases. As the cataract progresses, the crystalline lens becomes hazier and such lens causes light scattering within the eye, resulting in decreases in the visual ability such as color vision and spatial resolution. In this study, we measured spatial resolution for pseudo-cataract young subjects wearing foggy filters. Subjects observed a grating through an integrating hemisphere inside which LEDs (inducing further scattering as glare) were attached. We manipulated the light intensity from LEDs (i.e., level of glare) and the haze factor of the filter. The results showed that, irrespective of the haze factor, the spatial resolution decreased as the level of glare increased. However, the rate of the decrease changed with the haze factor; it was larger as the haze factor increased. From the analyses of spatial resolution obtained, we propose a new method for estimating the haze of the crystalline lens.

INTRODUCTION

In Japan, most elderly people, particularly over the age of 80, suffer from cataract. Cataract is the most prevalent age-related eye disease in which the crystalline lens becomes hazy. It is well known that cataract causes light scattering within the eye, resulting in impairments in various visual abilities such as color vision and spatial resolution.[1] Given the growing population of elderly people and the importance of healthy life for elderly people, it is essential to assess the haze level of their lens (i.e., the progress in cataract) quantitatively and, on the basis of it, to provide them with appropriate visual environments. In the present study, we propose the method for estimating of the haze of crystalline lens by measuring spatial resolution for pseudo-cataract young subjects wearing foggy filters.

METHODS

Six young subjects ranging from 21 to 23 years of age participated in the present experiment (4 males and 2 females; mean age of 22.3). All stimuli were presented on 17 inch in CRT monitor, controlled by a personal computer which also controlled the experimental timing and recording from a keyboard. The stimuli were viewed monocularly using the right eye from a distance of 135.5 cm. In front of the participant's eye, an integrating hemisphere was located. Figure 1 illustrates the integrating hemisphere. In this, a foggy filter, a scattering filter, and LEDs (as a glare source inducing further scattering within the eye) were arranged. Four foggy filters with different haze value (i.e., amount of haze) were used; 0 (we refered to filter 1), 5.27 (filter 2), 9.03 (filter 3) and 13.46% (filter 4). The scatter intensity from the LEDs was either 100lx, 500lx, 1000lx or 2000lx.

Figure 2 is an illustration of examples of the stimulus display used for the measurement of spatial resolution. In the display, a sine wave grating and four black rectanglars were presented on a gray background. The grating was inclined either 0, -45, or 45 degree from vertical and served as a test stimulus. The grating had various frequencies in a range of 0.9-30 cpd and always had a fixed number of stripes, independently of its frequency. Therefore, the size of the grating changed depending on the frequency (from 0.9 to 30 cpd). The contrast of grating was either 0.1, 0.3, 0.5 or 0.7. Each rectangular subtended 0.4×0.8 deg and served as a frame to keep a fixation on the center of the display.

The experiment was conducted in a dark booth. Each participant sat on a chair while viewing the display through the integrating hemisphere. After dark adaptation for 5 min, the participants practiced the task for several trials until they were familiarized with the task, followed by an experimental session. In the present study, to measure the spatial resolution, we determined a threshold for the width (spatial frequency) of the grating by using a up-down method. At the beginning of each trial, the rectanglars was presented and then the grating was presented for 5 ms. The participant's task was to report the orientation of grating. When the subject responded correctly the orientation of grating, the width of stripes for the next trial was reduced (spatial frequency increased) by 6.25% of the current trial. When the subject responded incorrectly, the width for the next trial was increased. After 2 reversals of the up-down staircase, width adjustment was reduced to 50%. When 9 reversals were completed, the trial was stopped and the threshold was calculated by averaging the width of the last four reversals. There were 12 blocks of 16 trials. The order of conditions, i.e., scatter intensities, haze values of filter, and gtating's contrasts, were randomized across the subjects.

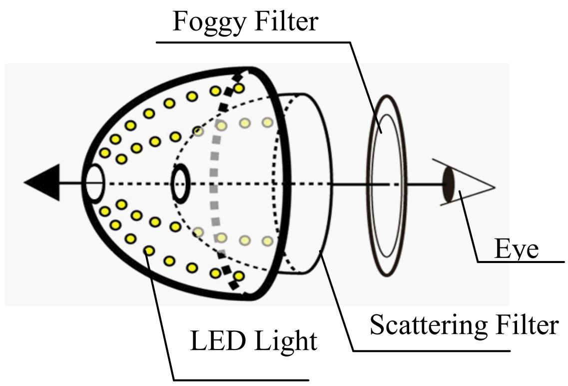

Figure1. Light scattering was configured LED light and scattering filter. There were the device of light scattering and foggy filter in front of the subject's eye.

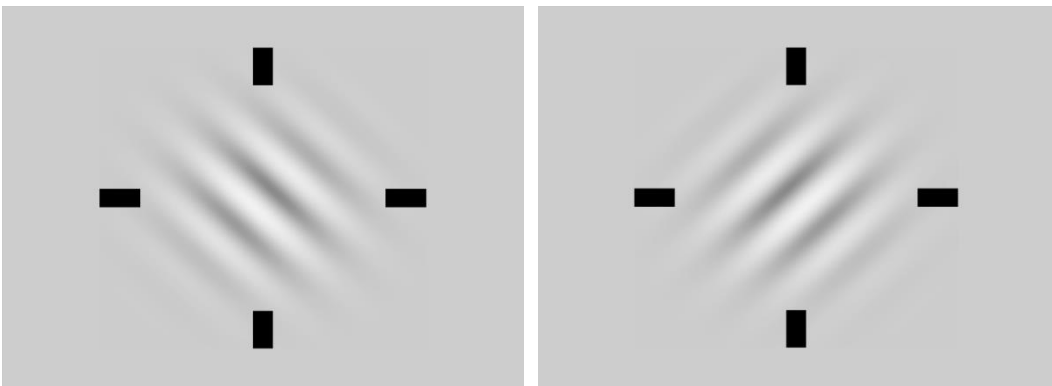

Figure2. The stimulus of gratings (Left inclined -45° and right inclined 45° as the condition of contrast 0.7)

RESULTS

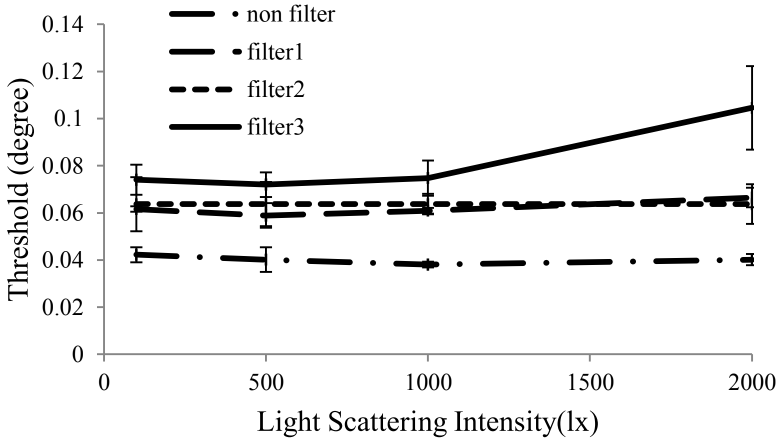

Figure3. The change of thresholds with increasing light scattering intensity as condition of contrast 0.1 (Subject KY)

Figure3 shows the change of threshold with increasing light scattering intensity. It is the result of subject KY when the condition of contrast was 0.1. Light scattering intensity was plotted on the vertical axis and thresholds on the horizontal axis. This data is the averages of the three trials. The result shows that thresholds decreased with increasing light scattering intensity. Additionally, thresholds also increased with increasing haze value of filters. The peak threshold was 2000lx for light scattering intensity. The similar results were appeared in another condition of contrast and other subjects.

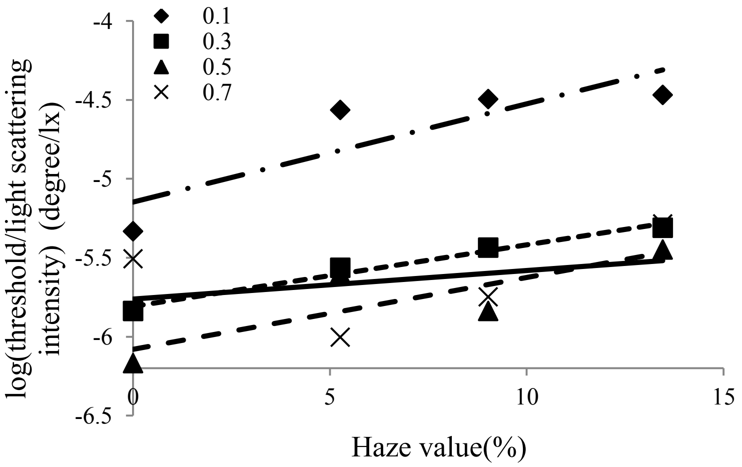

Figure4. The change of slope for haze values is plotted. The slope was obtained by dividing the threshold by light scattering intensity.

Poster paper

Figure4 shows the change of slope which was obtained by dividing the threshold by light scattering intensity for haze values in each condition of contrast. Haze value was plotted on the vertical axis and the slope which was logarithmic on the horizontal axis. Four points each of the conditions of contrasts were approximated by straight lines. The result was presented as the mean of all subjects. All values of the slope increase with increasing haze values.

DISCUSSION

We found the spatial resolution decreased with increasing light scattering intensity. Additionally, this decrease rate became higher with increasing haze values of filters. According to Figure4, the condition of contrast 0.3 was highest determination coefficient in all conditions of contrast. Therefore, we got the following of formula which could estimate the haze value of the crystalline lens. The haze value of crystalline lens can estimate by substituting the threshold and light scattering intensity.

$$\text{Haze value}[\%] = 5.8082 + \frac{\log\left(\frac{\Delta T}{\Delta E}\right)[\text{degree}/\text{lx}]}{0.039}$$

T; Thresholds, E; Light scattering intensity

CONCLUSION

The spatial resolution was influenced by the degree of haze and the intensity of light scattering in this experiment. Additionally, we produced the function which could estimate the haze value of the crystalline lens. By using this function (above formula), it is possible to know how much progresses has cataract each patient. Therefore, we suggest the present method as a new method for estimating the haze of the crystalline lens.

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MEASUREMENT OF COLOR APPEARANCE WITH COLOR CATEGORY RATING METHOD UNDER ORGANIC LIGHT EMITTING DIODE

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Keywords: OLED, Color category rating method

ABSTRACT

Organic light emitting diode (OLED) illumination has several unique features: thin, plane emission, and high-efficiency. Here we evaluated the color appearance of the Munsell color chips under OLED light with a novel color category rating method. A subject stayed in a booth whose illumination source was variable and observed a color chip placed on a gray background. The illuminance on the color chip surface was about 450 lx. The subject described the order of the colors perceived in the color chip using up to three colors out of 11 basic color terms (red, blue, green, yellow, purple, pink, orange, brown, black, gray and white), and also rated the weight of each of the selected colors by dividing a total of 10 points between all perceived colors. For example, a subject may describe the color appearance of a chip as purple 7, blue 2 and gray 1. The results were compared with those obtained under ordinary D_{65} fluorescent lights. Our results showed that under the OLED light the rate of "orange" increased while that of "purple" and "yellow" decreased.

INTRODUCTION

Organic light emitting diode (OLED) light is expected to become a next-generation illuminant along with LED light. However, OLED light has a greatly different spectral distribution from current illuminants: there are few shorter wavelength components and it contains neither ultraviolet nor infrared rays. This makes it especially suitable for illuminating pieces of art since there would be little chance of damage from synchrotron radiation. However, the altered spectral distribution may affect color appearance.

Current fluorescent lighting is generally kept low in museums to avoid damage to the exhibits. Typical illuminance adopted at the museum is 50-150 lx, while the suggested illuminances for an office and for a living room are 750 lx and 500 lx, respectively. Under the photopic conditions, mostly the cones are functioning and color appearance can be generally predicted by measuring the chromaticity of an object. However, when the illuminance gets lower, color appearance cannot be predicted by merely measuring its chromaticity.

When people observe color, they can describe not only the detail of its attributes such as hue and saturation, but also classify roughly which category of the color name it belongs to. This is known as categorical color perception. Research on categorical color perception often involves experiments in which subjects choose one color term from eleven color terms (red, blue, green, yellow, purple, pink, orange, brown, black, gray and white), known as basic color terms, to describe the color [1].

Categorical color perception under OLED light has been investigated [2]. It is reported that most OSA color papers observed under OLED were classified to the same category as those under D_{65}. However, one major drawback to this experimental paradigm is the inability of a subject to report a perceived small color difference between chips of the same category. For example, although one can clearly call two shades of purple differently such as lilac and plum, it is not discriminable in this categorical color naming method. To address this shortcoming, we devised a new rating system based on categorical color naming that will provide a more detailed analysis than traditional categorical color naming method. In this study, we used this novel rating system to estimate the color appearance of Muncell color chips under high illuminance OLED light and compared it with the responses under a fluorescent light.

METHODS

We first compared the correlated color temperature and color rendering index (Ra) of the OLED light and D_{65} fluorescent light. The correlated color temperature of the OLED light was 4900 K and the color rendering index (Ra) was 81.0. The fluorescent light was similar, with a correlated color temperature and a color rendering index (Ra) were 5200 K and 84.0 respectively. Observation illuminance was 500 lx.
The spectral distribution of the illuminants used in the experiment is shown in Figure 1.

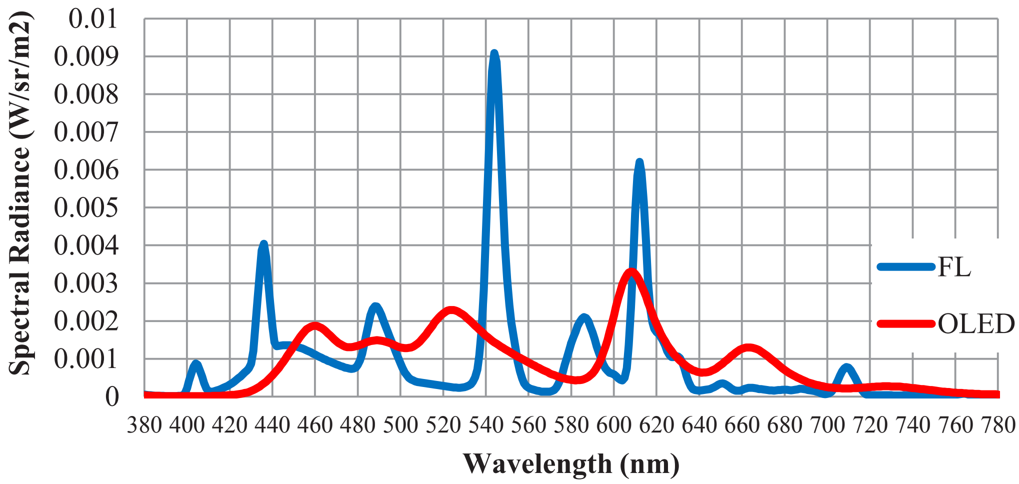

Figure 1. Spectral distributions of the illuminations

For the experiment, each subject stayed in a booth whose illumination source was variable and observed a color chip placed on a gray background. Before starting the experiment, a subject sat in the booth for 5 minutes to adapt to the illumination. Then, the subjects started a session consisted of responding to 146 Munsell color chips. The subject described the color perceived in the chip using up to three words from a set of 11 basic color terms (red, blue, green, yellow, purple, pink, orange, brown, black, gray and white), and also rated the weight of each of the selected colors by dividing a total of 10 points between all perceived colors (**category rating**). For example, a subject may describe the color appearance of a chip as purple 7, blue 2 and gray 1. The subject was also asked to choose the focal color, which appears to represent its color name, of each of 8 chromatic categories by picking up one color chip from 146 Munsell color chips for each of the category (**focal color selection**).

Four male subjects participated in the experiment. They had color normal vision, which was tested with Ishihara Plates. All the subjects conducted 2 sessions of the category rating experiment for each illuminant, and 1 session of the focal color selection experiment.

RESULTS AND DISCUSSION

Category rating

In order to analyze if the perceived color component changes, we calculated the average points for all the categories by averaging the points obtained from all the subjects. Figure 2 shows the average point of each color of all the subjects. Error bars indicate the standard deviation across subjects. The vertical axis shows all the subjects' average point, and the horizontal axis lists each color. Responses under the OLED light and the fluorescent light are shown in blue and red, respectively. All the subjects showed the similar tendency. When the results from both lights were compared, the fluorescent light had higher scores for green, purple, and white. Red, orange, gray and black were higher under the OLED light. Blue, yellow, pink and brown did not show any difference. However, no statistical significance was found for all 11 categories.
The spectral distribution in Figure 1 shows that the fluorescent light has high spectral radiance at the shorter wavelengths of 400-440 nm, the middle wavelength of 540-550 nm, and the longer wavelength of 610-620 nm. These high spectral radiances has narrow peaks of approximately 10 nm width. OLED light, on the other hand, has broader peaks at several ranges: 510-530 nm, 590-620 nm and 650-680 nm. There are also wide ranges of wavelengths, such as between 450-550 nm whose radiances are rather flat and mild.

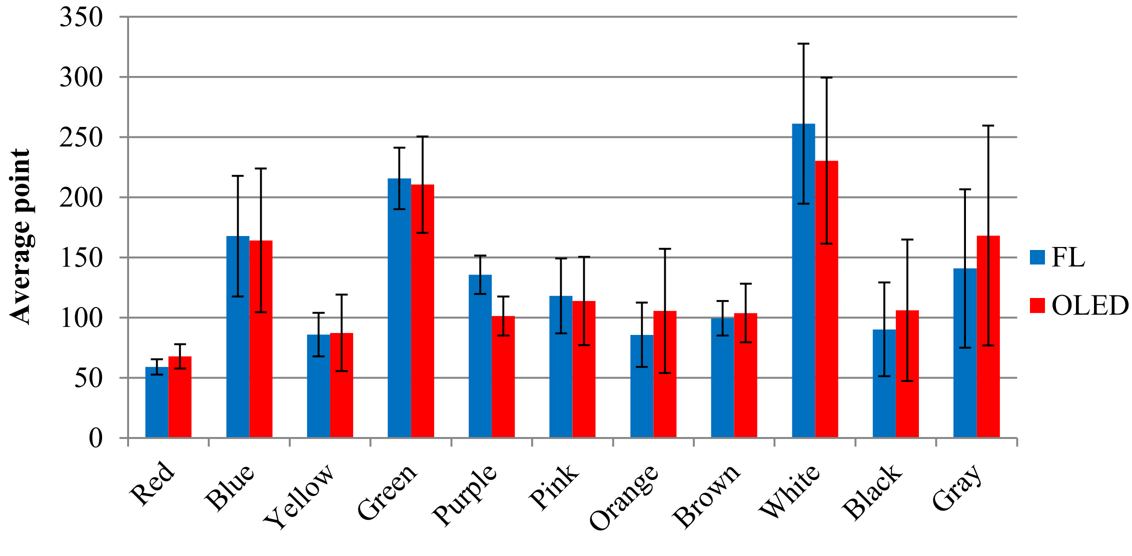

Figure 2. The average point of each color of all subjects

The differences in the response might be related with the difference in the spectral distribution of the light sources. The response of the purple obtained from the fluorescent light can be mainly caused by the spectral components of 400-440 nm, the green for 540-550 nm. The responses of red and orange for OLED were superior to those for fluorescent light as OLED has the higher spectral intensities in 590-620 and 650-680 nm.

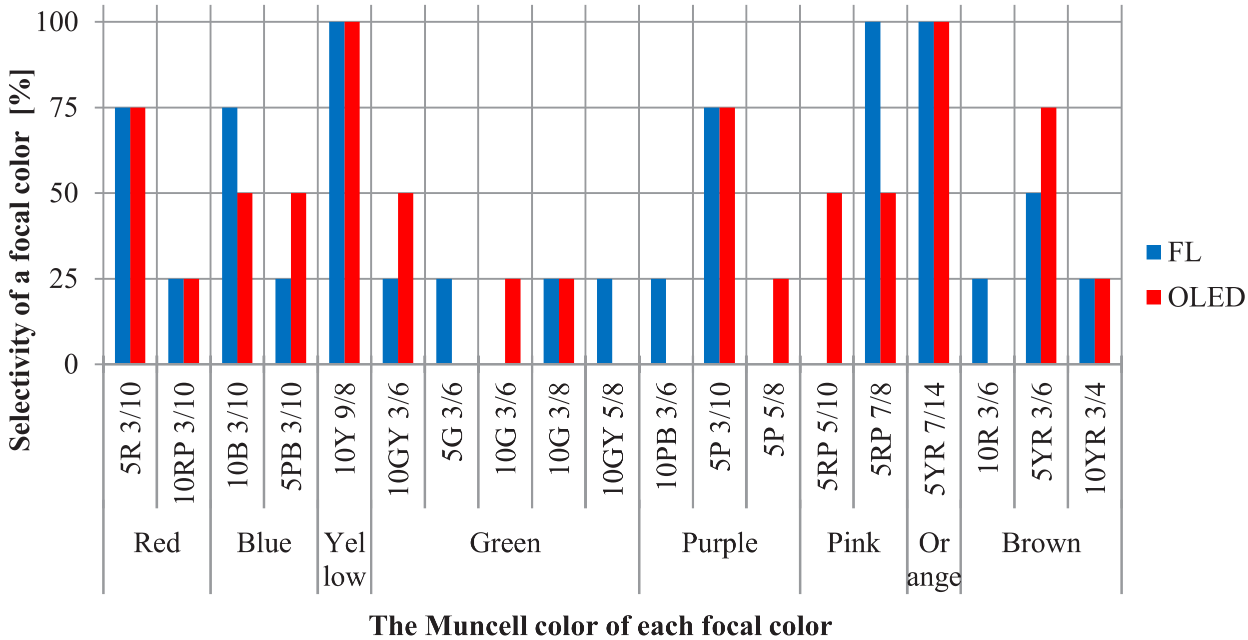

Figure 3. The Munsell color selected as the focal color and selectivity

<u>**Focal color selection**</u>

The Munsell colors selected as the focal color and its selected percentage are shown in Figure 3. Yellow and orange were very consistent with both lights. Purple and red are also consistent, as the selected percentage are 75% for both lights.

Blue and pink were consistent under the fluorescent light, while they were not so consistent under OLED light. Brown, on the other hand, was consistent under the OLED light but not under the fluorescent light. Green had a wide variety of choice as the focal color regardless of the lighting condition, and we could not determine which Munsell color chip represents green best.

We hypothesize that two very consistent colors, yellow and orange, were selected by their relatively higher chroma compared with other color chips. This hypothesis can be applied also to red, blue and purple. We need, however, further experiments to verify this hypothesis.

SUMMARY AND FUTURE WORK

We find that switching to OLED from a fluorescent light would likely increase the color appearance of red, orange, black and gray and decrease the color appearance of green, purple and white. Focal colors of red, yellow were very stable under both lights.

With our method, we are able to record small changes in appearance of the color. We would like to conduct the same experiment in lower illuminance condition to explore how the color appearance of the colors is affected by iluminance level.

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QUANTITATIVE EXAMINATION OF COLOR CONSTANCY ACROSS DIFFERENT LIGHTING ENVIRONMENTS BY USING COLOR NAMING METHOD

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Keywords:color constancy, color adaptation, elementary color naming

ABSTRACT

The extent of color constancy was examined by elementary color naming method. Subjects did color naming for three achromatic and forty chromatic Munsell color chips under three illuminants D, A, and A' whose color temperature was lower than A. In the color naming task, subjects reported perceived components of whiteness, blackness, and chromaticness out of 100%. And then chromaticness was divided into red, yellow, green, and blue components following the color opponency rule. The results were plotted and the distributions were compared in a polar coordinate system where the chromaticness was taken as radius and hue (rate of red, yellow, green, and blue) as angle. The color constancy index was defined by overlapping area of distributions from two different illuminants. The index was higher, that is higher color constancy, between D and A than that of D and A'.

INTRODUCTION

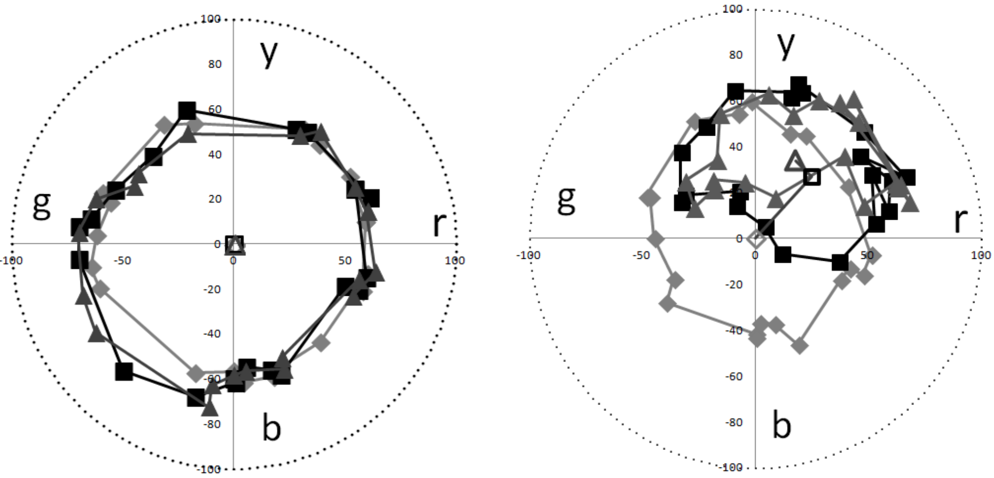
We can perceive the color of surface of reflecting objects constantly even under varying illumination conditions. This phenomenon is called color constancy. Although many studies have focused on the color constancy, there were a few studies examining quantitatively. Elementary color naming is one of the color naming method and the main purpose of the present study was to quantify color constancy by using this color naming method and that is useful for revealing subjective color appearance of an observer under various illuminant conditions. In elementary color naming method, an observer is asked to report a perceived color of object in terms of its whiteness, blackness, and chromaticness; an observer report, for example, that a perceived color contains 40% whiteness, 30% blackness, and 30% chromaticness. If chromaticness is perceived, the observer is further asked to estimate percentages of color components (i.e., red, yellow, green, and blue) contained in the perceived color following the color opponency rule: for example, an observer report that 40% redness and 60% yellowness is contained. In the present study, we measured subject's color appearance to various color chips under different illuminants with (adaptation condition) or without adaptation (no adaptation condition) to the illuminants. If we assume that no color constancy is achieved in the no adaptation condition, we can determine the amount of color constancy in some illumiant condition by calculating differences in the subject's color appearance (measured by the color naming method) in the adaptation condition relative to those in the no adaptation condition. In the present study, we compared the color constancy between different illuminant conditions.

METHOD

Three subjects(RN, KF, RI) who had normal color vision participated in the experiment. 43 Munsell color chips were used. 20 of them had value 6 and chroma 6, another set of 20 had value 4 and chroma 4, and the remaining 3 were achromatic. Hue of chips was selected to be evenly distributed along the hue circle: 5R, 10R, 5YR, 10YR, 5Y, 10Y, 5GY, 10GY, 5G, 10G, 5BG, 10BG, 5B, 10B, 5PB, 10PB, 5P, 10P, 5RP, or 10RP. Achromatic color chip was N4, N6, or N8. The chips were located in a board(10×20cm). Except for the center part(1.4×1.4cm), the surface of the board was N5 and experimenter set chips at center. Three illuminants were used: D, A, A' illuminants. The coordinates of those illuminants were (x=0.307, y=0.331), (x=0.442, y=0.391), and (x=0.528, y=0.406), respectively. To measure the color appearance without adaptation to the illumiants, we used a tube subtending 36 cm in length and 0.7 cm in diameter. The experiment was conducted in a room under one of the three illuminats. Before an experimental session, subjects practiced the task for several trials until they were familiarized with the task. At the beginning of each trial, one of chromatic or achromatic chips was presented and the order in each trial was random. There were 18 session for each subjects(6 conditions ×3 times). The task of subjects was to report a perceived color of chip by estimating percentages of its whiteness, blackness, and chromaticness in a way that the total percentage of these attributes was 100%. If the chromaticness was perceived, subjects was further asked to estimate percentages of color components (i.e., red, yellow, green, and blue) included in the perceived color in a way that the total of proportions was also 100%. Note that in the second task, the subjects followed the color opponency rule in which we described above.

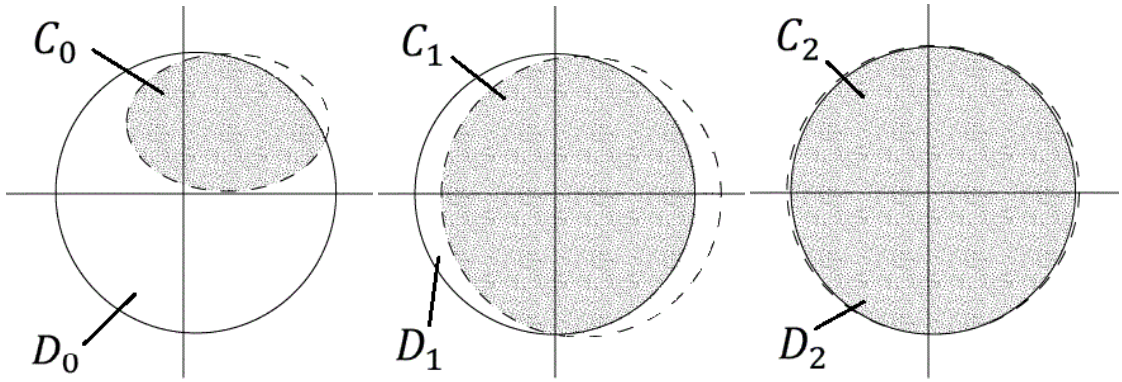
RESULTS AND DISCUSSION

All data obtained were plotted as polar coordinates in which the percentage of chromaticness was taken as radius and hue (red, yellow, green, and blue) as angle. Fig.1. shows the result of one subject (RN) in (a) the adaptation and (b) the no adaptation condition. Each marker in the figure represents the results of color naming under D(diamoneds), A(squares), and A'(triangles) illuminants. Open symbols show the results for the N6 chip under each illuminants. As shown in the figure, plots are quite similar across the three illuminants in the adaptation condition (see Fig. 1a), suggesting that the color constancy is highly achieved. On the other hand, plots were shifted to the y, r, quadrant as color temperature was dropped, suggesting that none of the color constancy is achieved. Note that the data for the N6 chips were almost centered in the adaptation condition while in the no adaptation condition, the data were shifted to y, r quadrant as color temperatures drop. The result of color naming to achromatic N6 had no chromaticness under D illuminant(even in without adaptaion condition) so we considered data of under D illuminant as the base and we tried to quantify the degree of color constancy between D and A ore D and A' illuminants. Fig.2 is pattern diagram of each conditions. We considered the data of in without adaptation condition as degree of color constancy is zero and if perfect color constancy is achieved, plotted data under A and A' illuminants are same as under D illuminant. Fig.2. (0) is data of in without adaptation condition and Fig.2.(1) is with adaptation. Fig.2. (2) shows expected result if color constancy is perfect. Let D_n(n=0,1,2) be the area of plotted results of under D illuminant (which are shown by solid line) in each conditions and let C_n(n=0,1,2) be the overlap area between results of under D and other illuminants (which are shown by grey color in Fig.2). Then the color constancy index (CCI) is $(C_n - C_0)/(D_n - C_0)$ and $D_2 = D_1 = C_2$. CCI is on a scale of 0 to 1, where 1.0 would be perfect constancy. This index was calculated for each subject. Fig.3 shows the indices of between D and A (it is shown DA in Fig.3) or D and A' illuminants(it is shown DA' in Fig.3) for 3 subjects. Left is value/chroma = 6/6. Right is value/chroma = 4/4. Diamonds show the indices of subject RN. The indicices of subject KF and RI are shown by Filled square and open triangles respectively. From the data obtained, we found the tendency. The degree of color constancy between D and A illuminants were higher than that of between D and A’ illuminants. This tendency was common among subjects.



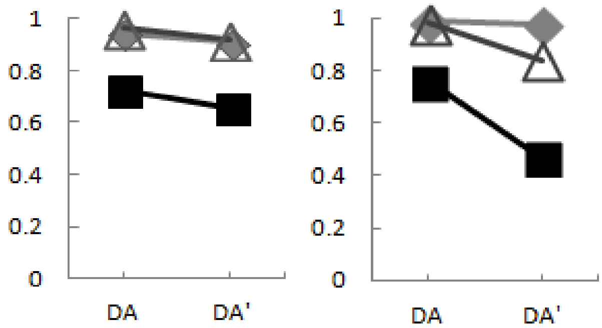
(a)with adaptation **(b)without adaptation**

Figure.1 Result of subject RN(Value/Chroma=6/6)



(0)without adaptation **(1)with adaptation** **(2)perfect color constancy**

Figure.2 Pattern diagram



Left: Value/Chroma=6/6 Right: Value/Chroma=4/4

Figure.3 Degree of color constancy

CONCLUSION

In this study, we proposed a new color constancy index. The results showed individual difference but we found the tendency. As color temperature drop, the degree of color constancy is drop(see Fig.3). This tendency has also been reported in other study[1] . This method has improvement. For example, this method can't use to achromatic color chips. To resolve this point is one of the future tasks.

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EFFECT OF COLOR ON THE SPACE BRIGHTNESS USING BORDER LUMINANCE OF COLOR APPEARANCE MODE

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Keywords: space brightness, color appearance mode, border luminance

ABSTRACT

Recently, many researchers have proposed space brightness indices that are well matched to human perception. However, those indices do not accurately reflect space brightness in some cases. Particularly, several studies found that observers reported enhancement of space brightness when there were colored objects (e.g., colored furniture), but the color effects are not taken into account in those indices. In the present study, to examine quantitatively the influence of color on the space brightness, we measured border luminance of color appearance mode for spaces with chromatic or achromatic furniture. Participants observed a test stimulus located in a scale model simulating a room and adjusted its luminance to determine the transition point from object color mode to light source color mode. The results showed higher border luminance in the chromatic furniture condition than in the achromatic furniture condition. This suggests that subject's space brightness was enhanced by chromatic furniture.

INTRODUCTION

To design a lighting environment, horizontal illuminance is generally used as a brightness index of room. However, it is frequently reported that, even when horizontal illuminance is high, a room does not appear bright. To solve this discrepancy between the horizontal illumianance and observer's brightness, many researchers have proposed space brightness indices that are well matched to human perception. In those indicates, however, color effects are not taken into account. There is increasing evidence that, when there are colored objects such as colored furniture in a space, the brightness is enhanced, as compared with that for a space with only non-colored objects.
The purpose of this study was to examine quantitatively the influence of color on the space brightness. For this purpose, we measured a border luminance of color appearance mode, i.e., the transition point from object color mode to light source color mode, to a scale model simulating a room. The number of furniture and horizontal illuminance in the room were manipulated. We compared the border luminance between rooms with chromatic and achromatic furniture.

EXPERIMENTAL METHOD

In the present study, a 1/8 scale models simulating a living-room(width; 450 mm, length; 580 mm, height; 300 mm) was used. Figures 1 and 2 show schematic illustrations of the model and the device to measure the border luminance of color appearance. The room was uniformly illuminated by luminous ceiling with three different levels: 100, 300, and 1000lx (measured at the center of the room). The number of furniture was manipulated: 2, 4, and 8 piece of furniture. Table 1 shows Munsell value of interior surface. A gray test patch (N5, 12 × 15 mm) was placed in the center of

the room. The test patch was illuminated by LED lamps from the bottom and its luminance was able to change independent of the room light.
The participant's task was to adjust the luminance of the test patch and to determine the border of the appearance mode, i.e., transition point from the complete surface-color mode. There were 20 blocks of 18 trials. The order of conditions was randomized across participants. Before an experimental session, participants practiced the task for several times until they familiarized with the task. Participants were 5 people in 20's.

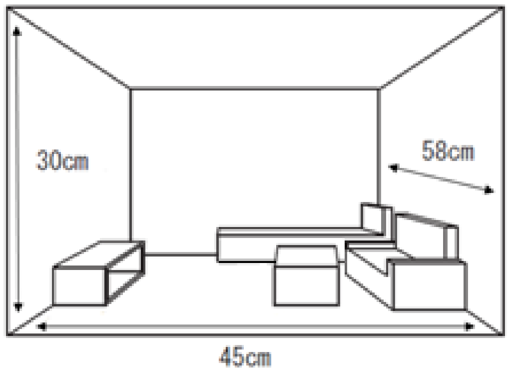

Figure1:Scale model

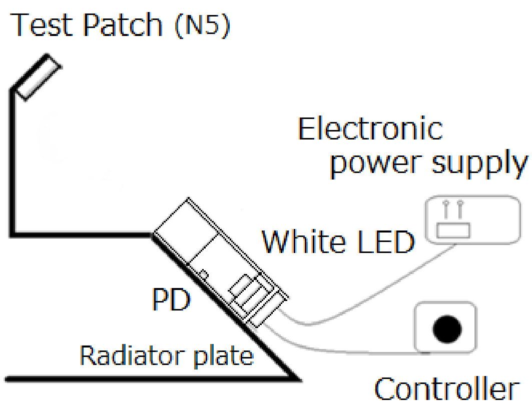

Figure2:Experiment device

Table 1 Munsell value of eight kinds

Item	Chromatic furniture	Achromatic furniture
Wall	N7.7	N7.7
Floor	N3.7	N3.7
Bed1	5B5/9	N5.0
	5PB3/2	N3.0
Bed2	5Y8/14	N8.0
	5YR6/13	N6.0
Sofa1	5GY7/12	N7.0
	5G4/10	N4.0
Sofa2	5PR5/14	N5.0
	5R4/14	N4.0
Table1	5Y8/14	N8.0
	5YR6/13	N6.0
Table2	5P5/9	N5.0
	5PB3/12	N3.0
TV stand1	5PR5/14	N5.0
	5R4/14	N4.0
TV stand2	5GY7/12	N7.0
	5G4/10	N4.0

RESULTS

Fig. 3 shows the results of two subjects (MN1 and YO). The abscissa represents the number of furniture in the room, and the ordinate represents the border luminance on chromatic color furniture condition set by participants. Square, triangle, and circle symbols show the border luminance at the room illuminance of 100, 300, and 1000 lx, respectively. Black and white symbols indicate achromatic and chromatic furniture conditions, respectively. A close inspection of the results from MN1 revealed that the border luminance increased as the room illuminance increased. Furthermore, the border luminance in the chromatic furniture condition was higher than that in the achromatic furniture condition. It was increased as the number of furniture increased.
Unlike the results from MN1, the results of subject YO showed a tendency that the border was almost identical in both the chromatic and achromatic furniture conditions, although it was increased as the room illuminance increased. The number of furniture did not affect the border lumiancne of the participant.

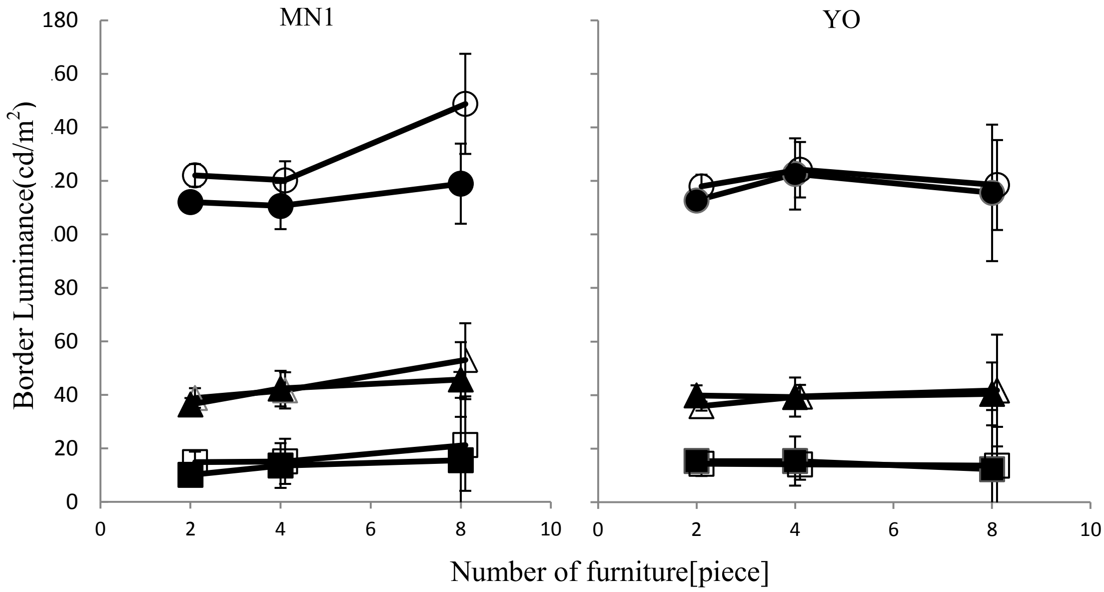

Fig.3. Border luminance as a function of room illuminance

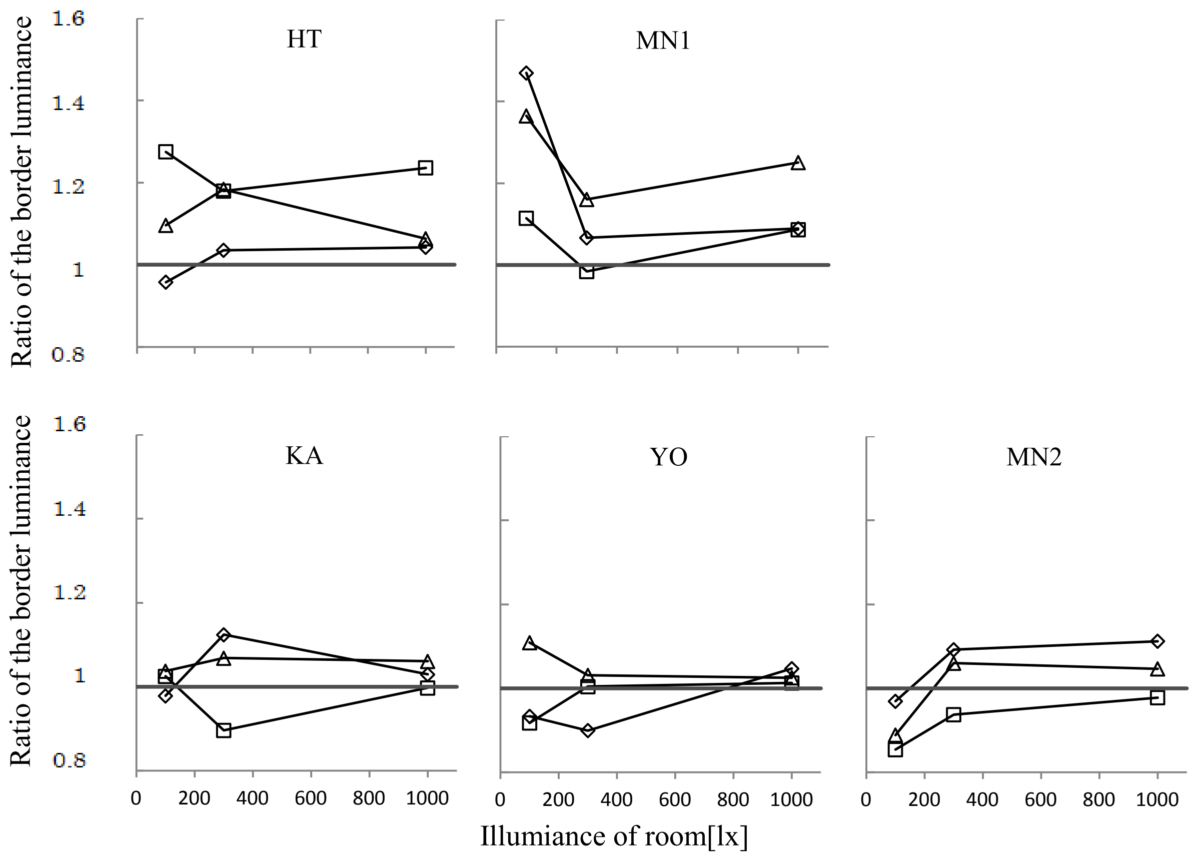

Fig.4. Border luminance as a function of the number of furniture

Poster paper

Poster paper

Fig.4 shows the ratios of the border luminance between the chromatic and achromatic conditions. If these values are more than 1, subject's space brightness was enhanced by chromatic furniture. The abscissa represents the horizontal illuminance measured from the center of the room. Triangle, square, and diamond symbols show the ratios in the furniture conditions of 2, 4 and 8 pieces, respectively. Upper panels show the results of subjects who showed higher border luminance in the chromatic furniture condition than the achromatic furniture condition. The ratio in the border luminance between the two color conditions were more than 1 under the most conditions, specifically in a range of 0.96-1.46. That is, subject's space brightness was enhanced by chromatic furniture. Lower panels in Fig. 4 show the graph of three subjects. As shown in the figure, the border luminance had little influenced by the chromatic furniture. The ratios of the border luminance was almost 1 or less, suggesting that subjects' space brightness had little influenced by chromatic furniture.

DISCUSSION

In this study, to examine quantitatively the influence of color on the space brightness. Particularly, we looked at the number of furniture in the room. We measured border luminance with chromatic or achromatic furniture. All subjects adjusted border luminance highly as the horizontal illuminance was increased. That is, subject's space brightness was enhanced as the horizontal illuminance was increased. Some subjects adjusted border luminance highly as the number of chromatic furniture increased. That is, subject's space brightness was enhanced by chromatic furniture. While other subjects did not change. That is, there was individual difference that enhancing effect of subject's space brightness by chromatic furniture: Takada et al [1] . have shown that subjects was called "color type" who adjusted the border luminance of the chromatic furniture condition was higher than an achromatic condition. Furthermore subjects adjusted border luminance highly as saturation of chromatic furniture increased. While subjects was called "luminance type" who adjusted the border luminance of the chromatic furniture condition was same as an achromatic condition.

The result of this study shows that there was individual difference that enhancing effect of subject's space brightness by chromatic furniture, but it is not clear from the result of this study why it happens. We could research this individual difference by checking whether subjects judge space brightness while watching which position of the space when subjects adjusted border brightness. For example, I measure the movement of eyes directly. Or we could research it that subjects received same amount the influence of the color even if the subjects were watching which position of the space when subjects adjusted border luminance by pasting the color chart on the walls in model.

CONCLUSION

Our results showed that subject's space brightness was enhanced as the room illuminance increased. Some subject's space brightness were enhanced by chromatic furniture. Therefore, the color affects of the space brightness.

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Luminance and chromaticity measurement with 3D object maps

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Keywords: Colorimetry, Natural Image, Digital Camera, 3D, Kinect

ABSTRACT

Recent studies have proposed the method for measuring chromaticity and luminance distributions of a natural scene with a digital camera. In this method, using multiple images of the scene taken with different exposures, a high dynamic range image is created. By analyzing the created image, chromaticity and luminance distributions are acquired. By combining this method and Kinect that can acquire depth information of objects, the present study proposes the method for measuring the chromaticity and luminance distributions together with a 3D map of objects in a space. We conducted an experiment in which two images were taken by a digital camera and Kinect cameras. On the basis of point correspondences over the two images, a transformation matrix was computed. We examined the accuracy of the matching between the image obtained by Kinect and that transformed from a digital camera image.

INTRODUCTION

Recent, development of lighting technology has enabled us to create various visual environments easily according to the needs of various groups of people such as elderly people and people with eye diseases. Although illuminace is generally used to estimate brightness of the environments, many researchers and architects have often reported that the illuminance does not always correspond to observer's brightness. Instead of the illuminance, many studies have proposed various brightness indices such as Feu and reported that those indices are well matched with observer's brightness[1]. Because those indices are based on the luminance and chromaticity distributions within a space, it should be essential to measure those distributions.

A colorimeter is usually used to measure luminance and chromaticity. However, quite long time is needed for a single point measurement to obtain their distributions in a space. To resolve this problem, a camera based colorimeter has been used which can measure luminance and chromaticity distribution over one million locations of a space in a few seconds[2].

In this method, a high dynamic range image of the space is created from multiple images taken by a digital camera with different exposures. The luminance and chromaticity of each pixel is then calculated.

In the present study, we propose the method for quickly measuring the chromaticity and luminance distributions, together with a 3D map of objects, by combining a digital camera based colorimeter and Kinect that can measure depth of objects. Several studies have shown that brightness can be affected by color of objects in a space[3]. Therefore, it would be useful to create a 3D map of objects for correcting brightness indices measured in a situation with various color objects located. Kinect has two types of cameras and get two types of images: a RGB image and a depth image with depth information. Because the RGB camera of Kinect can't change exposures, it cannot be used as a camera based colorimeter. In the present study, we used a digital camera to create a high dynamic range image and computed a transformation matrix on the basis of point correspondences over the two images taken by the Kinect RGB camera and the digital camera.

METHOD

In the present study, Microsoft Kinect for Windows (Microsoft Corporation, Model:1517) and CCD camera (ARGO TXG13c) with a fish eye lens (FUJIFILM FE185C046HA-1) were used. To calculate the RGB image coordinates corresponding to depth image coordinates, we compute the Digital camera image points matched with RGB image point. When we got some points to compute transformation, we take the image of the board which has 9 points.

Coordinates and Parameters

We use four coordinates to compute corresponding points of two images: image coordinate, world coordinate, camera coordinate and normalized coordinate. Fig.1 illustrates relationships of these coordinates. Internal parameter has the focal length and center of the image. External parameter has rotation and transformation matrix. The relationship of image coordinate and world coordinate is expressed as follows.

$$s\begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = \begin{bmatrix} f_x & 0 & c_x \\ 0 & f_y & c_y \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} r_{11} & r_{12} & r_{13} & t_x \\ r_{21} & r_{22} & r_{23} & t_y \\ r_{31} & r_{32} & r_{33} & t_z \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \\ 1 \end{bmatrix} \quad (1)$$

where $(u \quad v)^{-1}$ is the point in images and $(X \quad Y \quad Z)^{-1}$ is the world coordinate point.

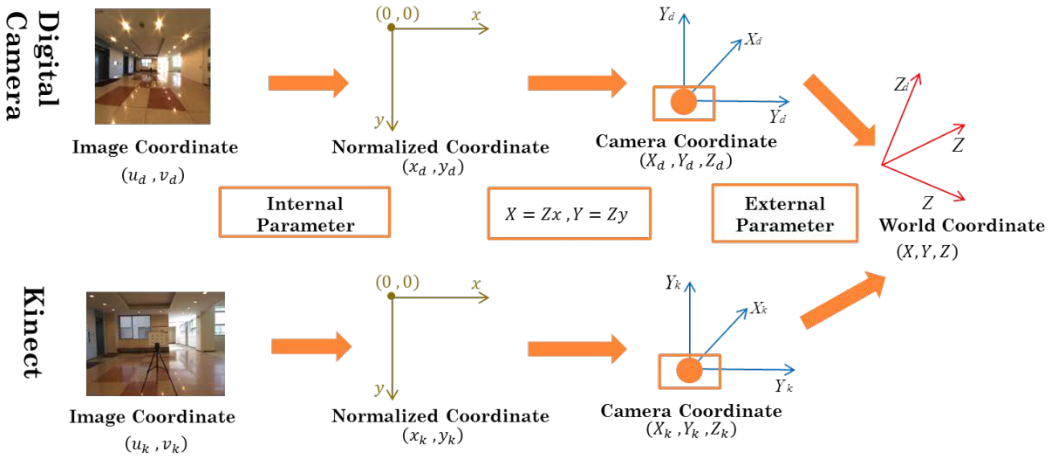

Fig.1 Relation with four coordinates

ALGORITHM

In the present study, world coordinate points corresponding to Kinect RGB image coordinate is computed and (1) by using the calculated world coordinate points Kinect RGB image coordinate are transformed into the digital image coordinate in world coordinate. We use method of Zhan[2] when we get internal parameter. About transformation from RGB camera coordinate to world coordinate, Kinect can get depth image and value of Z so we can consider Kinect RGB coordinate to be world coordinate. Therefore Kinect external parameter is unit matrix in rotation matrix and all elements in transformation matrix. Next, we compute external parameter of digital camera. We can get external parameter by OpenCV. We need depth information so we get target board images are changed about distance from camera to target board each image.

EXPERIMENT

We computed the points in world coordinate from Kinect RGB image coordinate and Digital image coordinate points which were matched. Kinect was located at the X=0 and Z=0 and we set X ≧0 in right area. We got external parameter in two cases. In first case, we got external parameter by five images were in 0≦X≦1000[mm] area. In second case, we got it by fifteen images were in -1000 ≦X≦1000[mm] area. The 22 images to estimate errors were X = -1000, -500, 0, 500, 1000 and Z = 1000, 1500, 2000, 2500, 3000, 3500[mm].

RESULT

Table.1 and Table.2 show estimated errors. Table.1 shows the small area to compute external parameter and Table.2 shows the wide area to compute it. Colored cells mean the place of image to estimate external parameter. In small area external parameter case, the errors in X<0 are average 73.88, in X≧0 are average 16.37 and in all area are average 37.28. In wide area external parameter case, the errors in X<0 are average 19.16, in X≧0 are average 22.40 and in all area are average 21.22. Maximum estimated error in small area is 146[mm] and in wide area is 80[mm]. We can understand wide area external parameter is better than small area external parameter.

Table.1 Estimated error in small area external parameter

	X =−1000		X =−500		X =0		X =500		X =1000	
Z	ΔX	ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	ΔY
3500	131	20	79	17	32	9	10	6	33	5
3000	117	16	53	10	31	5	6	7	30	4
2500	100	17	52	14	26	3	3	5	30	6
2000			38	9	10	4	4	4		
1500			21	10	8	3	2	2		
1000					5	2				

Table.2 Estimated error in wide area external parameter

	X=−1000		X=−500		X=0		X=500		X=1000	
Z	ΔX	ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	ΔY
3500	40	9	9	7	9	9	31	7	62	6
3000	33	8	6	6	11	6	27	7	51	4
2500	5	7	6	3	12	6	20	3	33	3
2000			19	3	12	3	5	4		
1500			36	3	7	4	20	3		
1000					10	9				

DISCUSSION

In this present study, we can compute the matching RGB image coordinate and Digital image coordinate in the small error was 80[mm]. In contrast Table.1 and Table.2, in the estimated error in entire area wide area external parameter is better than small external parameter. However when we contrast them in $X \geqq 0$ in which small area external parameter was computed, the average error was 16.37 in small area and 22.40 in wide area so we can understand in small area external parameter was better. Therefore we should choose parameters by situations. When we have to get chromaticity and luminance distribution in wide area, we use wide area external parameter and we use small area external parameter when we have to get it in small area.

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HOW EQUIVALENT CONSPICUITY IN TWO-COLOR COMBINATIONS IS EXPRESSED IN COLOR SPACE

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Keywords: color conspicuity, color combination

ABSTRACT

If we can present color combinations of the same conspicuity to users, it may help them choose arbitrary color combinations suited for particular purposes (e.g. spatial design, color accessibility etc.). This study aims to find quantitatively how equivalent conspicuities are expressed in a color space. In the experiment, we used two center-surround type color combination stimuli: the reference and the test stimulus. A subject adjusted the saturation of the center of the test stimulus along a given direction in the a*b* plane until the test stimulus had the same conspicuity as that of the reference stimulus. The results indicate that the equivalent conspicuous points are well-expressed as an ellipse. Further, our results indicate that the degree of conspicuity was different depending on hue even if the color difference was the same. These results show the similar trends as a previous study [1].

INTRODUCTION

In 2006, a new act on accessibility went into effect in Japan. Since then, many companies tried to share the rules for sign systems, or establish guidelines for their usage. It is not too much to say that sign systems are playing an important role in universal design. In these sign systems, selecting appropriate colors as a method of achieving conspicuity is easy and highly effective, as it doesn't require any physical change of the existing properties. In fact, we can see many sign systems that use color as a property for conspicuity in places such as stations. In this case, it is necessary to select colors based on its conspicuity in addition to taking its particular purpose, such as spatial design, color accessibility, into account. However, it is difficult to choose appropriate colors which fulfill both conspicuity and the purpose simultaneously: if we emphasis its conspicuity, that color might not suit for its purpose of usage, and vice versa. As a result, the presentation of the colors is limited, and it cannot be accomplished from wide variety of choices. As for a trend of conspicuity and emotion mediated for the color combination reported in the previous researches [1] [2], it is difficult to choose specific color, and its choice is really restricted. If we can offer multiple color combinations of the same conspicuity to users, it may help them choose arbitrary color combinations suited for particular purposes. This study aims to find an attribute of the equivalent conspicuity quantitatively in two-color combinations.

METHODS

Equipment

The experiments were conducted in a booth whose walls were covered with black velvet. A fluorescent light lit the inside the booth in order to prevent subjects from dark adaptation. The illuminance of the booth was approximately 180 lx. A LCD monitor (EIZO ColorEdge CG245W 24.1 inch), which controlled by ViSaGe (Cambridge Research System), was placed in front of the subject in order to present stimuli. The distance between a monitor and a subject was approximately 100 cm. The subject could observe the stimulus freely.

Stimuli

A schematic diagram of the stimuli used in the experiment is shown in Figure 1. The stimuli consist of two center-surround type color combinations: one for the test and the other for the reference. They were presented on a black background on the LCD. The size of the center square was 2 x 2 deg, and that of surround square was 4 x 4 deg. A gap between the two stimuli was 2.8 deg. L* of the stimuli was 50. The color used for the reference stimulus was constant throughout the experiment: its center and surround were (0,50) and (0,20), respectively, in (a*, b*) color plane. The surround of the test stimulus was set to be either (0,0), (0,20), (0,-20), (20,0) or (-20,0). The center of the test stimulus was changed along a given 16 directions that equally spaced at a 22.5 degrees interval whose center was fixed for the above mentioned colors. The ranges of the adjustment for each direction were controlled so as not to exceed the color gamut of the monitor.

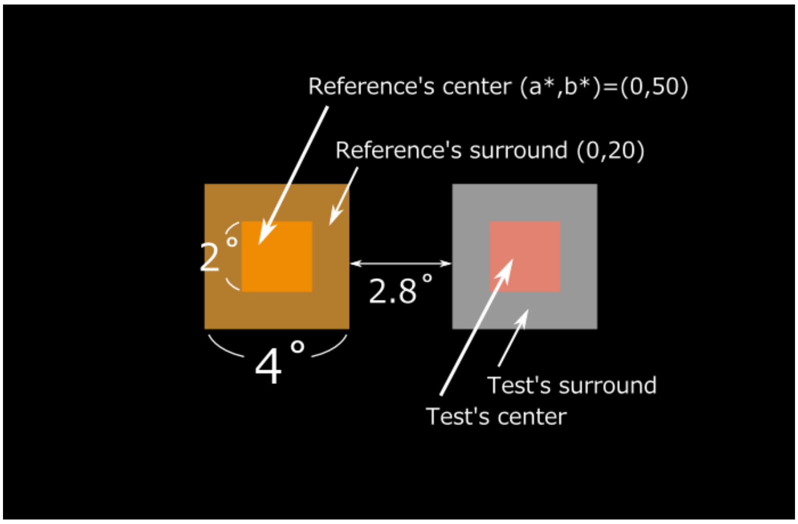


Figure 1. Example of a stimulus image

Subjects

Five subjects participated in the experiments. They were university students who had normal or corrected-normal acuity. Their color vision of all the subjects was normal, examined with Ishihara plates.

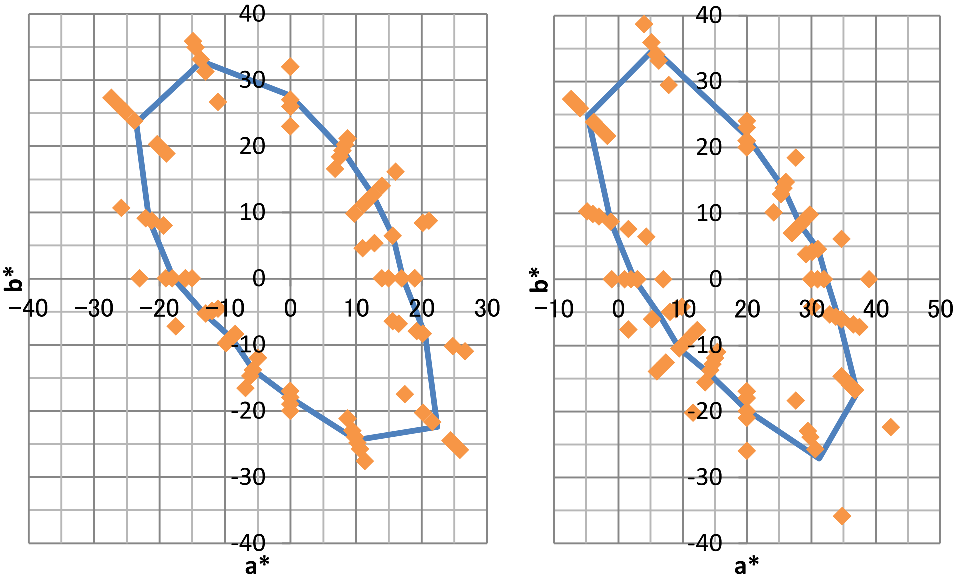
Procedure

Before starting a session, a subject stayed in an experimental booth for 5 minutes to adapt to the illumination of the booth. When the experiment started, the subject was asked to adjust the saturation of the center of the test stimulus until the test stimulus had the same conspicuity as that of the reference stimulus. Each subject conducted 5 sessions. Each session divided into 6 sets and each set consisted of 16 adjustments for each direction. In each set, the location of the test stimulus was kept constant, either to the right or the left. The order of presentation and the initial saturation were randomly selected.

RESULTS AND DISCUSSION

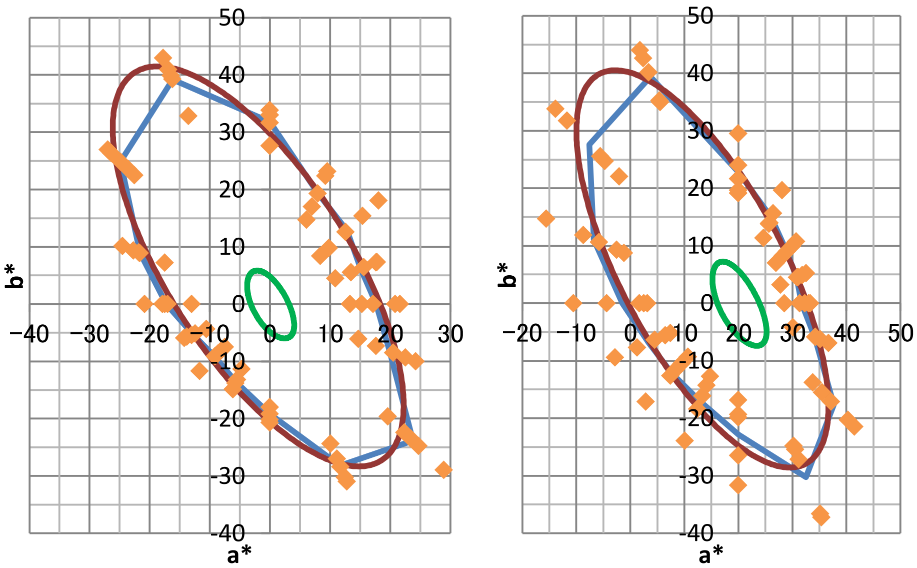
The results of the experiment are shown in Figures 2 and 3. In Figure 2, an example of the result obtained from one subject (KY) is shown. Orange dots indicate the results of each setting. Blue lines show the average of all the settings for each direction. In Figure 3, orange dots indicate the averaged results obtained from each subject. Blue lines indicate the average among all the subjects.

Red line shows an ellipse approximation. The green ellipses indicates the MacAdam ellipse for (0,0) and (20,0).



(a) **(b)**

Figure 2. Results obtained from one subject KY
(a) and (b) are results for (0,0) and (0,20), respectively.



(a) **(b)**

Figure 3. Results obtained from all subjects
(a) and (b) are results for (0,0) and (0,20), respectively.

Subjects reported that the color of the same conspicuity was not found for some directions in (0,-20) and (-20,0) conditions. It may partly be because the gamut of the monitor used in the experiment was not large enough to obtain the color in those particular directions.

A fitted ellipse had a longer axis which is inclined approximately 30 degrees counterclockwise from the b* axis. The MacAdam ellipse centered around (0,0) also has the same degree of inclination. A similar trend was also seen in the other points. These coincidences come from the non-uniformity of the L*a*b* color space.

Next, we calculated the color differences using CIEDE2000 color difference formula, which was defined to decrease discrepancies between colorimetric and visual color differences in CIELAB. Color differences between the surround color and the center colors with the same conspicuity obtained for all the directions are shown in Figure 4. The color differences between the surround color and the center colors of the similar hue with higher saturation were smaller. Moreover, these outlines inclined counterclockwise from the b* axis. This result suggests that the degree of conspicuity was different depending on hue even if the color difference was the same. These results show a similar tendency as previous reported research [1].

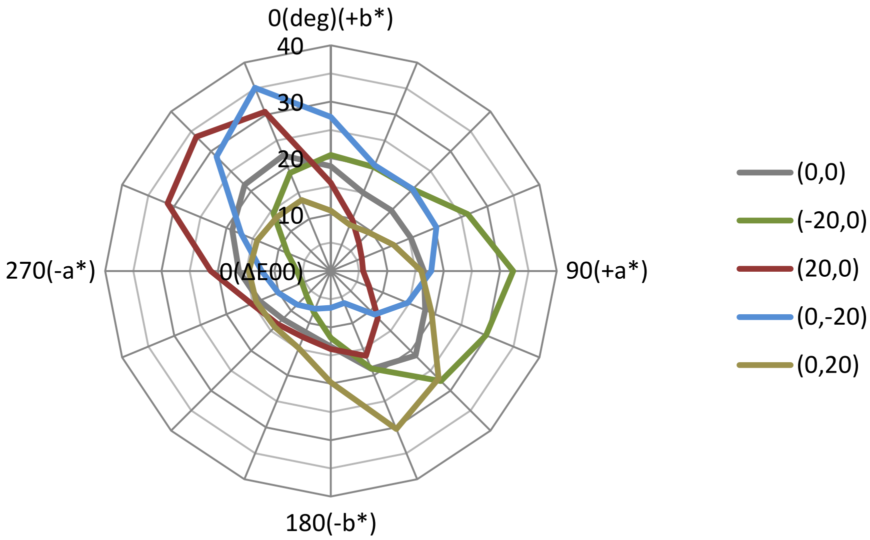


Figure 4. Color differences between the surround color and the center colors with the same conspicuity

CONCLUSION

The experimental results indicated that the equivalent conspicuous points were well-expressed as an ellipse and inclination was the same as the MacAdam ellipse. Furthermore, color differences obtained from CIEDE2000 showed a trend of smaller color differences in the first and in the third quadrant and larger differences in the second and in the fourth quadrant. These indicated that the degree of conspicuity was different depending on hue even if the color difference was the same, however, some colors may have been affected by the monitor color gamut.

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DESIGNING COLOR SCHEME FOR CONTEMPORARY MUDMEE SILK PRODUCTS

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Keywords: color, color scheme, silk

ABSTRACT

The Mudmee silk is local textile with the Thai cultural values. From the study, it was found that Mudmee silk originally belonged to Thai-Lao ethnic groups in Buriram Province. One piece of silk was commonly made with at least 3 colors. The very popular colors for making patterns on the plain color silk were red, yellow, white, and green which are bright colors which resulted in the color scheme design. The color scheme design was made by using complementary colors such as polychromatic colors or tonality. Using monochrome colors or neutral colors in color scheme design was not popular. From above reasons, the researcher has designed the new color scheme patterns for Mudmee silk on 17 pieces of silk by using monochrome colors, polychromatic colors, complementary colors, and neutral colors. The Mudmee silk products made from the new color scheme patterns will have a contemporary look that meets with the needs of consumers. This will add value to the cultural based products which is in accordance with the creative economy.

INTRODUCTION

The ancestors of Esarn or Northeastern region people have accumulated their local wisdom in terms of weaving through oral communication for thousands of years. The weaving knowledge was learned and practiced by the local people and was handed down from generation to generation. Their skills are considered the elaboration art which is unique and outstanding craftsmanship and well known in international level. Buriram province is a major silk production source in the country since Rama the fifth: in the year 1905. (Thailand Culture Encyclopedia Foundation of Siam Commercial Bank. 1999: 2782). Until now, the aforementioned area has been the residential area of Thai-Laos ethnic groups. One piece of silk was commonly made with at least 3 colors. The very popular colors for making patterns on the plain color silk were red, yellow, white, and green which are bright colors (S. Prajonsant et all. 2003 a: 55-67) which resulted in the color scheme design. The color scheme design was made by using complementary colors such as polychromatic colors or tonality. Using monochrome colors or neutral colors in color scheme design was not popular. In the past, the silk producers used the traditional color scheme to produce their silk routinely, so they have been familiar with color scheme patterns and all agreed to use the same color scheme patterns for years. However, some silk products do not meet with market demand. The consumers demand for a variety of products (S. Prajonsant et all. 2003 b: 127) which is consistent with the Office of the Higher Education Commission (2004: 91) that the development of new designs or traditional patterns is low because there is a lack of designers and weavers in the local area did not dare to carry out things outside the box besides what they have seen or done. They are not confident and afraid that they will make mistakes by making things that are different from what they have been taught. This article is the results of the designing color scheme for Mudmee silk products. The designs were developed in order to give the products a contemporary look that responding to the idea in promoting and developing the creative economy.

RESEARCH OBJECTIVES

1) To trial to use color scheme from color theory in designing and producing Mudmee silk.

2) To examine consumer acceptance when customers firstly saw the products.

RESEARCH METHODOLOGY

This research is a creative design research which aimed to create design outputs that can be used commercially. The first step in the research methodology was designing patterns of the model silk by using the color scheme from color theory such as using monochrome colors, polychromatic colors and focusing on color principles such as harmony of colors, discord colors, double complementary colors, intensity of colors, and neutral colors. The next step was to disseminate the patterns to 2 groups of local community enterprise: Nonggo village's female weavers group and Napho district's local handicrafts center, Napho district, Buriram province in order to produce 17 pieces of Mudmee silk. The researcher has monitored the Mudmee producing and weaving process. After that, the consumer acceptance when customers firstly saw the products was examined by asking opinions of the sample derived from the non-probability sampling which was a purposive sampling. This was conducted by questioning the interested people who came to the researcher's product exhibition/show. And then the accidental sampling method was employed with the sample group of 120 people.

FINDINGS

1) The results from monitoring the silk production when comparing with the designed patterns showed that the silk producers/weavers could dye the neutral color according to the designed patterns equaled 50.00 percent and could dye the mixed colors according to the designed patterns equaled only 37.00 percent. The shape and proportion of the designed patterns after Mudmee tying could be maintained only 71.00 percent.

2) The results from the study of the consumer acceptance of products showed that most of the population samples were female, aged 51-60 years. After calculation for the frequency from the total number of the population samples, it was found that the average age was 50 years old. Their income equaled 25,001 to 30,000 THB per month. When calculating the frequency from the total number of the population samples, it was found that the average of the income was 44,849 THB per month. The satisfactory level of the samples when they first saw the products was in the highest level. They liked the overall colors and patterns of the Mudmee silk at the highest level. They liked the silk fabric at the high level, and viewed that the overall products will get an attention from the market at the high level.

Mudmee silk design outputs made by using color schemes.

1.1) Monochrome means using only one color in different value as shown in the silk piece

1-3.

1.2) The Polychromatic refers to the use of many colors as the color scheme based on the color theory such as:

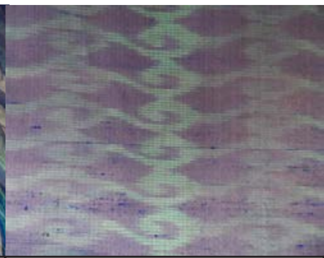
1.2.1) Harmony is using 2-3 colors on the side of the color wheel as shown in the silk piece 4-6.

1.2.2) Intensity refers to how bright or vivid the hue is which controlling over surrounding colors. The intensity color would outstandingly appear when it was surrounded by the gray color as shown in the silk piece 7.

1.2.3) Complementary colors is the use of opposite colors (primary colors) or using the secondary complementary colors as shown in the silk piece 8.

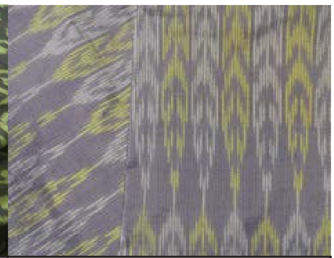
1.3) Using neutral colors means the Mudmee silk designed by using neutral colors: using the neutral color with the whole piece and using the neutral colors with other colors as shown in the silk piece 9-17.

Piece 3, the blue Mud mee silk. Reduce the brightness by using light gray warp threads. Weft threads were dyed in blue and tie dyed to create the bright sky blue. Alternate with white patterns.



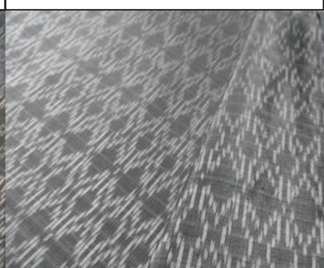
Piece 6, the violet Mud mee silk. Use gray warp threads. Weft threads were dyed in violet and tie dyed to create the blue violet and blue green patterns.

Piece 7, the brown Mud mee silk with bright yellow patterns. Use brown warp threads. Weft threads were dyed in brown and tie dyed to create bright yellow patterns.



Piece 8, the light violet Mud mee silk. Use light gray warp threads. Weft threads were dyed in light violet and tie dyed to create yellow patterns. Alternate with white patterns.

Piece 9, the black Mud mee silk. Us gray warp threads. Weft threads were dyed in black and tie dyed to create white patterns.



Piece 10, the gray Mud mee silk. Use gray warp threads. Weft threads were dyed in black and tie dyed to create white patterns.

Piece 12, the red Mud mee silk. Use gray warp threads. Weft threads were dyed in red and tie dyed to create light gray, dark gray, and black patterns.

Piece 13, the pink Mud mee silk. Use gray warp threads. Weft threads were dyed in pink in medium value and dyed to create red brown, gold, and tie dyed the Weft threads to create white patterns.

DISCUSSION

The results showed that there was a reduction of the brightness of Mudmee silk's colors. The reduction derived from the designed patterns because the color determination on warp and weft threads has created the harmony of the color of the silk. The color mixing and a shiny look appeared when looking at the silk. However, using the gray color warp threads which is the neutral color caused the reduction of the color brightness. The first appearance of the products is very important because the consumers can be impressed with the products. The color scheme design was made by using single color with the neutral color and harmony color scheme which was made differently from the traditional Mudmee silk design. Silk is considered as products for a niche market: it is a small market targeting to the high-income customer groups. These groups of customers can afford the high priced products. These customers have very specific needs. The researcher viewed that these products will have good opportunities in the future because the world society is changing into the aging society. The people from the society will be the main customers of silk products in the future.

ACKNOWLEDGMENT

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Poster paper PA14

AN ASSESSMENT OF SIMULTANEOUS DYNAMIC RANGE FOR HDR RENDERING

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Keywords: HDR scene, tone mapping operator, Naka-Rushton equation, simultaneous dynamic range, photoreceptor model

ABSTRACT

High dynamic range (HDR) image rendering has been an active research area in the last two decades. In real-world scenarios, there is a wide range of luminance (around 14 log units) between highlights and shadows. However, according to previous reports, the simultaneous dynamic range of human vision is 3.73 log cd/m^2. This property suggests that it is unnecessary to compress the full dynamic range of luminance in a real-world scene for realistic rendering. In this study, we present a sequence of psychophysical experiments to determine an appropriate simultaneous dynamic range depending on the HDR scene using an HDR rendering algorithm. The experimental results are summarized as follows: (1) for an HDR scene within the range of human vision, a rendered image with a higher simultaneous dynamic range within this range is preferable, (2) for an HDR scene beyond the range of human vision, a rendered image with the same simultaneous dynamic range as that of human vision is preferable, and (3) a rendered image with a higher simultaneous dynamic range is preferably observed under ambient light rather than in a dark room.

INTRODUCTION

Owing to the popularization of the personal computer and the Internet in recent years, we have many opportunities to view digital images in daily life. We now use digital cameras as the most common imaging devices. However, a display monitor as a commonly used image display device has a narrow range of luminance (at most, only about 3 log units), while the real world has a much wider range of luminance (around 14 log units). Therefore, it is difficult to reproduce an HDR scene on the display. The technique that compresses the dynamic range to display an HDR scene on an LDR monitor is called "tone mapping," and various methods have been proposed so far. In many of these methods, the S-shaped function [1] modeled by Naka and Rushton has been used. This model uses a sensitivity parameter that can change the simultaneous dynamic range that the human can perceive. However, the parameter had to be empirically determined.

In this study, we performed subjective evaluation experiments with HDR scenes to clarify the relationship between the dynamic range of the actual HDR scene and the simultaneous dynamic range for realistic HDR rendering [2] using the S-shaped function.

RENDERING ALGORITHM

In this study, we used the HDR rendering algorithm proposed in Ref.[2] to reproduce the images used in the evaluation experiments. The algorithm is a spatially variant operator for imitating the S-potential function and realizing the local adaptation process as follows:

$$R_s^{(i)}(\sigma_m,\sigma_d)=R_{\max}\frac{I_s^{(i)^n}}{L_s(\sigma_m,\{\sigma_d\})^n+\sigma^n};\ i=R,G,B, \tag{1}$$

$$L_s(\sigma_m,\{\sigma_d\})=\frac{1}{k_s}\sum_{p\subset\Omega} f_{\sigma_m}(p-s)\prod_j g_{\sigma_{d_j}}(I_p-I_s)I_p, \tag{2}$$

$$k_s=\sum_{p\subset\Omega} f_{\sigma_m}(p-s)\prod_j g_{\sigma_{d_j}}(I_p-I_s), \tag{3}$$

Here, $R_s^{(i)}$ is the LDR image output of the channel i at pixel s. $I_s^{(i)}$ is the HDR image intensity of i at s. L_s is the surrounding intensity, σ_m is the standard deviation for a Gaussian f in the spatial domain, and σ_d is the standard deviation for a Gaussian g in the luminance domain. K_m is a normalization factor, and Ω is the whole image. $R_{\max}$ is 255 for an 8-bit output device, and σ is the average luminance of the HDR image. In Eq. (1), n is the sensitivity parameter that determines the simultaneous dynamic range, and its value is generally determined empirically between 0.7 and 1.0 [3]. Figure 1 shows the different S-shaped functions for different sensitivity parameters for σ = 1. The simultaneous dynamic range widens if the sensitivity parameter n becomes small. We generate multiple images by changing n for the experiments.

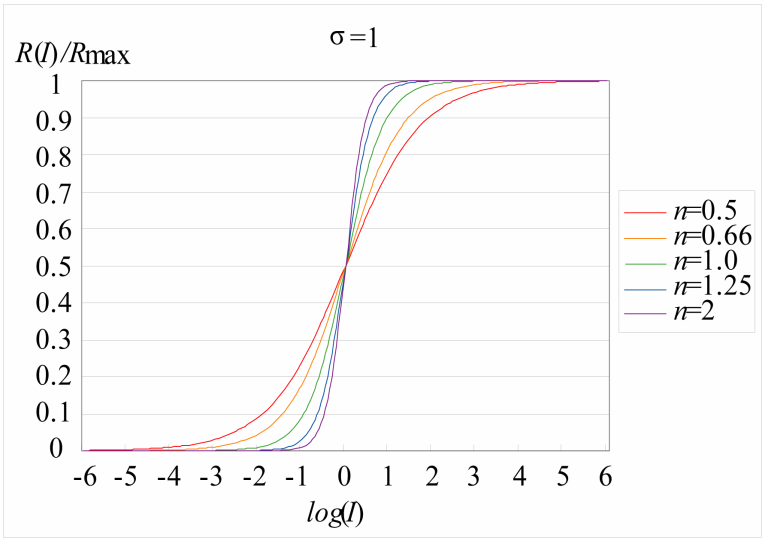


Figure 1. S-shaped response curves for different sensitivity parameters n.

EXPERIMENTS

EXPERIMENTAL METHOD

In our experiments, we used a Canon EOS-1Ds digital camera for capturing test scenes. Multiple images of the same scene captured with different exposure times were combined into an extended range image. We set up 3 HDR scenes with dynamic ranges of about 1, 2, and 4.00 log units as shown in Fig. 2. For each scene, we prepared a set of images, each with a different sensitivity parameter n as shown in Table 1. We used two different lighting conditions. (A) The target scene was illuminated by only a point light source (3070 K) in a dark room, and (B) the target scene was illuminated by ambient light from fifteen 100 W incandescent lamps (2760K).

Rendered images were displayed on an Eizo ColorEdge CG221 LCD monitor. Three to Five subjects participated in each experiment. The experimental procedure was as follows. 1) Each subject memorized the scene for 3 min. 2) After viewing the scene, two images were displayed on the monitor in random order from image sets of the reproduced image. 3) The subject selected the image more similar to the memorized actual scene from the two reproduced images. This procedure was performed for all experimental conditions.

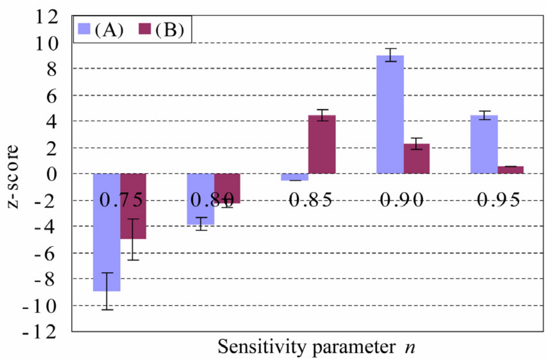


(a) 1 log unit in (B) **(b) 2log units in (A)** **(c) 4 log units in (B)**

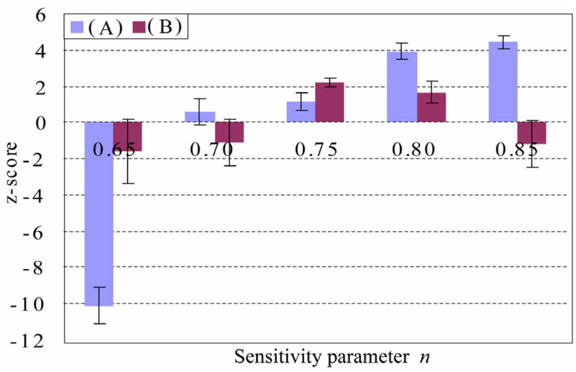
Figure 2. Examples of HDR test scenes.

EXPERIMENTAL RESULT

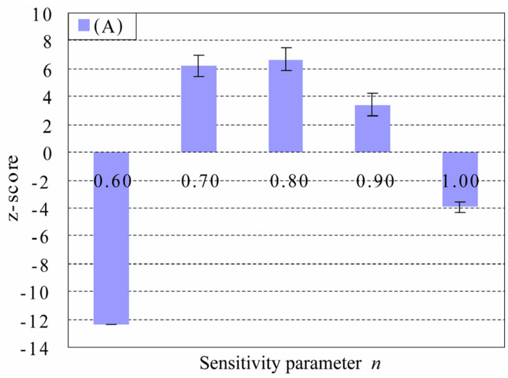
The evaluation result is summarized in Fig. 3. The vertical and horizontal axes of graphs show the Z-score and the sensitivity parameter *n*, respectively. Figure 4 shows a comparison between the dynamic range of the scene and the simultaneous dynamic range with the highest rating. According to Figs. 3 and 4, the rendered image with a higher simultaneous dynamic range was preferably observed under the ambient lighting condition (B) rather than in a dark room under the point-source lighting condition (A). These results suggest that the difference in surrounding brightness of the visual environment affects the appearance of the HDR scene in human vision. In addition, according to Ref. [4], the range of human vision is about 3.73 log cd/m^2. For an HDR scene within the range of human vision, a rendered image with a higher simultaneous dynamic range within this range is preferable. However, for an HDR scene with a dynamic range beyond that of human vision, a rendered image with the same simultaneous dynamic range as that of human vision is preferable.



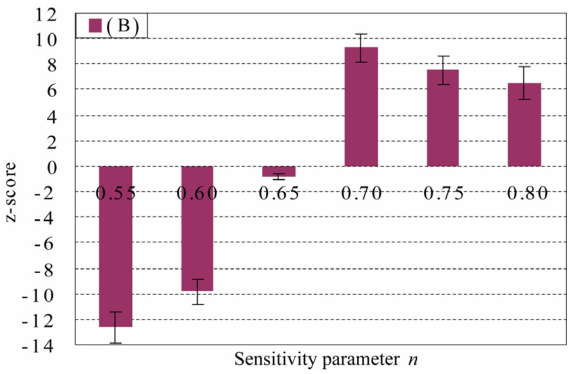
(a) Dynamic range of 1 log unit



(b) Dynamic range of 2 log units



(c) Dynamic range of 4 log units in (A)



(d) Dynamic range of 4 log units in (B)

Figure 3. The experimental results.

Poster paper

Table 1. Experimental conditions.

Dynamic range of the HDR scene	Lighting condition	Sensitivity parameter n	Simultaneous dynamic range for rendered images
$10^{1.00}$	(A)	0.75～0.95	$10^{2.74}$ ～ $10^{3.47}$
	(B)	0.75～0.95	$10^{2.74}$ ～ $10^{3.56}$
$10^{2.00}$	(A)	0.65～0.85	$10^{3.05}$ ～ $10^{4.00}$
	(B)	0.65～0.85	$10^{3.05}$ ～ $10^{4.00}$
$10^{4.00}$	(A)	0.60～1.00	$10^{2.61}$ ～ $10^{4.35}$
	(B)	0.55～0.80	$10^{3.27}$ ～ $10^{4.74}$

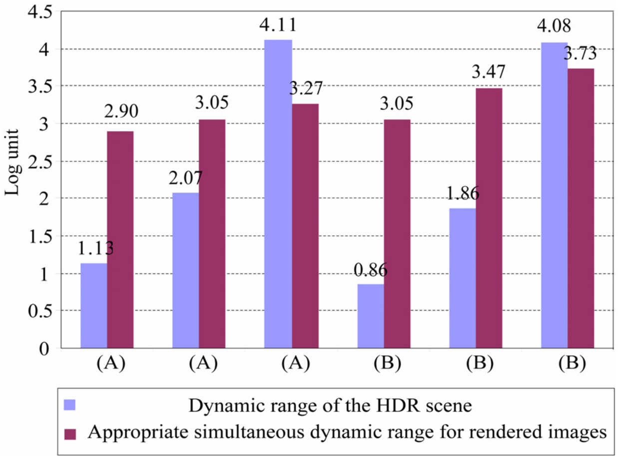


Figure 4. Appropriate simultaneous dynamic range for actual HDR scenes.

CONCLUSIONS

This study conducted subjective evaluations with HDR scenes to clarify the relationship between the dynamic range of the actual HDR scene and the simultaneous dynamic range for realistic HDR rendering. The experimental results determined the appropriate simultaneous dynamic range depending on the dynamic range of the actual HDR scene for image rendering.

ACKNOWLEDGEMENT

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THE IMPRESSION OF HUE IN PRACTICAL COLOR CO-ORDINATE SYSTEM(PCCS)

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Keywords: PCCS, Semantic Differential Method, Impression

ABSTRACT

The Practical Color Coordinate System (PCCS) was developed by the Japan Color Research Institute in 1964. The main feature of PCCS is its 'Hue–Tone system'. In PCCS, a color is represented by two attributes: hue and tone. As Wakata and Saito has reported in 2012 on PCCS tones, this study focuses of hues. Stimuli were 12 hues in PCCS. Each hue consisted of 11 tones. For each hue, the tones were pasted in a row on a neutral grey mount. A total of 129 subjects were asked to respond to the images of the stimuli. We used a 7-point semantic differential method (20 words) to record their responses. We have obtained four factors be the factor analysis. These results showed that the factor structure of hue was different from that of tone.

INTRODUCTION

Many colors exist in our life. When treat the color, we use any color system. Many color order systems were developed such as Munsell system, Ostwald system, and NSC. This study focuses on perceptions of hue in the Practical Color Coordinate System (PCCS).

PCCS was developed by the Japan Color Research Institute in 1964, based on psychological elements. The psychological intervals of individual attributions (hue, lightness, and saturation) are constant. The feature of the PCCS is "Hue–Tone system." Tone consists of lightness (value) and saturation (chroma). Color is usually represented by three attributes—hue, value, and chroma—but the PCCS can represent a color by two attributes, hue and tone, hence the name "hue–tone system." Each tone has an individual image, that is, "dark" tone colors (low lightness and middle saturation) have a heavy and dim image; "vivid" tone colors (middle lightness and high saturation) have a bright and clear image. These images are common even with different hues. Thus, the PCCS offers the advantage of treating the color as an image by using tone. We reported about tone in *conference of the color science association of Japan 2012* and *AIC 2012*. The PCCS has a hue-tone system. Tone refers to intensity of colors such as "pale red," "deep blue," or "soft purple." Hue refers to color quality, for example, the terms "reddish" and "bluish" refer to hues.

This study investigates the influence of color, parti cularly hues, in the PCCS gradation scheme.

Poster paper

METHOD

Stimuli

Hue circle of tones; eleven tones (vivid, bright, deep, light, soft, dull, dark, pale, light grayish, grayish, dark grayish) were used for tone stimuli. Tone stimuli (twelve hues; 1.5 cm × 1.5 cm) were pasted in a circle on a neutral gray mount (10 cm × 10.5 cm) (Figure1).

Gray scale; chromatic color stimuli (nine color chips; 1.5 cm × 0.7 cm) were pasted in a row on a neutral gray mount (10 cm × 10.5 cm) (Figure2).

Hue belt; typical twelve colors (2:R, 4:rO, 6:yO, 8:Y, 10:YG, 12:G, 14:BG, 16gB, 18B, 20:V, 22:P, 24:RP) were used as hue stimuli, and each stimul us (eleven tone color chips, 3 cm × 1.5 cm) was pasted in a row by gradation (order in which value and chroma change) on a neutral gray mount (5 cm × 21 cm) (Figure3).

Figure 1. Sample of hue circle of tones

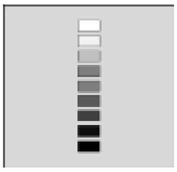

Figure 2. Sample of Gray scale

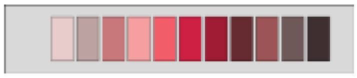

Figure 3. Sample of Hue belt

Procedure

In this experiment, the number of participants was 129(70 male and 59 female, average age 20.7 ± 1.4 years). The seven-point scale semantic differential method (SD method) was used with a questionnaire consisting of twenty pair words (warm–cool, sweet–not sweet, soft–hard, feminine–masculine, loosen–strained, cheerful–gloomy, bright–dark, dynamic–static, light–heavy, distinctly–blurred, dull–sharp, clear–muddy, gaudy–subdued, composured–fidgety, preferable–hateful, stable–unstable, beautiful–ugly, plain–rich, modern–classic, and loud–quiet).

Subjects were divided in five groups. Each group was presented with a different order of colors and a different order of the twenty pair words. The subjects looked at each color and answered the questionnaire.

RESULT and DISCUSSION

Note: This paper reports only data on hues. The related data on tones are reported in *conference of the color science association of Japan 2012* and *AIC 2012*.

Factor Analysis

The SD results were evaluated by factor analysis. The result of the factor analysis (maximum likelihood method, promax rotation) revealed four significant factors (Table1). The first factor seemed to combine Osgood's notions of a ctivity and potency. The second factor consisted of concepts "loose–strained," "distinct–blurred," "dull–sharp," "clear–m uddy," and "gaudy–sub dued." It seemed to be Osgood's potency, but the words that constituted the potency were divided into first factor, “bright-dark” etc. Oyama (2001) proposed that Osgood’s potency was split into sharpness and lightness. The second factor was trig gered by perceptions of sharpness and lightness, which served as stimuli for judging color gradations. The term “distinct–blurred,” for instance, was related to color shade specifically. The third factor w as similar to Osgood’s notion of evaluation. The fourth factor consisted of the concepts “light–heavy” and “plain–rich.” This factor reflected the “mood” or “atmosphere” of colors. It is thought that this factor had the same triggers as the second factor.

Table 1. Pattern matrix(Factor analysis)

			FACTOR			
			1	2	3	4
warm	–	cool	.810	-.345	-.023	-.036
sweet	–	not sweet	.721	-.124	.186	-.164
feminine	–	masculine	-.675	.086	-.115	.210
dynamic	–	static	.604	.183	-.255	-.131
cheerful	–	gloomy	.594	.234	.024	.137
bright	–	dark	.575	.196	-.002	.243
soft	–	hard	.567	-.370	.100	.148
loud	–	quiet	.499	.214	-.399	-.129
sharp	–	dull	-.150	.667	-.013	.062
distinctly	–	blurred	-.121	.664	.083	.002
clear	–	muddy	-.070	.530	.296	.272
gaudy	–	subdued	.399	.517	-.016	-.012
loosen	–	strained	.478	-.513	.145	.157
preferable	–	hateful	.181	.169	.748	-.131
beautiful	–	ugly	.172	.368	.745	-.137
composured	–	fidgety	-.144	-.192	.572	.067
stable	–	unstable	.045	-.063	.467	-.079
light	–	heavy	.261	.125	-.147	.580
plain	–	ric	-.236	.031	-.120	.552

The fourth factor was not relevant for the unicolored experiment because “mood” or “atmosphere” is caused by interaction with color factors. For example, in an everyday scene, impressions of fashion were based on colors of jackets, shirts and pants, or skirts; impressions of interiors were based on cushions, sofa s, and carpets. These interacted with each other to form the overall impression of the scene. (Of course, shape and materials of these items is important, but we referred to only color in this study.) Items of fashion and interior can unify and combine hue as well as the tone, for example, “reddish colors” or “bluish colors.” Thus, the cause by which the fourth factor was observed is based on such a color scheme. This was also applied to the second factor.

Factor Score

The average value of the factor score for each stimulus was calculated and plotted on the scatter plots (Figure4, 5). First factor: This factor expressed “activity” and “potency.” Red (2:R) and red–purple (24:RP) showed high values, and green (12:G) and purple (22:P) showed values near 0.0, and blue (18:B) and violet (20:V) showed low values. A previous study showed that red scores high and blue scores low for “activity” (Osgood et al.; 1957). Second factor: This factor expressed “intensity” or “clarity.” Variations in scores were narrow. The highest value was 0.414 in 2:R, and lowest value was −0.407 in 10:YG. Hue did not play a role in this factor. Third factor: This factor expressed “evaluation.” The variations in scores were narrow here as well. However, the feature of hue affects values: Cool colors showed high values, while warm colors showed low ones. The highest value was 18:B, and the lowest value was 8:Y. PCCS employs the psychological four primary colors consisting of red (2:R), yellow (8:Y), green (12:G), and blue (18:B). In addition, yellow and blue are paired in Herring’s Opponent process. Thus, it is possible that combinations that are potentially paired are relevant. From another viewpoint, previous studies showed that blue tends to be favored. These results are also applicable to this study.Fourth factor: This factor expressed “mood” or “atmosphere.” The tendency through which the value of each color circulates

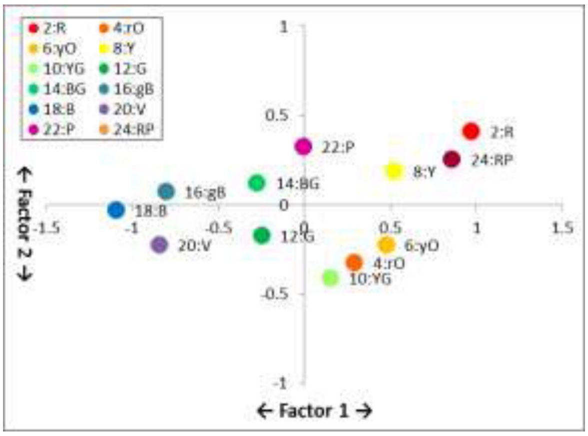

Figure 4.Image map of factor score(Factor1×Factor2)

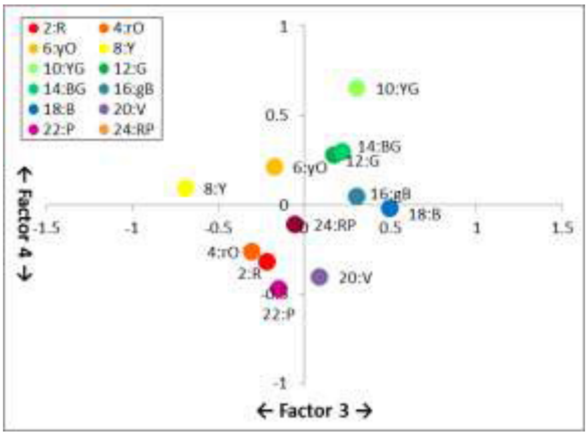

Figure 5.Image map of factor score(Factor3×Factor4)

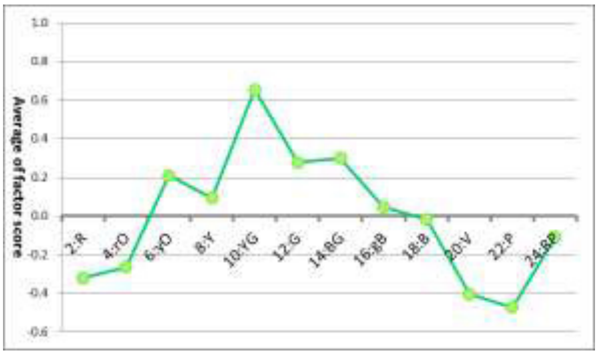

Figure 6. Image profile of factor score: Factor4

was observed by making 10:YG into the peak; 22:P showed the lowest value. 10:YG and 22:P represent a complementary color relationship in PCCS hue circle(Figure6).

CONCLUSION

The result of factor analysis suggested that the impression of hue was based on four factors. The influence of hue's gradation scheme was observed in the second and fourth factors. The influence of a color was not observed in the scores of the second factor because of individual differences in capturing stimuli. In the fourth factor, it was characteristic that change of the impression that met the hue circle by making 10:YG into the peak was observed.

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Poster paper PA16

STUDY ON COLOR EVOLUTION AND DEVELOPMENT OF URBAN – EXAMPLE OF URBAN COLOR PLANNING IN HANGZHOU

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Keywords: Urban color, color evolution, color development, Dominant hue

With high speed development and globalization in Chinese cities, the characteristics of each city are disappearing; faceless scene is becoming the crisis of Chinese city features. To be an indispensable element to create a city, urban architectural color chaos and characteristics loosing are important parts of this “crisis”. However, Many color planning, however, is emphasis in old town, and lack of horizontal comparison analysis and quantitative analysis in city color between old town and new town. This study selected 5 major cultural districts of Chinese historic city—Hangzhou, measured the color of buildings that status in different ages' typical in each district and carried out questionnaire of citizens' urban color consciousness, then, quantitative comparison between color in old town and new town in Hangzhou. According to the result, it will discuss the problem of color continuing and loose in development of both old town and new town and try to find out the general laws of urban color development, offer theoretical support to Hangzhou urban color planning.

Poster paper PA17

IMPRESSION OF THE SPACE UNDER THE FLAT TYPE LIGHTING –COMPARISON BETWEEN OLED AND LED-

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Keywords: OLED, spatial impression, semantic differential scale method, factor analysis

ABSTRACT

Organic electroluminescent lighting (OLED) is expected to become one of the next generation lighting devices. In this research, we investigated the impression of a space illuminated by either flat-type LED lighting panels or OLED panels by changing the area of the illumination. The experiment was conducted with a small box in which miniature furniture was placed. Subjects rated the impression of the room for 20 adjective items in five steps while observing the model of the living room. From the results of the rated values, we found that the space illuminated by the surface-emitting type illumination will increase the impression of “brightness” and “uniformity” as the area of illumination increases. Moreover, OLED lighting was found superior in many items, such as "warm" and "soft". From the results of factor analysis, several factors were extracted, such as “amenity”, “activeness”, and “personality”.

INTRODUCTION

In recent years, Organic Electro-Luminescence (OLED) lighting has been attracting attention as a next-generation illuminant. This type of lighting has several important features including a wide range of illumination, thickness, and flexibility. The researches dealing with OLED in practical use, however, have just started and it is essential to explore various aspects of OLEDs before it enters the market. One of the biggest differences between OLED and other lighting devices is that OLED is a surface-emitting light source. When installed as a ceiling light, it is possible to place many OLED panels right next to each other to occupy a large area of a ceiling. Compared with conventional point or line light sources such as incandescent and fluorescent lamps, the setting of area light sources can cast shadows of the objects in a completely different way. As a result, OLED may mediate a different impression of the space. The purpose of this research is to find the effects of the relative ratio of the light source to the ceiling on the impression of the space under its illumination. Moreover, a flat-panel type LED lighting panel, which looks similar to an OLED panel, has recently entered the market. In order to find the differences in LED and OLED under a similar way of lighting, we repeated the same experiments for both light sources to find any potential effects of the light source on the impression of a space.

EXPERIMENT

The experiment was conducted with two small boxes, whose size was 300mm × 310mm × 110mm. One was illuminated with OLEDs while the other with flat-panel type LEDs which had the same chromaticities. In order to mimic a living room, we set several pieces of miniature model furniture inside them: a dining set composed of a table and chairs were placed in the center, a TV was placed to the left, and a sofa was placed to the right. Two different combinations of the panels (OLED manufactured by Lumiotec and a prototype custom-made RGBLED, and LED manufactured by Epoch and RGBOLED manufactured by Pioneer) were installed as a light source at the top of each booth. Chromaticities of the panels are shown in Figure 1. In all rooms, the area of the light was limited either by the number of panels or by a slit. The size of the slit was 40mm × 220mm, which allowed approximately 10% of the ceiling to be occupied. The experiment was also performed without a slit, where the room was illuminated with two panels (50%) or four panels (100%). Schematic locations of the light sources and the views of the room are shown in Figure 2. The illuminance of the center of the box was 480lx for all the slit conditions. The subjects were asked to evaluate the impression of the room for 20 Japanese adjectives, which are shown in Table 1, with a scale of 1 to 5 depending on their impression [1]. Subjects observed the room inside the box for 3 minutes to adapt to its illumination before starting a session. 9 subjects (6 male subjects and 3 female subjects) served in this experiment. 5 of them tested under all conditions, while the remaining 4 tested under only the 100% condition. All of the subjects were tested for either 2 or 3 sessions for each experimental condition.

Table 1: 20 adjectives

calm	cheerful	gentle
relaxing	bright	unique
natural	lively	spacious
warm	large	vivid
relief	interesting	showy
soft	uniform	dazzling
tasteful	premium	

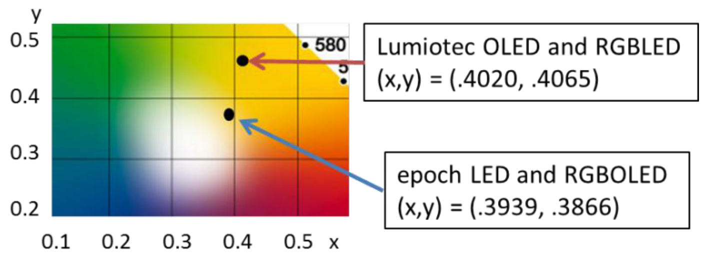

Figure 1. Chromaticities of each lighting source

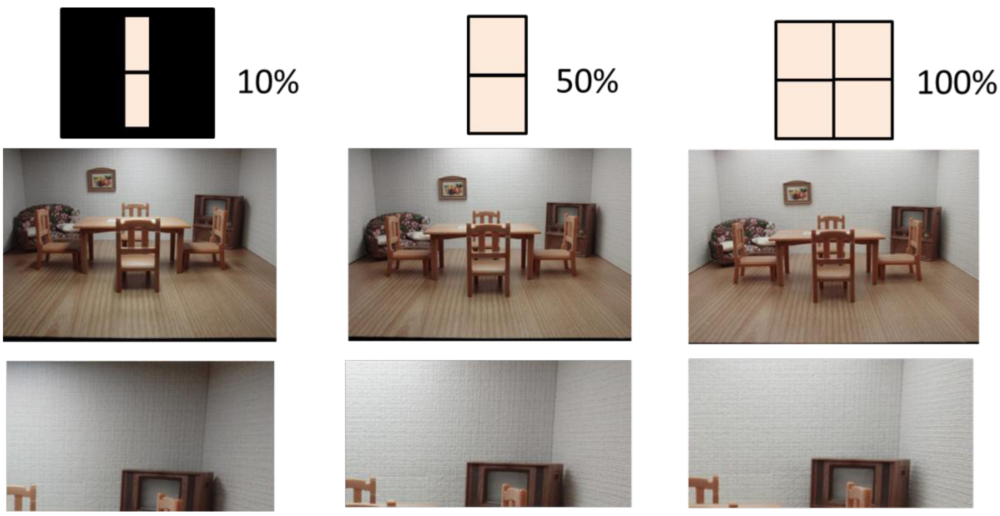

Figure 2. Light emission areas (10%, 50%, 100%)

Poster paper

RESULT & DISCUSSION

Figure 3 shows some typical results which showed significant differences between OLED and LED lights. Items whose evaluation values obtained with OLED were higher than those with RGBLED were: "warm", "soft" and "tasteful". Items whose evaluation value obtained with RGBLED were higher than those with OLED were: "lively", "bright" and "cheerful". Items whose evaluation value obtained with RGBOLED were higher than those with LED was "tasteful", "premium" and "vivid". None of the items whose evaluation value obtained with LED were higher than those with RGBOLED.

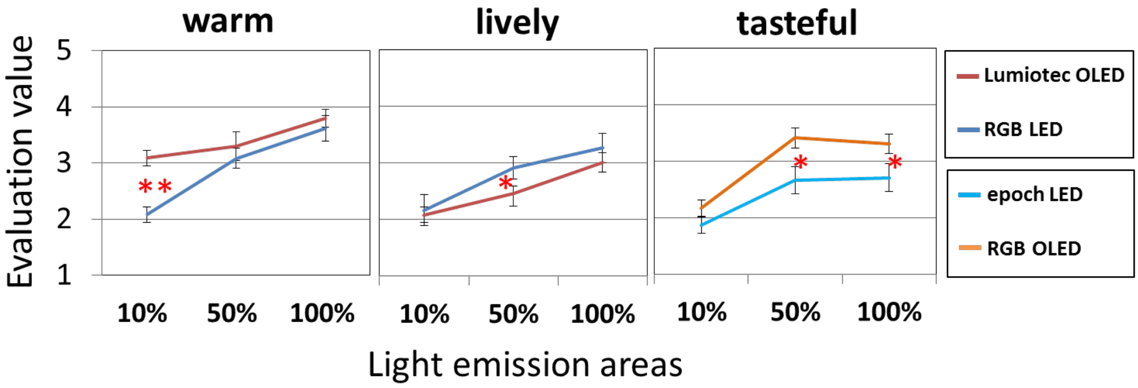

Figure 3. Evaluation items with different evaluation values between OLED and LED

In order to find if there is a correlation between the evaluation score and the light emission areas, linear fittings were conducted to all the estimated values. We averaged the evaluation values across all 9 subjects. The slopes of the fitted line and the R^2 were calculated. Figure 4 shows some typical examples which showed a good correlation between the evaluation value and the width of the slit. The items whose evaluation value increased with the width of the slit were "bright" and "uniform". In all light sources, their slope is greater than 0.7 with R^2 greater than 0.8, which means they can be well-fitted with a linear fitting. Items that showed no correlation with the width of the slit, with a slope of around 0, were "personalized", "interesting" and "calm".

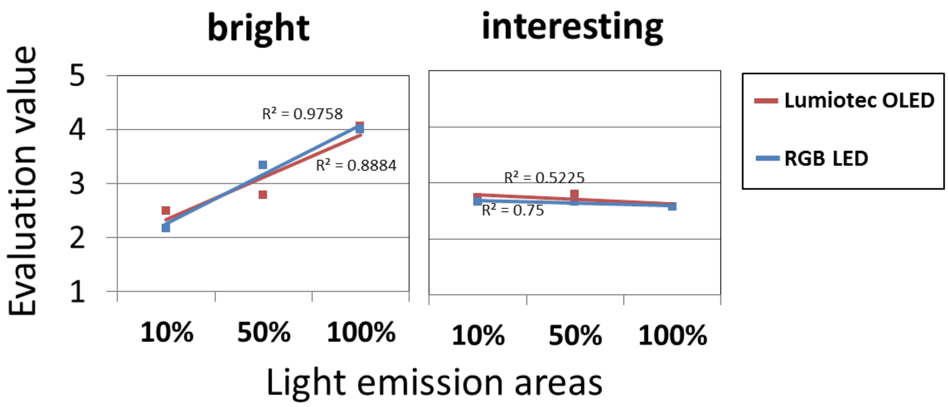

Figure 4. Evaluation values as functions of light emission areas

Factor analysis was performed using the factor extraction method of maximum-likelihood estimation. Factors for three high ranks were adopted. The rotation of factor axes using the Varimax method made it easier to extract factors. The cumulative contribution ratio of the first and second factors is 45.3%. We named the first factor as "**activeness**", derived from the amount of the factor loadings such as "lively" and "bright". The second factor was named as "**amenity**", derived from the factor loadings such as "warm", "gentle" and "relax". The third was named as "**personality**". Naming of these factors was derived from studies of a number of semantic differential scale methods. We derived a factor score by multiplying the evaluated values. We used this value to clarify the relationship of each factor and light emission areas, illustrated in Figure 5. The first factor (activeness) increases as the light emission area increases and is closely related to the lighted area of the ceiling. It is interesting that the values obtained from LED are higher than those of OLED for several emission area conditions. We need to clarify why this is the case, but it seems that the light from the LEDs gives the subjects a greater impression of "bright" and "lively", which is the opposite of the impression of OLEDs. The second factor (amenity) obtained from OLEDs is higher than that of LEDs for all emission area conditions. We think that these factors can be mediated from the characteristics of OLEDs themselves (its mild impression and lack of short wavelength).

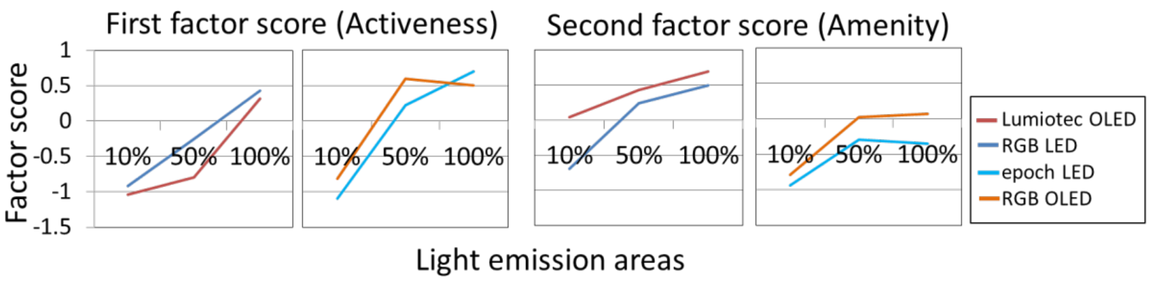

Figure 5. Factor scores

CONCLUSION

We have conducted an experiment to evaluate the impression of space illuminated by OLED lighting and by flat type LED lighting. From the results of the evaluation, we found that the impression of brightness and uniformity increased with the area of the illumination on the ceiling. Moreover, OLED lighting was observed to be superior in many impression items, such as "warm" and "gentle". From the results of factor analysis, we extracted three factors of "amenity", "activeness" and "personality". The amenity factor measured from OLEDs is higher than that of LED for all emission area conditions.

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COMPARISON OF PERCEIVED SATURATION DIFFERENCE BETWEEN COLOR ANOMALOUS AND NORMAL OBSERVERS

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Keywords: saturation perception, brightness perception, color anomalous, staircase method, psychophysical

ABSTRACT

In order to obtain the proper degree of color enhancement for anomalous color vision, difference of perceived saturation between two chromatic stimuli was measured. Before the saturation experiment, brightness matching was done using the test stimuli. Saturation differences are evaluated using a brightness difference for red, yellow, green, and blue stimulus sequences. Results of one weak deuteranomalous observer showed that perceived difference of saturation of the red and green stimulus pairs is smaller than those of normal observers, while no significant difference was obtained for yellow and blue stimulus pairs.

1. INTRODUCTION

In Japan, about 5 % of male is X chromosome-linked congenital color deficiencies, and the number of people becomes larger than 3 million which is non-negligible. Along the stream of color universal design, we introduced a way to enhance color of digital image for color anomalies using a criterion of preference, and examined whether color enhanced images are more preferable than the original ones for 9 protan and deutan observers [1]. Results showed that the enhancement we employed was effective for images that include reddish parts such as cherry fruits or pinkish parts such as flowers. In the way of color enhancement employed in our study, chromaticities of each pixel are extended along the protan or deutan confusion lines, or the lines in between. Although it is not a simple saturation enhancement, our method brought saturation enhancement of original image as a result. It was also indicated that the degree of enhancement where preference evaluation becomes maximum varies with image as well as individuals. However, appropriate degree of color enhancement was not examined precisely, because it is based on saturation perception of individual observers and the measurement is too elaborative and time consuming.

Nowadays genetic base of anomalous color vision has been revealed [2], and various models and simulators have been proposed [3-5]. On the other hand, it has been widely known that there exist large individual differences in the degree of anomalous trichromats from close to normal to nearly dichromats [6]. From practical point of view, to obtain the data of perceived saturation for individual observer is rather important than his/her genetic basis, to provide appropriate color enhancement for the observer. Therefore in this study, we measure the saturation perception of congenital color anomalous observer and normal observers. Saturation differences are evaluated using a lightness difference scale for red, yellow, green, and blue stimulus sequences.

2. EXPERIMENT

2.1 Apparatus

Sizes of the experimental booth were 180 cm (d) × 120 cm (w) × 210 cm (h). Viewing distance of the display and observers was horizontally 120cm. The display used in this study was a SAMSUNG SyncMaster XL24.

2.2 Brightness matching experiment

In order to compare the perceived saturation between anomalous and normal observers, perceived saturation difference between a pair of stimuli that has different purities but the same hue was assessed by the brightness difference between a pair of achromatic stimuli. In such experiment, brightness of the two stimuli should be equal because saturation difference is the amount to be extracted. As widely known [7], there exist large individual differences in the brightness sensitivity to chromatic stimuli, brightness matching experiment was carried out before the saturation evaluation to obtain equal brightness settings for each observer.

Figure 1 shows the chromaticities of test stimuli plotted on the a*b* chromaticity diagram. Values were calculated from the display calibration data, sRGB conversion to XYZ, and the transform to L*a*b* assuming the maximum white as a reference white. For the blue stimuli, one achromatic and two chromatic stimuli were prepared denoted as B0, B1, and B2, respectively. For red, yellow, and green, one achromatic and three chromatic stimuli were prepared, denoted as R0 to R3, Y0 to Y3, and G0 to G3, respectively. Luminance of R0, Y0, G0, and B0 were 100.9, 90.5, 118.2 and 18.1 cd/m^2, respectively. Brightness of the stimuli with the same hue, e.g., R1, R2, and R3, was matched to the brightness of the corresponding gray, e.g., R0. In order to do that, serious of stimuli with nearly constant metric chroma were prepared which was called xx-LUT, e.g., R1-LUT etc. Figure 2 shows the chromaticities of R1-, R2-, and R3-LUT plotted on the a* vs L* plane.

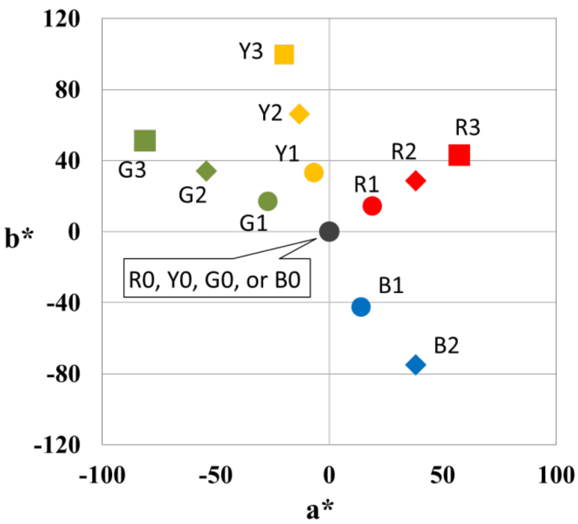

Figure 1. Stimuli plotted on a*b* plane

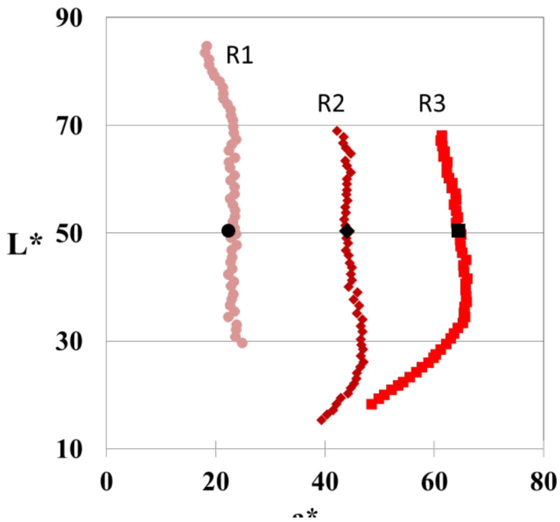

Figure 2. R1-, R2-, and R3-LUT plotted on a*L*plane

In the brightness matching experiment, achromatic and chromatic stimuli were presented as juxtaposed square stimuli. Size of one square subtends 3.198 degree in visual angle. Luminance of the former was fixed and it was regarded as the reference. Brightness matching was carried out using double stair case method. Luminance of the chromatic stimulus was varied along the corresponding LUT. At least 3 sessions were conducted for each of 11 chromatic stimuli, and the average value was employed as the matching point. As expected, large individual differences were observed in the brightness matching results for all stimuli.

2.3 Saturation difference experiment

Figure 3 shows the configuration of the saturation difference experiment. A pair of chromatic stimuli with equal brightness was presented on the left-hand side, and a pair of achromatic stimuli was presented on the right-hand side. Size of one square subtends 3.198 degree in visual angle. One of the achromatic pair was fixed in luminance as the reference, and luminance of the other was varied. At the beginning of the session, luminance of the variable was set either definitely brighter or darker than the reference. Observer was instructed to response difference of which pair is larger than the other. Double stair case method was employed to reach the criterion.

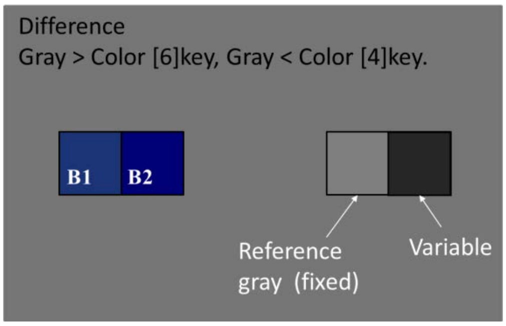

Figure 3. Configuration of the saturation difference experiment

2.4 Observers

Eight observers with normal color vision and one observer who was diagnosed as congenital deuteranomalous participated the experiment. All observers were examined for their color vision using Ishihara charts, panel D-15, and anomaloscope.

3. RESULTS AND DISCUSSION

Figure 4 shows the results of the saturation difference experiment. Horizontal axis indicates the pair of stimuli, and the vertical axis indicates the calculated lightness difference (ΔL^*) of the achromatic pair at the matching point. Vertical bars with the normal observers indicate the standard deviation among 8 normals. Numerals indicates the ratio of ΔL^* between Deuteranomalous and the average of normal observers. As shown in the figure, ΔL^*s of the Deuternomalous are smaller than those of normals for red and green pairs, while ΔL^*s for yellow and blue pairs are close to or even larger than those of normal except the case of B1 vs B2. Reason of large difference found in this pair is not known at the present.

In this paper, only one deuteranomalous observer could participate the experiment. Because his deficiency is rather weak, he seems to perceive red and green to some extent. Further experiment is expected to gather data from anomalous observers to obtain appropriate degree of color enhancement in various applications to aid color vision deficiency.

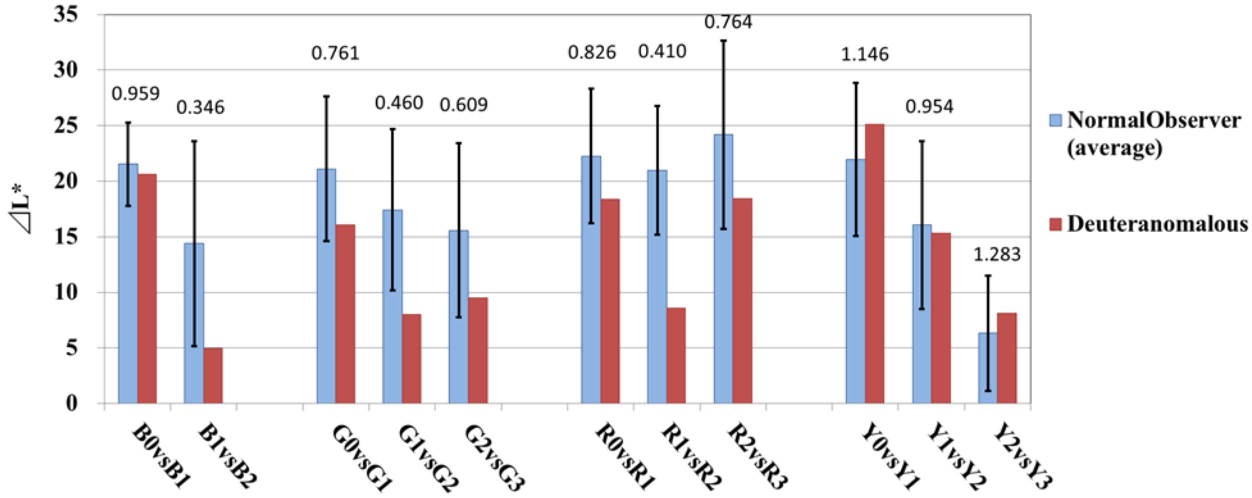

Figure 4. Results of the saturation difference experiment

ACKNOWLEDGMENT

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Poster paper PA22

ACCURACY OF COLOR MEASUREMENT BY USING DIGITAL CAMERAS AND THE STANDARD COLOR CHART

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Keywords: Colorimetry, Measurement Accuracy, Calibration, Digital Camera

ABSTRACT

We examined five different digital cameras and evaluated their accuracies of color measurement. Commercially available digital cameras are not intended for use in color measurement. Thus, users have to calibrate the camera system by themselves for the purpose. We adopted the image correction method, in which, samples are photographed with some standard color charts side by side in one photo and the photographed images are color-corrected using the colorimetric data of the color charts. This method has an advantage that the measurement accuracy does not depend on the camera used; Users can freely replace the cameras. Using the X-rite ColorChecker 24-color chart as standard colors, we examined how the accuracy of color measurement depends on the camera used. As a result, we showed that the expected accuracy is less than 5 in the CIE L*a*b* color difference unit within the color gamut of the standard colors, irrespective of the camera.

INTRODUCTION

Recently, commercially available digital cameras are widely used to measure a color [1,2]. They are high resolution, easy to use and not expensive. However, they are not intended for use in color measurement. Therefore, for the accurate color measurement, users, not manufacturers, have to calibrate the camera system. Calibration methods fall roughly into two categories, "the camera calibration method" and "the image correction method." The camera calibration method is to measure the camera's spectral response functions beforehand, and using these response functions, photographed images with the camera's inherent color space are converted to colorimetric images [1]. The image correction method is to photograph a sample and some standard color charts side by side in one photo, and the photographed image is color-corrected using the colorimetric data of the standard color charts as references [2].

The camera calibration method has the same advantage that the usual measuring instruments have. Once the response functions are obtained for a camera in hand, there is no need to repeat the calibration process (i.e., measuring response functions). However, it has some disadvantages. The measurement accuracy depends on the camera system and the repeat accuracy is difficult to evaluate. They are usually certified by manufacturers for measuring instruments, but it is not the case for digital cameras.

On the other hand, the image correction method requires users to take a photo with the well-calibrated color charts each time. However, owing to this extra work, a photographed image itself has colorimetric data in it. Users can freely replace the cameras; Theoretically, the measurement accuracy does not depend on the camera used. This is a great advantage of the method.

In this study, we focus our attention on the image correction method and examine how the accuracy of color measurement depends on the cameras used. We applied the same image correction method to the photos taken by five different cameras and compared their accuracies of color measurement.

Poster paper

METHOD

The digital cameras compared in the experiment are listed in Table 1. All cameras were used in RAW mode and the RAW format files were converted to the uncompressed 24-bit TIFF format with 8-bit per channel sRGB color space using the computer programs provided by the camera makers. The sRGB color space was defined by the International Electrotechnical Commission (IEC) [3]; Its color gamut is narrow and it covers only a central part of the whole color space as discussed later. However, we adopted the sRGB because it is one of the most common color spaces in the imaging products and almost all digital cameras on the market have the sRGB color space mode.

As a standard color chart, the X-rite ColorChecker 24-color "Passport" version was used. This product is a *de facto* standard in the imaging society and the sRGB values of 24 constituent colors are provided by the X-rite; the colorimetric data are shown in Table 2.

Table 1: Specifications of Digital Cameras Used in the Experiment

No.	Name	Maker and model	Lens	Image sensor	Image size (pixels)
1	EOS	Cannon EOS kiss Digital N	EF-S 18-55 mm F3.5-5.6	8 megapixel CMOS 22.2×14.8 mm	3456 × 2304
2	LUMIX	Panasonic LUMIX DMC-G1	G Vario 14-45 mm F3.5-5.6	12 megapixel live MOS 17.3×13 mm	4000 × 3000
3	D50	Nikon D50	DX 18-55 mm F3.5-5.6 GII	6 megapixel CCD 23.7×15.6 mm	3008 × 2000
4	D5100-1	Nikon D5100	(same as above)	16 megapixel CMOS 23.6×15.6 mm	4928 × 3264
5	D5100-2	Nikon D5100	(same as above)	(same as above)	4928 × 3264

Table 2: Colorimetric Data of X-rite ColorChecker 24 Colors

ColorChecker		Munsell (standard)		sRGB (standard)			L*a*b* (D65, standard)		
No.	color name	H	V / C	R_{std}	G_{std}	B_{std}	L*	a*	b*
1	dark skin	3 YR	3.7 / 3.2	115	82	68	38.0	11.8	13.7
2	light skin	2.2 YR	6.47 / 4.1	194	150	130	65.7	13.7	16.9
3	blue sky	4.3 PB	4.95 / 5.5	98	122	157	50.6	0.4	-21.6
4	foliage	6.7 GY	4.2 / 4.1	87	108	67	43.0	-15.9	20.4
5	blue flower	9.7 PB	5.47 / 6.7	133	128	177	55.7	12.8	-25.2
6	bluish green	2.5 BG	7 / 6	103	189	170	71.0	-30.6	1.5
7	orange	5 YR	6 / 11	214	126	44	61.1	28.1	56.1
8	purplish blue	7.5 PB	4 / 10.7	80	91	166	41.1	17.4	-41.9
9	moderate red	2.5 R	5 / 10	193	90	99	51.3	42.1	14.9
10	purple	5 P	3 / 7	94	60	108	31.1	24.4	-22.1
11	yellow green	5 GY	7.1 / 9.1	157	188	64	71.9	-28.1	57.0
12	orange yellow	10 YR	7 / 10.5	224	163	46	71.0	12.6	64.9
13	blue	7.5 PB	2.9 / 12.7	56	61	150	30.4	26.4	-49.7
14	green	0.25 G	5.4 / 8.65	70	148	73	55.0	-40.1	32.3
15	red	5 R	4 / 12	175	54	60	41.3	49.3	24.7
16	yellow	5 Y	8 / 11.1	231	199	31	80.7	-3.7	77.5
17	magenta	2.5 RP	5 / 12	187	86	149	51.1	48.2	-15.3
18	cyan	5 B	5 / 8	8	133	161	51.2	-19.7	-23.4
19	white	N	9.5	243	243	242	95.8	-0.2	0.5
20	neutral 8	N	8	200	200	200	80.6	0.0	0.0
21	neutral 6.5	N	6.5	160	160	160	65.9	0.0	0.0
22	neutral 5	N	5	122	122	121	51.2	-0.2	0.5
23	neutral 3.5	N	3.5	85	85	85	36.1	0.0	0.0
24	black	N	2	52	52	52	21.7	0.0	0.0

The procedures of the image correction method applied for each camera are as follows:

Step 1) Take photos of an A4 (size: 210 x 297 mm) white matt sheet under the uniform illumination of D65 fluorescent lamps in a spherical dome with a diameter of 600 mm, and calculate the shading correction coefficient for each pixel of photos.
Step 2) Take photos of a sample with the ColorChecker 24-color chart (size: 60 x 90 mm) under the same illumination condition of Step 1. As a sample, another ColorChecker chart was used.
Step 3) Perform the shading corrections for photos of Step 2 using the coefficients derived at Step 1.
Step 4) Calculate the color correction values, which convert the camera's inherent RGB values of 24 colors of the standard chart in the photos of Step 3 to the standard sRGB values in the Table 2.
Step 5) Apply the color correction values derive at Step 4 to all pixels of photos of Step 3.

At Step 5, the color corrected image files in the sRGB space are obtained. Conversion equations between sRGB and the tristimulus values are defined in Ref.[3]. Then, the color data can be converted to any color space attributes. We converted the sample data to the CIE 1976 L*a*b* color space for discussion.

RESULTS AND DISCUSSIONS

The results of measurement accuracies of the five cameras are shown in Table 3. In the Table, the color differences between the measured values of the sample chart and the standard values (Table 2) are shown in the L*a*b* unit. All data are the average values of three trials.

Table 3: Measurement Accuracies of the Image Correction Method in the ΔE^*_{ab} Unit

Camera name	EOS			LUMIX	D50	D5100-1	D5100-2
Correction method	No corr.	Shading Corr.	Color Corr.	Color Corr.	Color Corr.	Color Corr.	Color Corr.
1 dark skin	10.7	9.9	1.2	0.8	2.2	3.6	1.9
2 light skin	6.1	5.5	0.4	0.3	1.4	1.3	0.9
3 blue sky	5.4	5.7	0.5	0.5	1.4	1.3	1.2
4 foliage	10.3	9.8	2.5	1.3	0.9	1.6	3.1
5 blue flower	2.4	2.8	1.4	0.9	1.2	0.8	0.8
6 bluish green	6.2	6.8	1.5	0.7	2.3	0.4	0.9
7 orange	11.8	13.1	2.1	1.5	2.5	1.6	2.4
8 purplish blue	13.1	15.4	2.3	0.8	1.8	1.4	1.6
9 moderate red	9.5	10.9	1.6	1.3	0.7	2.0	0.6
10 purple	10.0	9.8	2.2	4.2	0.8	1.2	1.1
11 yellow green	3.2	0.3	1.5	2.1	0.5	0.7	0.3
12 orange yellow	5.7	6.1	2.7	2.0	2.0	2.8	2.2
13 blue	11.1	13.6	1.7	1.5	0.8	3.3	1.1
14 green	9.2	11.1	2.2	1.8	1.3	1.5	1.1
15 red	9.7	11.3	1.5	3.2	1.3	1.4	1.4
16 yellow	6.6	3.5	1.9	1.5	0.6	0.3	0.5
17 magenta	4.6	6.4	1.5	1.4	0.9	0.9	0.4
18 cyan	6.6	8.8	2.3	0.6	0.4	1.3	0.8
19 white	6.7	3.3	0.2	0.1	0.3	0.3	0.3
20 neutral 8	2.3	2.3	0.9	0.4	0.3	0.3	0.4
21 neutral 6.5	2.6	3.7	1.1	0.8	0.3	0.4	0.7
22 neutral 5	5.7	4.1	0.5	0.8	1.2	0.5	0.9
23 neutral 3.5	10.2	9.3	0.9	1.1	1.0	1.7	0.9
24 black	12.6	12.1	0.8	1.0	2.0	3.3	2.4
Maximum $\Delta E^*_{ab,max}$	13.1	15.4	2.7	4.2	2.5	3.6	3.1
Minimum $\Delta E^*_{ab,min}$	2.3	0.3	0.2	0.1	0.3	0.3	0.3
Average $\Delta E^*_{ab,ave}$	7.6	7.7	1.5	1.3	1.2	1.4	1.2

For the camera 1 (EOS), the results of each step are shown from the 2nd to the 4th column. When no corrections were applied (Step 2), the color differences (2nd column) were rather high and more than 10 for eight colors. Applying shading corrections (Step 3) showed no improvement (3rd) because these corrections only resolve the shading problem. Color corrections (Step 5) produced much improvement in the measurement accuracy (4th) and the maximum color difference was 2.7. For other cameras, the maximum color differences were 4.2, 2.5, 3.6, and 3.1. These results suggest that the measurement accuracy of less than 5 in the L*a*b* color difference unit is expected for the image correction method irrespective of camera used.

Finally, measurement range of digital cameras is summarized. In this experiment, we adopted sRGB color space as shown in Figure 1. The measurement range is limited within the sRGB color gamut. Moreover, we used the ColorChecker chart for the color correction standard. Thus, high measurement accuracy is expected within the ColorChecker color gamut (i.e., interpolation condition), but the accuracy would get worse outside the ColorChecker color gamut (i.e., extrapolation condition).

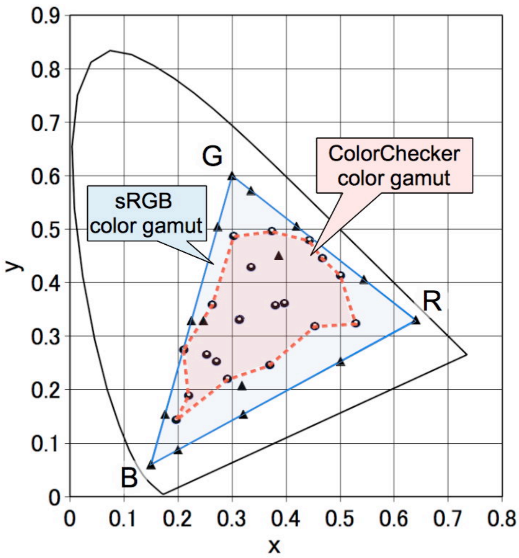

Figure 1. sRGB and ColorChecker Color Gamuts in the CIE 1931 xy Chromaticity Diagram

CONCLUTIONS

We measured colors by using five different digital cameras and showed that the measurement accuracy of the image correction method does not depend on the camera used. The expected accuracy is less than 5 in the L*a*b* color difference unit within the color gamut of the reference colors.

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CHARACTERIZATION OF BAKED COLOR OF COOKIE, TOAST AND CHICKEN: A MODEL OF LIGHT-COLORED FOOD

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Keywords: Steam oven, Food processing, Baking, Modeling, Formulation

ABSTRACT

Producing delicious-looking food is one of the features required of cooking equipment. For optimizing the technical advantages of oven cooking, color changes of light-colored food during oven cooking were characterized based on time-series colorimetric data. Three types of food materials were used as samples: toast (sliced white bread), plain cookie, and raw chicken meat pate. The colorimetric data were measured in situ using an optical fiber and a spectrometer under various conditions, with two types of steam ovens. Prediction expressions for the chroma and lightness (quantitative attributes) history of the food surface during oven baking were developed. The profiles of changes in the chroma and lightness for each material and under each set of heating conditions were investigated using the measured data and calculated values. The profiles, prediction method, and "browning index" defined in this study can be applied for optimizing automatic oven operation using the preferences index.

INTRODUCTION

In recent years, steam ovens and superheated steam ovens, in which steam is supplied to the oven chamber, are being increasingly used in the industry as well as domestic households. Heating in such an oven sometimes causes changes in the surface color of foods that is drastically different from that of foods processed in a traditional oven without supplying steam. Therefore, steam ovens must be typically operated by a human based on experience and visual confirmation of the texture of the food, while one would expect to obtain delicious-looking food using cooking equipment with automatic control.

As the first step toward the development of an automatic regulation system, an in situ (real-time) method for color measurement during high-temperature baking has been developed [1][2]. We have developed a browning scale for baked foods (plain cookies and sliced bread) based on color measurement data [3] and investigated the preference of baked food color by a method based on sensory evaluation [4]. In this research, we define a new expression for predicting the histories of the chroma and lightness of the food surface during oven baking. Three light-colored foods, plain cookies, sliced white bread, and raw chicken, are used as the model materials. The characteristic values in the expressions for each material and each set of heating conditions have been estimated from the measured colorimetric data. In addition, the optimal color of the baked food and a method to judge the optimal conditions for automatic oven operation are discussed.

METHODS

Two types of ovens are used in this research: Oven 1, a steam oven designed for domestic use (Panasonic Corporation, Model NE-V300, 1.43 kW electricity, 30 L); Oven 2, a steam convection oven designed for commercial use (Tanico Corporation, Model TSCO-4GBN2, 12.2 kW city gas, 78 L). Sliced white bread and raw chicken meat pate are used as food materials. The color changes on the food surface during oven heating were measured in situ by an optical fiber and a spectrometer coupled to the oven. Tristimulus values X, Y, and Z were calculated from the measured spectral data every 10 s and then converted to CIE 1976 L*a*b* and Chroma C_{ab}*, respectively. C_{ab}* was calculated using Eq. (1), as follows:

$$C_{ab}* = \sqrt{a*^2 + b*^2} \quad (1)$$

In this study, we mainly discussed the *L** and C_{ab}* values because they are quantitative attributes of the food color and are expected to show strong dependence on the color of baked food.

The baking time was around 1800 s for Oven 1 and 1000 s for Oven 2. The experiments were performed under conditions with and without the supply of steam (HA and SHS, respectively) at around 200°C.

RESULTS AND DISCUSSION

Color change of sliced bread and raw chicken upon oven heating

Figure 1(a) shows the changes in the *L** and C_{ab}* values for sliced white bread during baking. The *L** value decreased continually during heating, while the C_{ab}* value decreased/maintained initially and then started to increase with decreasing *L**. After reaching the peak value, C_{ab}* started to decrease again. Such a change profile was observed under all the heating conditions adopted.

Figure 1(b) shows the changes in the *L** and C_{ab}* values for the raw chicken meat pate. Under the SHS heating conditions, *L** rapidly increased within a few seconds of heating, because protein denaturation by heating with steam condensation caused the surface temperature of the meat to increase to the dew point temperature. Then, *L** started to decrease with increasing C_{ab}*. The raw chicken surface showed only a slight color change in 1800 s under the experimental conditions considered.

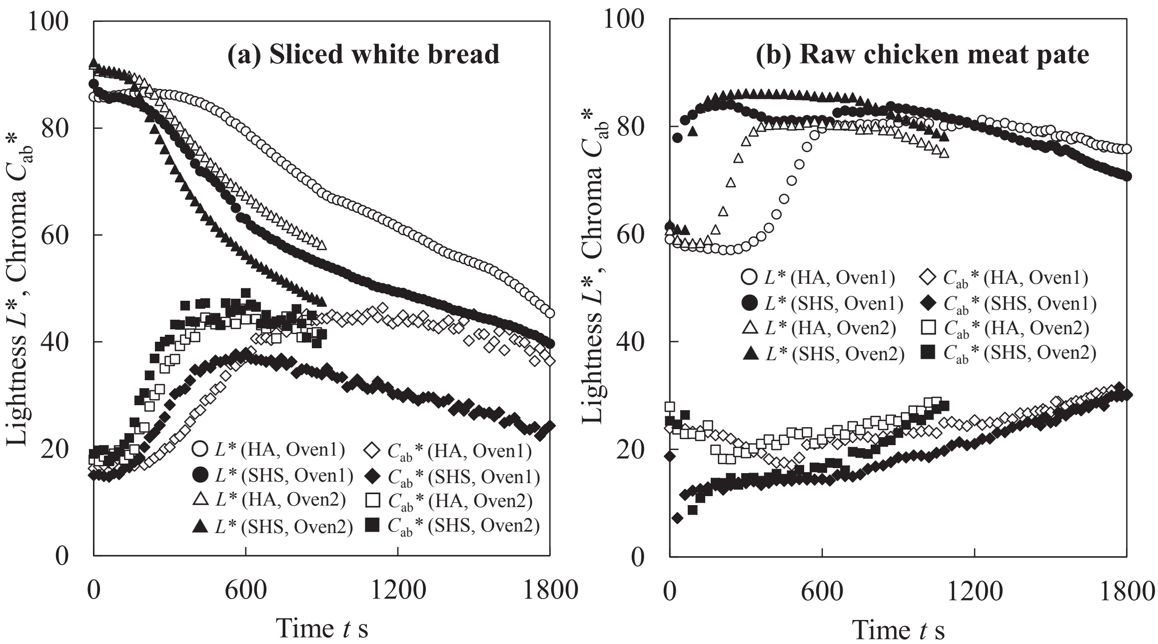

Figure 1. Measured changes in *L and C_{ab}* during oven heating**

Relationship between C_{ab}*, L*, and formulation

Figures 2(a) and (b) show the relationship between the C_{ab}* and L* with the values calculated by the approximate expression in equation (2). We proposed this equation for estimating the baking (browning) procedure. L_{max}* is the maximum value observed after 60 s elapsed; $C_{ab,0}$* is the value corresponding to the instant when L* reached the maximum and then began to decrease upon baking. A, B, and P are the fitting parameters defined by the histories of L* and C_{ab}* under each set of heating conditions.

$$C_{ab}{}^{*} = A(L_{max}{}^{*} - L^{*})^{P} + B(L_{max}{}^{*} - L^{*}) + C_{ab,0}{}^{*} \quad (2)$$

The profiles defined by the approximate expression in Eq. (2) are in good agreement with that based on the measured values. Figure 2(a) shows the profiles of sliced bread: L* decreased with an increase in C_{ab}*, reached the peak value, and then decreased. The acceptable range (food color considered suitable for consumption) of L* for bread defined by the European Standard [5] are shown in Fig. 2(a). The acceptable ranges for sliced white bread and plain cookies have been reported also by Sakai [4]. The ranges defined as the food color considered acceptable for consumption by most (75%) of the respondents in a survey and the values of the browning scale based on sensory evaluation are shown in Figure 3. These ranges can be defined by the profile of L* and/or C_{ab}* changes. Automatic regulation of the oven for baking can be realized using by the approximate expression and acceptable range.

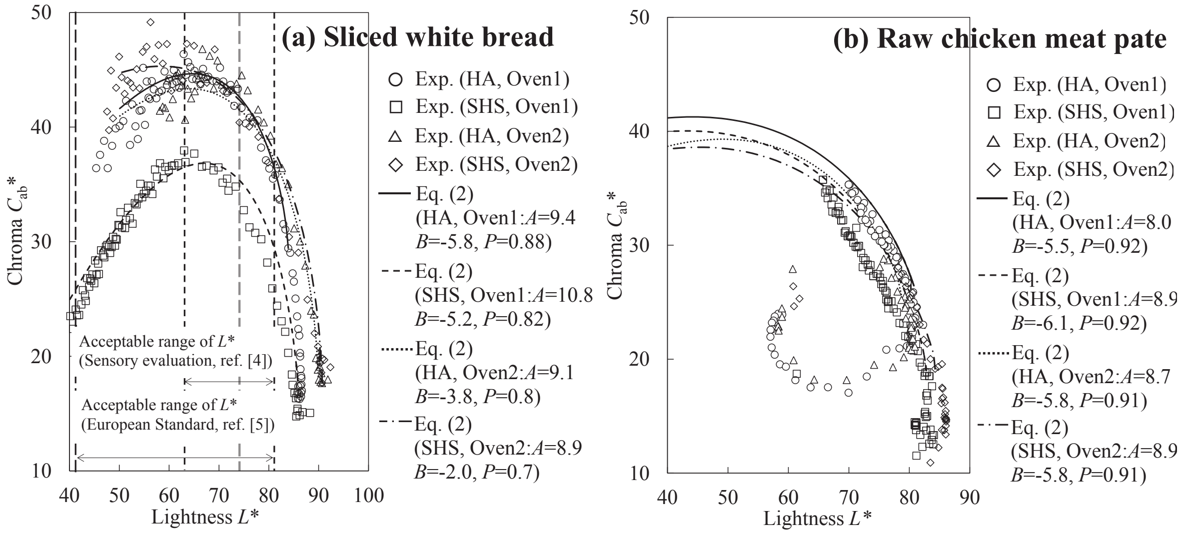

Figure 2. Profiles of C_{ab}*and L* changes by in situ measurement data and by the approximate expression in Eq. (2) with characteristic values of A, B, and P

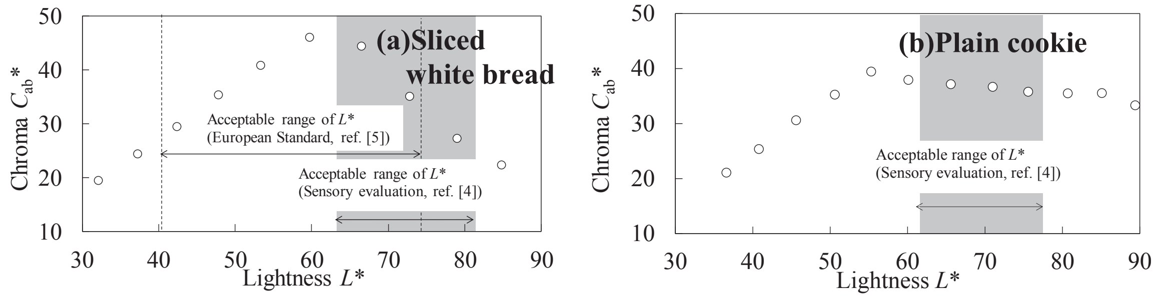

Figure 3. C_{ab}*and L* values of the browning scale using previous sensory evaluation study based on experimental data, and acceptable range of L* for consumption

Browning index for evaluating the baking procedure and future works

Two types of indexes for evaluating the baking procedure in an automatic oven for light-colored food are proposed. The values of x_L and $x_{L,C}$ are tentatively denoted as "browning Index by L^*" and "browning Index by L^* and C^*" for evaluating the color of baked food in this research. The definition of index x and the acceptable range of food color considered suitable for consumption are as follows:

$$x_L = \frac{L^*}{L_{max}^*} \quad (0.70<x_L<0.90 \text{ for toast, } 0.70< x_L<0.87 \text{ for plain cookie}) \tag{3}$$

$$x_{L,C} = \frac{L^*}{L_{max}^*} \times \frac{C_{ab}^*}{C_{ab,0}^*} \quad (x_{L,C} \text{ around the peak value for toast and plain cookie}) \tag{4}$$

For automatic oven operation, in situ color measurement is required; further, the measurement method should be simple, inexpensive, and as accurate as possible for the intended purpose. Meanwhile, there exists a strong relationship between the color of food considered acceptable for consumption and the viewer's emotion [6]. Properly browned foods are known to stimulate the appetite. The preferred color of food strongly depends on one's ethnic or cultural background. The temperature and moisture content profiles for the cooked food and their histories should be considered by the automatic operation algorithm in order to improve the quality, taste, and safety of food products.

CONCLUSION

Prediction expressions for the chroma and lightness history profiles of the surface of light-colored foods during oven baking have been developed based on in situ measurement data. The characteristic values used in the expressions for each material and under each set of heating conditions were calculated from the measured colorimetric data. Indexes for evaluating the baking color and methods for automatic oven operation were also proposed.

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Poster paper PA24

DIFFERENTIAL COLOR PERCEPTION THEORY

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Key words: New color; theory; red/green; Dichromatic; Differential perception

ABSTRACT

Trichromatic and Opponent-process color theories has introduced some complicated systems for color mixing and color perception.
Bothe theories has assumed three color receptors as principle color sensors for generating any colored scene; one receptor for shortwave called S-cone and another for medium wavelength called M-cone and another one for long wave length called L-cone.
Our approach to this inspiring phenomena has different simple assumption and distinct proposal for color mixing and perceiving.
Human color sight vision can be distinguished only by two color receptors, *Long* and *Medium*.
Each receptor gain signal has its own value and polarity with respect to each incident electromagnetic wavelength through the whole visible spectrum.
Blue color is only a color summation of (negative Red) and (negative Green), or it is just as -(Red+Green).
S-cones with rods surrounding the fovea of our retina work together for night vision and dim light perceiving.
color sense is now analogous to the other four known human senses since it has only two inversely related variables, i. e Positive (Red+Green) and negative (Red+Green).
After-image phenomena and simultaneous contrast explain the color polarity for the same receptor as well.
Cones topography on our retina coincide with our principle assumption, since the S-cones is approximately absent from the fovea spot (the most color sensitive part of our retina) and they spread with relatively very small population around the fovea in between rods (Williams et al., 1981) .

INTRODUCTION

Our four sensing systems, smell, touch, taste and hearing systems working with the same differential principal , depending on the rule of opponency, as easy as we consider that bitter is only the lack of sweat, cold is the lack of heat, darkness is the lack of light and blue is only the lack of yellow. It is going exactly with the law of conservation of energy, you can't get something from nothing.

In general, negative values is only the lack of the positive ones. It goes as Psychophysical process throughout our sensing systems as well.

Although Trichromatic and opponent process theories have solved some puzzles of the color phenomena but they still have some complicated three dimensional explanations to our fifth beautiful sense of vision and color perception.
Accordingly it seems wise enough to have some other theory for better understanding and simpler manipulation analogues to the other four senses in due.
"Differential Color Perception Theory" has been considered as a new color theory very analogues to the four human senses in the way mentioned above.
It is simple as "blue is only the lack of yellow".
This will go correct for all the components of yellow perception relative to the components of blue..

1. Biological differential colour perception amplifier

Figure 1 illustrates a synaptic network analogous to the conventional electronic differential amplifier (Delton T. Hom,1994).

The red triangular block shown on figure 1 stands for the whole synaptic network including L-cone receptor at the input gate followed by bipolar cell ended with ganglion cell at the output. Horizontal cells and Imecrene cells are included inside the symbolic triangle to perform positive and negative feedback effects for colour adaptation and hysteresis (Ido Perlman, 2012).

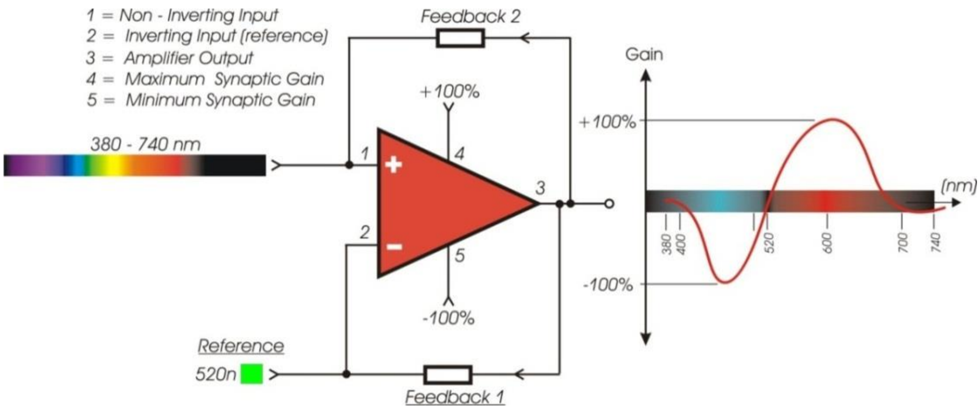

Figure 1. Red biological differential amplifier (RBDA).

Figure 2 shows the network effect of green biological differential amplifier**.**
The green triangular block contains M-cone receptor at the input followed by bipolar cell and ganglion cell at the output, horizontal cells function for negative and positive feedbacks to perform gain control and hysteresis.

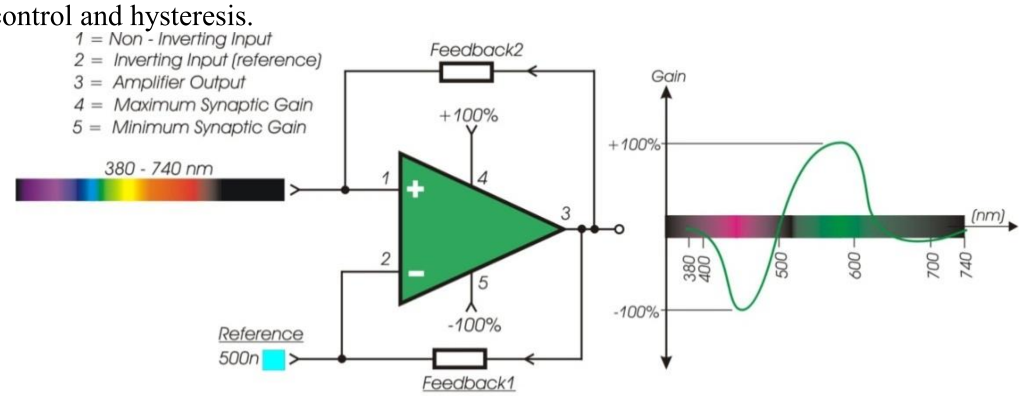

Figure 2. Green biological differential amplifier (GBDA).

2. L and M- receptors characteristic curves

Imposing outputs of RBDA and GBDA together will introduce L and M-receptors characteristic curves as shown on figure 3

3. Assumptions Analysis

Referring to figure 1. or figure 2. it can be expressing the illustration mathematically as shown on equation (1)

$$(V_1 - V_2)G = V_o \qquad (1)$$

Where: $V_1 = input\ \ 1\ to\ the\ differentiator$

$V_2 = input\ 2\ to\ the\ differentiator$

$V_o = output$

$G = Gain$

Considering the transfer function (1) it is possible to estimate three possible output states :

1. V_o will be positive if $V_1 > V_2$
2. V_o will be negative if $V_1 < V_2$
3. V_o will be zero if $V_1 = V_2$

According to the analogues electronic differential amplifier principal the red biological differential amplifier shown on figure 1 will flip its output to negative response for all the incident colour radiations less than a reference wave length of 520nm, our mind will perceive it as cyan with peak value at 480nm.

For all the incident colour radiations more than *520nm* it will flip the output to positive response and our mind will perceive red color with a peak value at around *600nm*.

If the incident colour is around *520nm* the output will be zero and our brain will perceive black.

For figure 2 the green biological amplifier will flip to negative response as far as the input incident spectrum is less than 500nm, this will lead to magenta perception with a peak value at 460nm.

For all the incident wavelengths more than a reference wavelength of 500nm the green biological differential amplifier will flip to green with its peak value at 570nm.

If the incident color is *500nm* the output will be zero and black will be perceived as default.

Our brain will receive two outputs one from the red differential amplifier and another from green differential amplifier, this will lead to full visible spectrum perception as shown on figure 3.

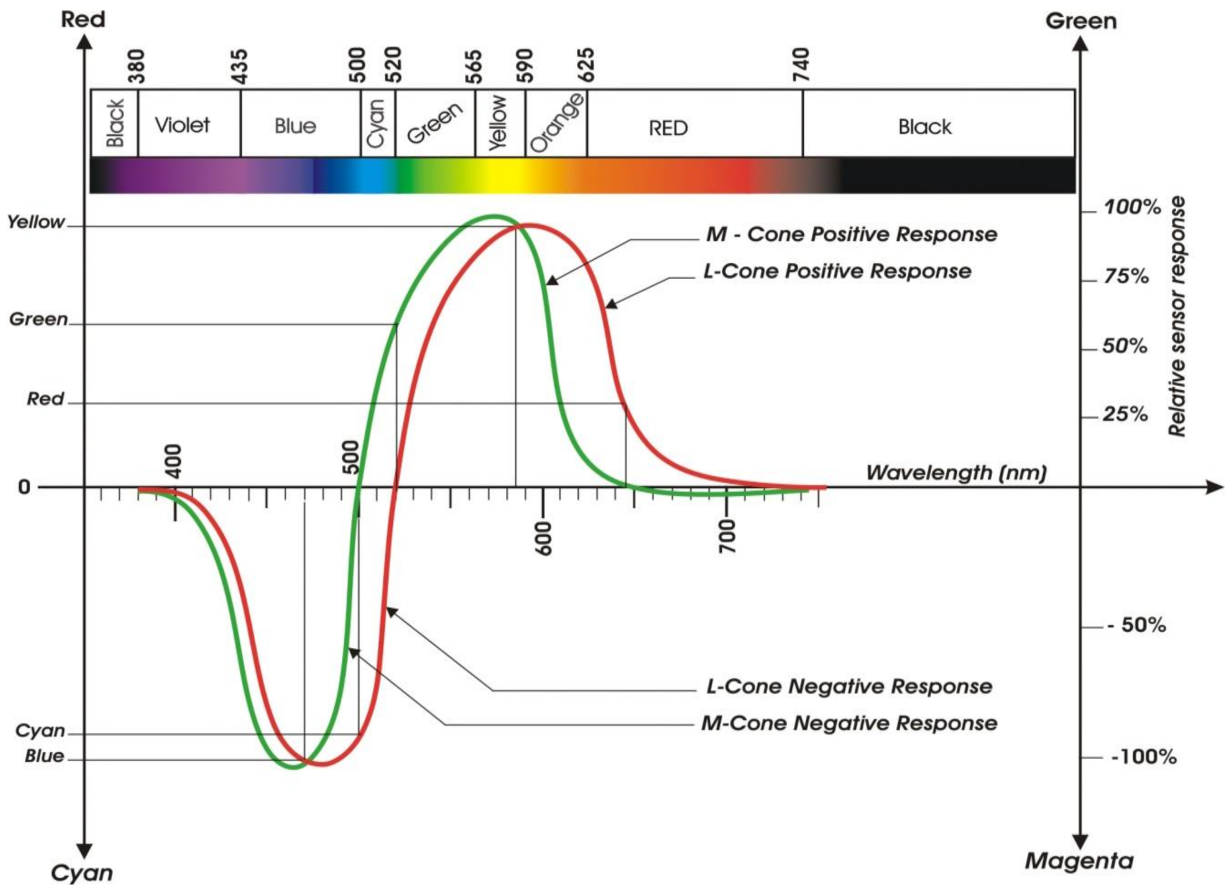

Figure 3. M and L- receptors characteristic curves

4. Colour space of Differential Colour Perception theory

Only two axis in the Cartesian space is enough to represent any color of our visible spectrum (figure 5)

Any point on the colour space of figure 5 expressing a specific colour with two components of Red and Green, P_1 is a point on the R-axis with 100% Red and 0% Green, it can be written as P_1(100,0) which is 100%Red, Blue can be located at P_6 (-100,-100).

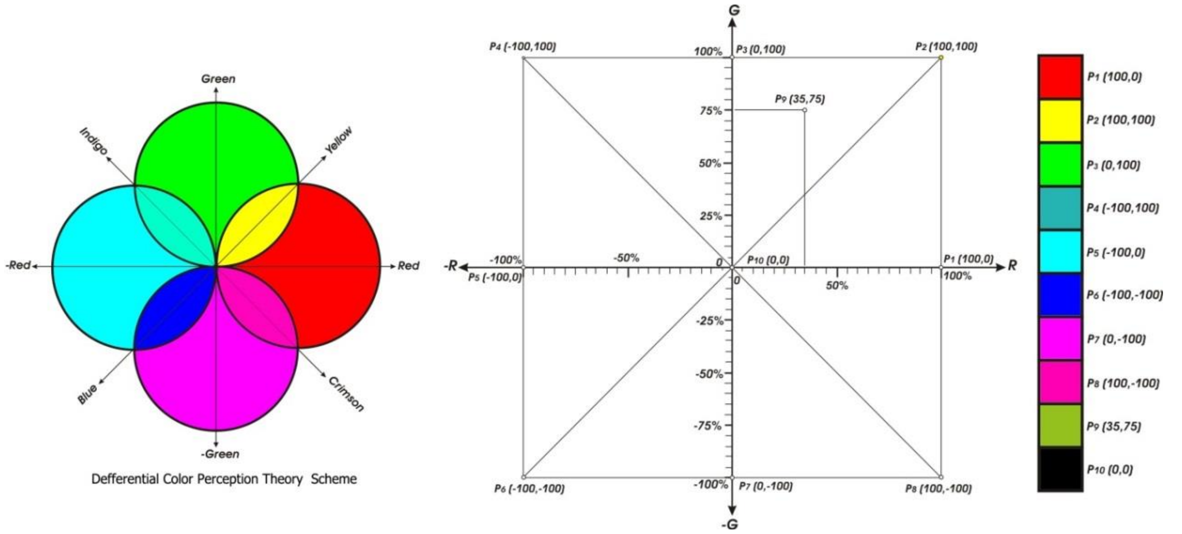

Figure 5: Colour scheme and color space of differential color perception theory

5. Perception Modes

In the night mode of our vision system we depend on rods and S-cones together for better sight details recognition.

Since night vision and dim light are genuine in the life of all mammals spices all the time the S-cone is genuine as well.

In the daylight mode one or more colour receptor/s could be far enough for better sight vision.

Due to the effect of those two different modes we could notice many differences in the genetic structure and locus of the S-cone visual pigment compared with the L- and M-cone pigments in out retina (Nathans et al., 1986), yet the S-cones are common to all vertebrate retinas and always form a consistent 8-10% of the cone photoreceptor population (Marc, 1982; Kolb and Lipetz, 1991).The S-cones are however, very few in the fovea center so causing a so-called S-cone blind spot (Williams et al., 1981) but they peak in number on the foveal slope at about 12% of the population.The pathways for transmitting information from S- cones to ganglion cells appears to be different from the midget pathways for the medium and long wavelength cones, the latter two chromatic pathways are via midget bipolar and midget ganglion cells connections related to a single spectral type of cone, either L- or M-cones

ACKNOWLEDGEMENTS

According to the characteristic curves of red and green biological differential amplifiers color mixing has to follow different color sets as ±(Red+Green), or simply as Red, cyan, Green and magenta. Or as an abriviation of (RcGm). *R* stands for Red, *c* stands for cyan, *G* stands for Green, *m* stands for majenta instead of RGB or CMYK systems.

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PSYCHOLOGICAL EXPERIMENT FOR MEASURING REACTING VELOCITY BY VOLLEYBALL DESIGN

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Keywords: color, image, sport, volleyball, reaction time

ABSTRACT

It appears that the movements of volleyball in various colors give us different images when they move quickly or slowly. While watching volleyball games, people have impression that boll design might take some significance effect toward game. Actually, volleyball athletes sometimes report that red/black ball seems heavier than other bolls. This study intends to estimate what and/or how effect might be taken by different of volleyball design.

First trial is measuring reacting velocity of detecting boll spinning direction. This experiment shows difference between each ball design, but accuracy rate data of this experiment shows interaction of ball design and boll fling speed. Second trial is measuring time gap between bolls falling down speed and observer's recognition speed. By this experiment, we expected to find out statistically significant difference by ball design or color combination, but it indicates there is difference between experimental groups.

INTRODUCTION

Japan Volleyball Association (JVA) is the National Body for the sport of volleyball in the Japan and is recognized as such by the Federation International de Volleyball (FIVB). JVA have an activity for giving official approval to ball for volleyball. In past day, it was always white. In today, it becoming various designed and colored as shown in Figure 1.

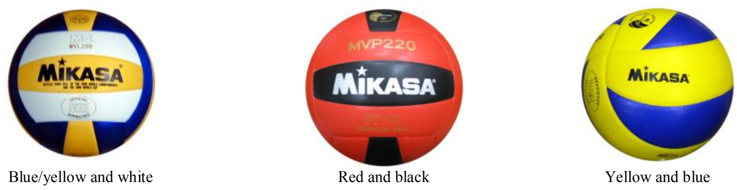

Figure 1. Ball Example

All of these balls are actually used in official games. I don't know report that study how felt these balls by people. In other hands, simple impression by members in Kanagawa University Volleyball team is it makes effective to playing performance. Then we try to measuring performance affectivities by ball design.

METHOD

Basic approach is measuring reaction time by simulation software on PC. Simulation software shows volleyball images to screen and subject respond spin direction (TEST1) or tap on time when ball touch down (TEST2). Screen image is shown as Figure 2. Ball images are made by take photo by actual volleyball. In this study, reaction time for spin direction recognizing and ball touch down time, are picked up. Because, spin direction of ball, is important for forecasting ball's locus at next moment. Time gap for ball touch down is important for preparing ball receiving.

Figure 2. Simulation Screen Image

TEST1:

April 29, 2009. 15 people of Volleyball team member of Kanagawa University. Subject mission is response when they recognizing spin direction. Tester measure a reaction time of it. Parameter is ball (Blue/yellow and white, Red and black, Yellow and blue like Figure 1), flying speed and spin speed.

Table 1: Statictics of Reaction Time (Average)

ball	Blue/yellow and white, Red and black, Yellow and blue
	712.42, 743.32, 986.85
	F(2,33)=17.11,p<.001
flying speed	2,4
	731.16, 678.06
	F(1,33)=.070,n.s.
spin speed	2,4,8
	812.48, 674.54, 607.52
	F(2,66)=.060,n.s.

TEST2:

April 2, 2010. 12 people of Volleyball team member of Kanagawa University. Subject mission is push bar on PC's keyboard when they recognize volleyball is touch downed. Tester measure a time gap from correct touch down time. Parameter is ball and flying speed.

Table 2: Statictics of Reaction Time (Average of estimation gap)

ball	Blue/yellow and white, Red and black, Yellow and blue
	14160.31, 9067.027, 11261.67
	F(2,6)=5.14,n.s.
flying speed	4, 5, 6, 7
	25545.06, 8697.60, 7515.65, 4227.05
	F(3,6)=4.76,p<.001

RESULT AND DISCUSSION

Test data include a lot of number of record. The actual number of record is 5584 for TEST1, and 3030 for TEST2. Use this kind of huge number of record, it easy to get result of “Significantly Different” by small difference. Figure 3 shows averages by ball design at TEST1. Just focusing these averages and takes single dimension ANOVA, then it is actually “Significantly Different”. But this is undesirable. It seems to more discreetly attitude is required, because another factor like spinning or flying speed is more effective than ball design.

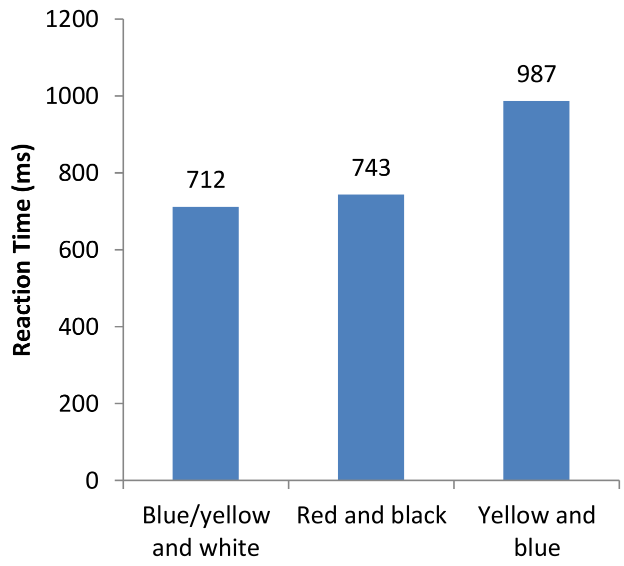

Figure 3. Averaged Reaction Time for Spin Direction

In TEST1, possible parameter is ball design, spin speed and ball flying speed, and takes ANOVA with these three parameters (Table 1). In TEST2, possible parameter is ball design and ball flying speed, and takes ANOVA with these two parameters (Table 2). By result TEST1 ANOVA, it still affective ball design and spin/flying speed is not. But ball design is not affective in TEST2 ANOVA.

These result of statistics analyze possibly indicates that ball design is affective to some visual recognition of volleyball player, but it is not always observed.

In other hand, difference by player is interested by some reason. Because ball design is not sure for game performance for many people, but everybody knows that player is sure about game performance.

By the result of test data, I think spinning recognizing is affected by ball design and not strongly affected by player. But ball touch down forecasting is more significant in point of view “player”. Figure 4 shows time gap for ball touch down forecast testing (TEST2).

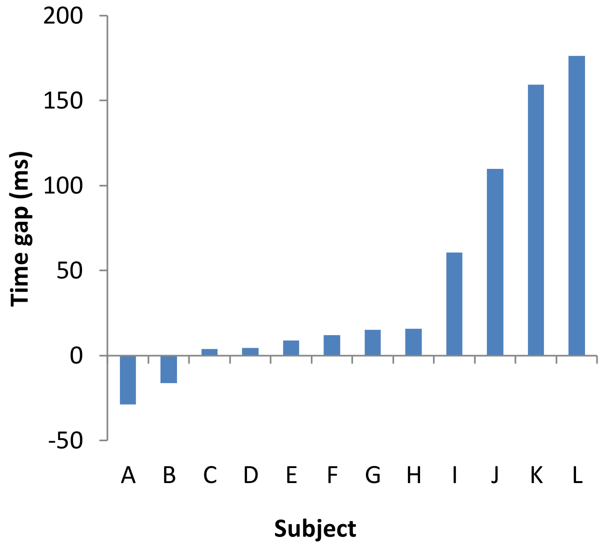

Figure 4. Averaged Time Gap for Ball Touch Down

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A WORLDWIDE SURVEY METHOD FOR MEMORY COLORS

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Keywords: Memory color, Flesh color, Preferred color reproduction, Worldwide surveys, Smartphone

ABSTRACT

This paper presents a novel method for conducting global surveys on memory color that allows the participants to conduct tests without limiting their research area and to make speedy measurements. We studied the preferred reproduction of memory colors using prints and displays, which limit the experimental location. In addition to smartphones, the use of which has been increasing, light-emission type media displays are less affected by ambient light than print materials. Moreover, it is easy to limit certain models. It was found that the difference in color reproduction among the same kinds of smartphones is slight without the use of a special color management. Therefore, we suggest a method for surveying memory color using the Internet and smartphones that is also suitable for global surveys. We also report the survey results after applying the proposed method in Japan and Thailand.

INTRODUCTION

In color reproduction method, there is preferred color reproduction in addition to true color reproduction to the original. The preferred color is related to the color from the subject's memory, and tends to differ based on culture and environment. The reproduction of flesh color has been studied in the field of color photography. Bartleson used the Munsell color system to investigate memory color and preference judgments on ten types of familiar objects. The subjects' preferred color for complexion had the same chromaticity as the mean memory color for that particular flesh tone [1]. Suzuki studied the racial attributes of the subjects and found that Asians prefer more reddish flesh colors than Caucasians, while Caucasians prefer more yellowish flesh colors than Asians [2]. Nishiura conducted surveys on color preference in Japan and several other countries (USA, Germany, Sweden, Italy, and Brazil) by applying their "systematic arrangement method" and showed there are regional differences in color preference [3].

However, the numbers of subjects and communities used for the surveys have been limited in previous researches because specific displays or prints have been used.

Since high-performance mobile devices such as tablets or smartphones have been widely used in recent years, data can be collected from the general public at any location in the world using this method. Additionally, smartphones, which are of a light-emission type, are less affected by ambient light than prints, and it is easy to specify a particular model. Therefore, we minimized the individual differences in colors using a limited number of smartphone models, and kept the brightness of the smartphones constant, which allowed us to deduce the error range of the individual differences in colors for the same model based on the measurement results.

Accordingly, in this study, we aim to realize surveys on memory colors using perception data collected from an unspecified number of subjects from around the world. Specifically, we suggest a new method for conducting worldwide surveys on memory colors using the Internet and the smartphones of each individual subject, and analyzed the results after applying this method for flesh colors in Japan and Thailand.

EXPERIMENT

Differences in colors among the same model of smartphones

It is known that there are the differences in color for different smartphones based on the model or degradation. Further, owing to variations in display brightness, differences in user preference have been shown in most smartphones with the same properties. After making the brightness of each smartphone constant, the differences in color between the same models were thus measured, and the errors were estimated.

Smartphones: Seven iPhone4S and twelve iPhone5 models were used (a variety of elapse times and production dates)
Digital values of calibrated colors: white (255, 255, 255), gray (128, 128, 128), flesh (209, 157, 135), red (128, 0, 0), and yellow (128, 128, 0)
Viewing distance: about 150mm
Display brightness: 160 cd/m^2
(The brightness sliders on the smartphones were adjusted to the middle position, and thus their relative brightness values were 50% in all ranges without automatic control.)

Evaluation based on Systematic Arrangement Method

As a subjective evaluation method of the image, a paired comparison method and systematic category method are generally used. The newly developed "systematic arrangement method" of our laboratory[4] is suitable for evaluations, such as for preferred colors, in which subjective judgment is required; in addition, it can be evaluated easily by unskilled users, efficient image evaluation of a large number is a presentation method which can be performed. This method is characterized in placing varied systematically L*a*b* three-dimensional to allow list on paper of one piece of two-dimensional. (Fig.1) For this experimental study, evaluation images of 49 (7×7) Mongolian (Japanese) and Caucasian faces were displayed as digital evaluation images on a smartphone. (Fig.2)

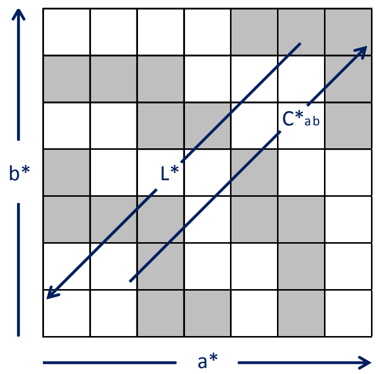

Figure 1. Systematic arrangement method: arranging a* on horizontal axis, b* on a vertical axis and L* on oblique axis in regular intervals

Figure 2. Evaluation flesh color "Mongolian (Japanese)" according to systematic arrangement method

For an easy evaluation by unskilled observers, we used the "systematic arrangement method" when presenting the samples. Two presentation steps were carried out for the evaluation because each image appears reasonably well on a smaller display.
The subjects had to select the one image that they viewed as the most suitable flesh color for the woman shown in the 49 Mongolian (Japanese) and Caucasian images evaluated. The evaluation method is described below.

Observers: 50 Japanese and 49 Thai subjects (males and females in their teen years to their 60s)
Evaluation images: Flesh color for "Mongolian (Japanese)" and "Caucasian" faces
Content of the evaluation: Select the "image of skin color that I think worthy of this most women" from the nine images of Fig.3 were selected systematically from Fig.2. Next, Select the "image of skin color that I think worthy of this most women" from the nine images vicinity of the image was then selected at that time. The most preferable flesh color of image were determined that the subject selected in the end was the person's memory color.

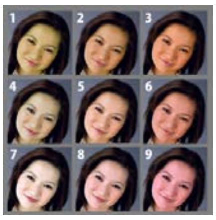

Figure 3. Flesh color evaluation of "Mongolian (Japanese)" face selected systematically from Fig.2 based on the systematic arrangement method

RESULTS AND DISCUSSION

Differences in brightness among different smartphones

Figure 3 shows the results of colors displayed of different smartphones by converting the tristimulus values, X, Y, and Z, into CIE L*, a*, and b* values, respectively. Table 1 shows the standard deviations of each L*, a*, and b* value on an iPhone4S and iPhone5 as determined from Fig.3. From Tab.1, the L*, a*, and b* error range of individual differences in colors for the same model was deduced as the average value of the standard deviation of five colors near the flesh color.

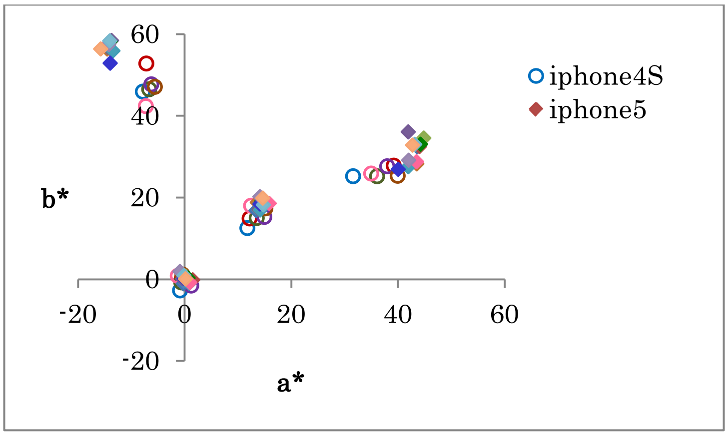

Figure 3. Measurements of the colors displayed on a smartphone

Table 1. Standard deviation of L*, a*, and b* on an iPhone4S and iPhone5

	iphone4S			iphone5		
Color	L*	a*	b*	L*	a*	b*
White	1.81	1.95	2.40	0.95	1.24	1.60
Gray	2.03	1.00	1.63	0.86	0.66	0.84
Flesh	1.71	1.39	1.83	0.89	0.64	1.06
Red	1.54	2.84	1.71	0.60	1.31	2.99
Yellow	2.10	0.80	3.09	0.83	0.57	1.78
Average	1.84	1.51	2.06	0.80	0.80	1.67

Memory color of Mongolian (Japanese) flesh color

In consideration of and the color difference models and error range of individual differences of colors for the same model as based on the measurement results showed Memory color of Mongolian (Japanese) flesh color in Fig.4. The average flesh color was selected the most in both Japan and Thailand, while the flesh colors selected in Thailand tended to be lower in saturation than those selected in Japan. Although the previous study suggested that it tend to prefer the fair flesh color in Japan compared with USA, Germany, Sweden, Italy, Brazil, it tend to be prefer the fair flesh color in Thailand than ever in those country.

Memory color of Caucasian flesh color

Figure 5 shows the average flesh color that was selected the most in both Japan and Thailand. However, in contrast to the earlier, the flesh colors selected in Thailand tended to be higher in saturation than in Japan.

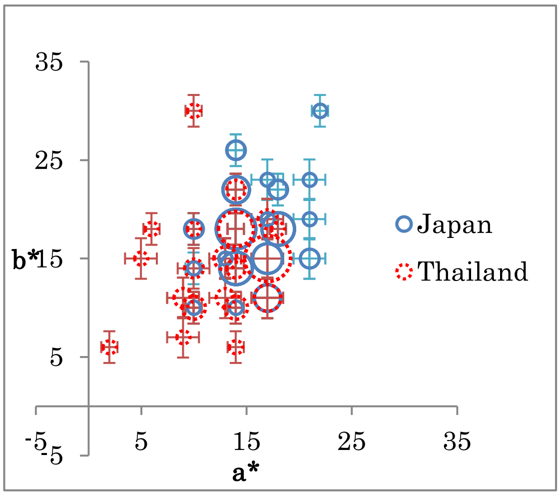

Figure 4. Memory color of Mongolian (Japanese) flesh color

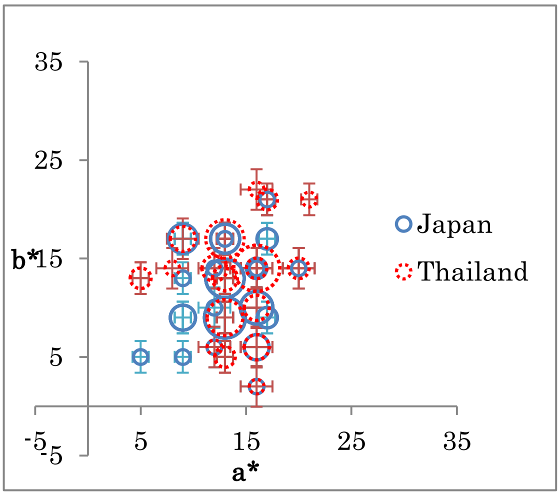

Figure 5. Memory color of Caucasian flesh color

SUMMARY

We suggested a new method for conducting worldwide surveys on memory colors using the Internet and individual smartphones. Furthermore, we conducted actual surveys in Japan and Thailand using the proposed method, and found that the preferred flesh colors between Thailand and Japan tend to differ. It is believed that if we minutely examine the color data of small mobile devices such as smartphones, the proposed method can be effectively used for detailed analyses worldwide.

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THE USE OF COLOUR MEASUREMENT IN RESEARCH INTO ART HERITAGE

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Keywords: post-Byzantine churches, Arbanassi, colour measurement, Munsell

ABSTRACT

This investigation combines the use of the scientific method of measuring colour with the physical representation of the human perception of a particular colour within the Munsell colour-notation system. The aim is to assess and compare the appearance and use of that colour in two heritage sites. The research is grounded in the case-study of two seventeenth century post-Byzantine churches in Arbanassi, Bulgaria. Previous research on the site had been limited to verbal description of the colours used in the church interiors. This work employs the correlation between the colorimetric measurements collected from green-coloured sections of wall decoration and the Munsell colour-notation system to allow a reasonably accurate translation of colorimetric data for the purpose of art historical investigation. The closest colorimetric (CIEDE2000) match was selected.

INTRODUCTION

The town of Arbanassi, situated in the middle of Bulgaria, contains a large selection of domestic and ecclesiastical architecture built and decorated in the seventeenth century, thus presenting the opportunity for the assessment and the comparison of the use of architectural colour in that era. (Haritonov, Chohadžieva and Rutževa 2003). During the late 1970s and the 1980s the wall paintings in the examined churches were cleaned, which revealed the original colours of the paintings. (Prashkov 1979 and 1985) Consequent implementation of a conservation programme, including omission of direct sunlight and control of humidity and air pollution, ensured the subsequent maintenance of the coloured surfaces in good condition. Two scenes from the wall paintings of the churches of the Nativity of Christ and of St Atanass are shown in Figures 1 and 2.

Figure 1 (left). Church of the Nativity of Christ, Arbanassi, Bulgaria: Nave.

Figure 2 (right). Church of St Atanass, Arbanassi, Bulgaria: Nave.

From an art historical point of view, the use of colour is of considerable interest because colour is one of the main elements in the construction of any decorative composition, and it may even mark a symbolic significance that is expected to be deciphered by an informed viewer. (Gage 1999) There is a relatively frequent use of green in the iconographic tradition of the Eastern Church (Sendler 1999). In both the examined churches the colour green can be found in the lower half of the background to the images which, within the compositional context, directly refers to the use of the word 'green' in the Scriptures, 'yârâq' in Hebrew, as the colour of vegetation (Jeremiah 17:8; Isaiah 57:5; Psalms 37:35).

Previous research on the two churches had been limited to the traditional and meticulous but subjective assessment and verbal description of the colours used in their interiors. In the monograph on the Church of the Nativity of Christ colours are mentioned only in a brief indicative list of the generic names (red, blue, green, and so on). (Prashkov, 1979) Some remarks on colour can also be found in the iconographic and stylistic characteristic of the wall decoration in the interior of the Church of St Atanass. (Rutževa, 2005) In the latter, evocative and emotionally charged language is used to describe the appearance of a colour in an attempt to introduce a discussion on the style and psychology of the colours used in the wall paintings. However, no matter how perceptive, such an account of the pictorial colours is still no more than a personal observation of those colours. This inevitably introduces the perceptional deception of one's observation into the description of colours, due to the complexity of the processes by which the intricate interaction between light, the eye and the brain result in the recognition of colour (Lamb and Bourriau 1995; Gregory 1998). Moreover, as personal perception is historically and socially constructed, it is debatable whether the psychological make-up of the painter and the beholder in the seventeenth century would be similar to that of an art historian writing at the end of the twentieth century. Finally, verbal description of colour is far from unambiguous.

By contrast, the use of colour measurement can provide an unambiguous description, but one which provides an abstract concept of colour, which may be an alien form of representation when used in discussions of an artifact in an art historical context. The possibility of employing a physical colour system such as the Munsell system in the present research permits the making of the transition between conceptual and visual colour and at the same time avoids the loss of the necessary precise notation. That loss would have inhibited accurate communication of the experienced colour (Berns 2000). The availability of computational methods allows a reasonably accurate translation of colorimetric data into Munsell notation for the purpose of comparative art historical investigation into the appearance of colour and its use within a number of heritage sites. This is the subject of the paper presented here as part of ongoing research on the colours employed in the wall paintings of the churches of the Nativity of Christ and St Atanass (Tantcheva et al, 2008).

METHOD

Before taking the measurements the coloured surfaces were cleaned from dust and any loose particles by using a soft brush and hand-held pump. For the collection of the colorimetric data we employed a hand-held Minolta CM-2600d spectrophotometer (8mm measurement area). All data were processed in the Colour Measurement Laboratory at the University of Leeds. It provided spectral reflectance factors for each sample (these were averaged from 16 measurements) at intervals of 10nm and these were converted to CIELAB values (using the CIE 10º observer and the D65 illuminant). For each colour measurement, the closest Munsell sample was found and the Munsell notation of that sample recorded. However, two metrics for similarity were used; one based on the closest spectral match and the other based on the closest colorimetric (CIEDE2000) match. In both cases, the match criterion was the least-square error metric.

RESULTS

The CIELAB values of the green colours for the churches of the Nativity and St Atanass are presented in Table 1.

Table 1: CIELAB values for the colours of the churches of the Nativity and St Atanass.

	L*	a*	b*
Nativity	47.58	-7.77	4.45
St Atanass	41.60	-5.89	4.48

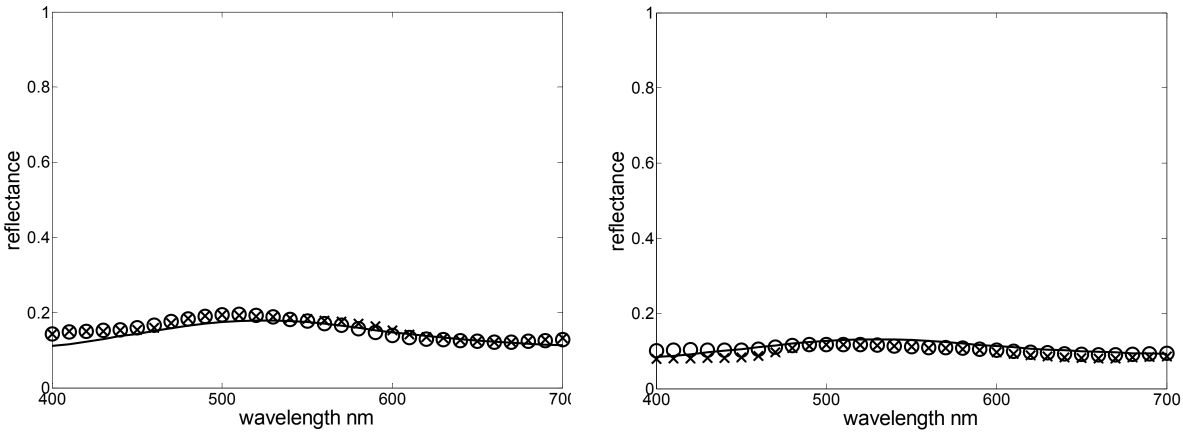

Figure 3: Spectral data for target (line) with spectral (circle) and colorimetric (cross) Munsell matches for the churches of the Nativity (left) and St Atanass (right).

The spectral data for the samples from the target churches and their corresponding spectral and colorimetric Munsell matches are shown in Figure 3. Although it indicates that both spectral and colourimetric matches are very close to the originals, the colorimetric matches should be considered the better representation of the appearance of the colour green in each of the churches. This is because these are the matches that correlate directly to human colour perception and not just to the properties of the coloured surfaces. Figure 4 shows an illustration (using sRGB representation but subject to the vagaries of colour management) of the spectral and colorimetric matches for the green colours from the two churches.

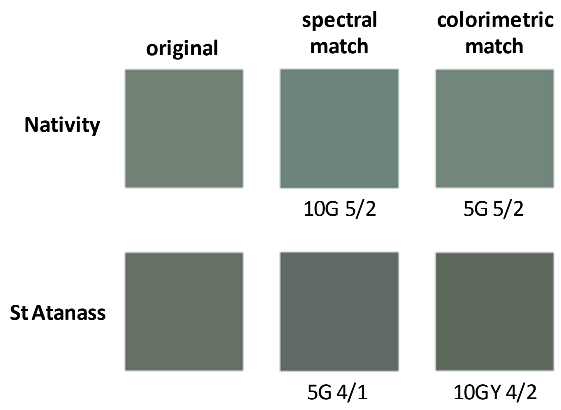

Figure 4: sRGB representation of the green shades.

Poster paper

DISCUSSION

This is the only Bulgarian historical site in which this method of colour comparison has been used in art historical research and is part of an ongoing investigation. The results of this examination contribute to the generation of a full set of colorimetric Munsell matches that will be representative of the artistic palette of both church interiors. Moreover, the manner of presentation allows the comparison of colours not only from these two sites but theoretically from an unlimited number of different sites by overcoming problems linked to colour vision, colour memory and colour reproduction in print. Thus the results presented here can be considered to be the beginning of the formation of the basis for further investigation into the use of colour in seventeenth century Bulgarian wall painting.

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EFFECT OF DATA SET AND HUE ON A CONTENT UNDERSTANDING OF INFOGRAPHIC

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Keywords: Infographic, content understanding, data set, hue

ABSTRACT

Nowadays, communication technology has changed considerably from the past. Infographic plays an importance role in communication and is widely popular among the graphic designer. It is well known that infographic is effective in communication. Since it helps people to easily understand a content and is an outstanding among text, the infographic is used as an effective tool in communication media. Several factors are said to be responsible for an understanding of the content for instance data set of graphic design, hue of infographic and so on. The objective of this study, hence, was to investigate data set and hue of infographic that influence over a content understanding. Students, who studied in bachelor degree of mass communication technology, were participated in this study. Expected experimental results will explore an effect of data set and hue of infographic on response time and correct understanding of the content. Our result might be a useful tool for designer to choose the appropriate infographic.

INTRODUCTION

Numbers of information from presentation through different media resulted in human needs to consist of highly understanding in those details and knowledge evaluation [1], which caused strain in memory system and might lead to confusing and long memory system declination[2]. Therefore, data organizing is needed for receiver to get complete and correct data, and easy to understand. Nowadays, infographic has an important role in data organizing due to infographic is the behalf of data and information by using graphic in presentation which effective in attraction from user as well as able to easily and clearly explain the complicate data.

Infographic is always presented by charts, diagrams, graphs, tables, maps and lists, etc.[3][4] Interestingly, bar charts mostly used in designing the infographic [5] due to able to present quantitative or scientific data better than other format organization and also show result which easily and clearly understanding [6][7].

Presentation in several format needs to consider amount of data and direction in communication for understanding and interpreting of the receiver. Hence, data presentation by bar charts should not consist of more than 12 data sets [8] especially data number 4-9 will be kept in human memory unit immediately [9] and color is needed to use for attraction and presentation. Because, color causes picture more outstanding in which lead to easily sensitizing and feeling [10]. Also efficiently help to see and connect related data resulted in understanding in presentation. However, according to either inside country and abroad are still less studying about infographic and studying variable of number of data set and interesting points to understanding of data of infographic picture.

EXPERIMENT 1

In Experiment 1, Test number of data set to content understanding of infographic by 30 testers who are students in faculty of mass communication technology, Rajamangala university of Technology Thanyaburi which age range between 18-25 years old with no eyes defective or improved eyes defective person. Testing 6 data sets of infographic consist of 2, 4, 6, 8, 10 and 12 data sets. Example of infographic in testing number of data set as shown in figure 1.

Content of data set in testing is comparative data by using a chance in unfamiliar relationship for protecting knowledge from tester experiences such as statistic of books with temperature in book store etc. Which present data by bar charts due to bar charts is the most famous in designing infographic as well as able to clearly present the number of data set.

Researcher has been designed 24 infographic pictures which consist of 2, 4, 6, 8, 10 and 12 data sets (6 data sets with 4 contents in each data set) and 24 question sets for checking content understanding, totally 24 marks which show in blue color of infographic to control color influence in content understanding.

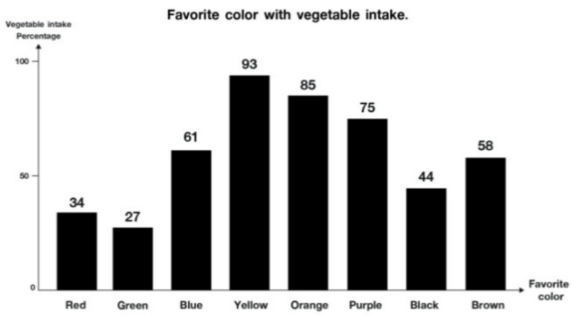

Figure 1. Example of 8 data sets presented as test stimulus.

EXPECTED RESULTS EXPERIMENT 1

We hypothesis that data set might influences to content understanding of infographic picture when data set increased, content understanding decrease. 2 and 4 data sets have understood the content of infographic picture the most. In which related to studying of Kosslyn and Stephen which have found that data set number 4, data set in showing the data difference has the most efficiency in presentation [11]. And keep in short term memory only a few second [12] and 12 data sets has the least content understanding of infographic picture due to consist of many data in understanding and difficult to remember.

If expected result shows that data set influences to content understanding of infographic, testing hue improve to content understanding of infographic will be investigated because several studies found that hue contributes to a better understanding. In experiment 2, hence, the effect of hue on content understanding will be explored.

EXPERIMENT 2

Experiment 2; testing hue to content understanding of infographic by 30 testers who are students in faculty of mass communication technology, Rajamangala university of

Technology Thanyaburi which age range between 18-25 years old with no eyes defective or improved eyes defective person. Use 10 colors in designing the infographic including of red, green, blue, yellow, yellow- red, blue-green, purple, black and gray. As shown in figure 2.

Hue of infographic designation using hue or property in identifying color by equally controlling chroma and lightness in designation in which choose color theory of opposite color partner. Designation of each infographic picture will be decided for one color in designing the bar charts, but topic, explanation and edge of bar charts used black color and white back ground.

Researcher designed 40 infographic pictures. According to the result from experiment 1, brought the most efficiency of data set in content understanding by adding more hue in designation consist 10 colors including of red, green, blue, yellow, yellow- red, blue-green, purple, black and gray (10 hues with 4 content in each data set). And 40 question sets for testing content understanding, total 40 marks, which used one data set in infographic designing to control color influence in content understanding.

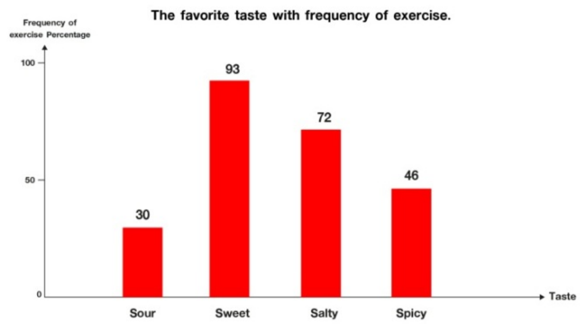

Figure 2. Example of red 4 data sets presented as test stimulus.

EXPECTED RESULTS EXPERIMENT 2

We hypothesis that hue of infographic might influences to content understanding of infographic picture which blue color has the most understanding of the content of infographic picture due to when use blue color for designing, mostly get the positive feedback and easier understand the data [13]. For yellow color, when designed white background and the appearance of the lightness of screen resulted in lesser acknowledge and also causing hardly understand the content of infographic picture.

Content understanding; a tester is able to answer in experiment correctly in which question needs to consist of understanding the content and analyze the data before answering, therefore can answer correctly including 4 choices.

Experimental room (2x2 meter), dark-closed room with covered by opaque materials which can control the lightness of room by use lightness at 500 lx as standard lightness of the room [14] and 1 set of computer, process of the experiment including;

1. The tester leanly sat on chair, perpendicular face to computer screen with space by 60 cm.

2. Keep on gray screen when sample set is ready, press 'enter' on keyboard to start the experiment

3. After that 1 second, infographic picture will be appeared at the same time, for the tester read and understand the infographic pictures. When decided time come resulted in show gray screen again. And change to question picture related to content.

4. The question will be the multiple choices. The tester press number 1, 2, 3 or 4 on keyboard, Hence, the process of the experiment has finished for 1 question.

5. The tester press 'enter' on keyboard for starting the next question. Repeat doing until complete the whole steps then completely finish.

SUMMARY

In this study, the relationship between data set and content understanding will be reported and also the effect of the hue will be investigated. Our result might give infographic designers for guideline tool of proper data set and hue of infographic. Hence, further study might properly change the infographic picture that has more detail. In the future, researcher expect to study the format of presentation and color tone to content understanding of infographic picture.

Poster paper

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Analysis on the Red Image and Arrangement of Colors utilized in Fashion Design with Flower Printings

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Keywords : Red, Flower printing, Fashion design, Arrangement of colors

ABSTRACT

This study has identified the differences on the utilization of red series colors by fashion style for fashion design expressed with flower printings. 2189 out of 112 designer brands were extracted from Paris, New York, London, Milano and Seoul collections between S/S collection of 2010 to F/W collection of 2012 for a fashion design image which were required for the analysis.

Natural Romantic style had an appearance of pale tone of RP-series. Neo-hippie style was expressing in R- and YR-series of bright and vivid tone. R-series of pale tone and RP-series of vivid tone colors were most observed in Modern style. In Maximalism style, R- and YR-series of pale tone, R-series of bright, strong and various tones were most employed. In Ethnic style, R-series of vivid tone colors were most applied. The analytic result of the color arrangement of fashion design with flower printings showed that the arrangement of complementary colors and the approximate colors were most used among coloration for Natural Romantic style and Ethnic style. In Neo-hippie style, the coloration by identical colors and high-low value of lightness were found most. In Modern style and Maximalism style, the coloration by identical colors and high-mid lightness value was more found.

The result of this study may be helpful for utilizing the colors when developing fashion design with red and flower printings.

Introduction

Among the colors, red is the first recognized and used as color in human history. Venus of Willendorf, which is known as the first human statue, buffalo paintings of Lascaux and Bitsalmun pottery use the color red. Red stands for vividness of blood and passion in the western countries while it is the color of brightness, vitality and fire in Oriental backgrounds. It has been used as the representative color of 'beauty' for both Oriental and western world. In Russia, 'krassnij(red)' and 'beautiful' has the same meaning[1]. In addition, 'Rouge', which is a symbol of sexual preference and womanhood, means red in French[2]. Furthermore, the color 'red' is the word associated with flower. Flower images have been used as design materials in various areas and in fashion, they are

[1] Harald Breaem. (2002), Die Macht der Farben. Euro books.
[2] Kim Young-In, et la. (2009), Color language of fashion. Kyomunsa.

diversely expressed as preference types mostly to symbolize the natural beauty. Therefore, red and flower have something in common in that they symbolize womanly beauty. In the previous studies, it is known that flower and red expressed in fashion have been paid attention from humanistic perspective and not studied much in detail for fashion. This study will review the related literature to examine the images of red and flowers, analyze their images in collection and investigate how red is used in tone and coloration by type of fashion design with flower printings.

Methodology

Through the literature research, this study observed the formative element of flower printings and its characteristics expressed in fashion design. The theoretical consideration on the forming element of flower image identified the symbolic meaning and image of flowers as an image and natural image of flowers represented as a subject matter of art and literature. It identified the types of flower printings expressed in fashion design and the attributes of fashion design by age with flower printings.

This study has identified the differences on the utilization of red series colors by the style for fashion design expressed with flower printings. For the analysis, 2189 images out of 112 designer brands were extracted from Paris, New York, Milan, London and Seoul collection between S/S collection of 2010 to F/W collection of 2012 when flower printings that emerged as trend. This data collection used the website 'samsungdesign.net' since September of 2012 till November. As a result of classifying the collection of images that were collected by referring to the seven types of fashion design such as Art deco style, Hippie style, Ethnic style, Neo-hippie style, Recycle style, Grunge style and Retro style in which flower printing considered in this literature research was expressed, it could be classified into Natural Romantic style, Neo-hippie style, Maximalism style, Modern style and Ethnic style. For those, the frequency, form of flower printing, arrangement and red of each type were identified.

To analyze red in fashion designs with flower printings, this study extracted 46 images made of the mixture of two colors. The YR, R and PR of the extracted images were analyzed by the tone of style pattern. They were also analyzed in terms of Munsell color schemes by hue, value and chroma.

Conclusion

The results of this study are as follows;

First, by observing the image of flower in nature, literature, art, and fashion design, all of them include ‘Beauty,’ ‘Femininity,’ and ‘Vitality of Nature’ in common, thus research acknowledged fundamental traits of the flower are these common characteristics. And the image of red in nature, literature, art, and fashion design, all of them include ‘Beauty’, ‘Allurement’, and ‘Power’. Flower and red are characterized with their symbolic meaning of beauty and both stand for life and regeneration and, at the same time, death.

Second, fashion designs with flower printings are classified as Natural romantic style, Neo-Hippie style, Maximalism style, Modern style and Ethnic style. Examining style characteristics of each type, Natural romantic style is a simple and natural silhouette focusing on human body design, Neo-Hippie style is a feminine and elegant hippie style, Modern style is elegant and sophisticated style which has restrained lines and pursued the simplicity, Maximalism style is a splendid modern romanticism style with delicate details and ornaments, and Ethnic style is a style that an ethnological motive was applied as created design in the traditional Oriental clothing composition. Examining the types of flower printings and characteristics according to the colors, Natural romantic style is comfortably and naturally expressed with small and scattered flower printings, Neo-Hippie style delivers smooth and tranquil color images of feminine flower printings, Modern style uses achromatic colors and vivid colors in simplified and abstract flower printings and Maximalism style has a characteristic of affluent color senses in romantic medieval flower printings.

Third, the analytic result of the fashion design with flower printings showed that Natural Romantic style was mostly expressed in RP-series of pale tone. Neo-hippie style was expressing in R- and YR-series of bright and vivid tone. R-series of pale tone and RP-series of vivid tone colors were most observed in Modern style. In Maximalism style, R- and YR-series of pale tone, R-series of bright, strong and various tones were most employed. In Ethnic style, R-series of vivid tone colors were most applied. The analytic result of the color arrangement of fashion design with flower printings showed that the arrangement of complementary colors and the approximate colors were most used among coloration for Natural Romantic style and Ethnic style. In Neo-hippie style, the coloration by identical colors and high-low value of lightness were found most. In Modern style and Maximalism style, the coloration by identical colors and high-mid lightness value was more found.

Table 1: Red in fashion design with flower printings

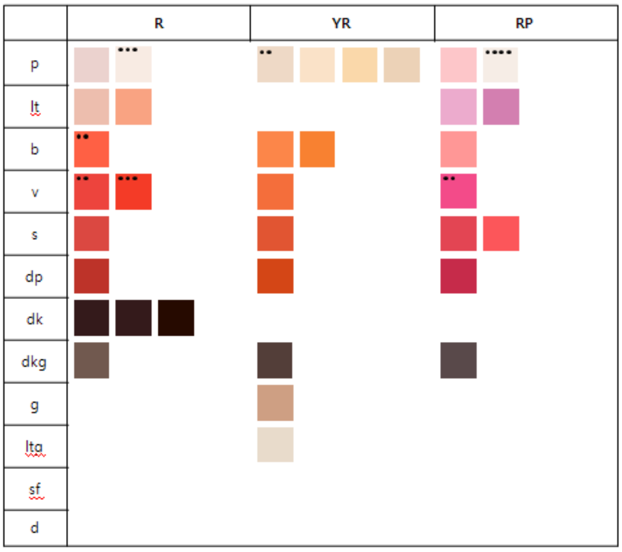

Table2: Color arrangement in fashion design with flower printings

color arrangement	identical colors	
	analogous colors	
	complementary, approximate colors	
color arrangement by value	high/mid value	
	mid/low value	
	high/low value	
color arrangement by chroma	high/mid chroma	
	mid/low chroma	
	high/low chroma	

The result of this study has its meaning for defining and systemizing the characteristic of the fashion design with flower printings. Also, the study opens possibilities for utilizing flowers and red with more various meanings and formations in the fashion, and can be utilized as a data enabling the fashion style in developing design with motives of flowers.

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Poster paper PA35

ANALYSIS ON FASHION DESIGNERS' COLOR IDENTITY IN COLLABORATION - A CASE STUDY OF GIORGIO ARMANI

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Keywords: fashion designer, color identity, color application, collaboration, integrative thinking

ABSTRACT

With rapid socio-cultural changes, there is a great emphasis on integration. Once specialized and segmented fields have now become integrated and collaborative. There are no exceptions to fashion industry.

We did a case study on creations of Giorgio Armani. The purpose of this study is to define Armani's brands' colour identity by observing colour applications of his designs, and to compare colour combinations applied. We collected photos of Armani's designs, extracted colours from these photos and made colour combinations. The result of this study is that Armani used coherent colours to show his unique look; he used brown as main colour, black and beige as sub colours and red as point colour. It also shows that the tones of colour differ according to the concept of the product.

In this study, we noticed that fashion designers use colours to show its brand identity. This study proposes a new color application method for designers working in collaboration.

INTRODUCTION

High concept and high touch are on the rise throughout the world economy and society.[1] Specialized and segmented fields of design have nowadays become integrated and collaborative. To create innovative and competitive products designers include participants from different domains to explore and integrate their specialized knowledge.[2] In particular, we can easily find fashion designers working with artists, industrial designers or brands to develop high conceptual products.

Fashion designers, to create products beyond the fields of fashion, take on new challenges to design products in different areas. The concept of fashion is much more extensive. Fashion is not just about the trends and designing clothes, but fashion is to create a fashionable life for consumers. The fashion designer Armani is one of a leading creator challenging in integrated design fields. In his official web site, he cites his design products as a whole as "Armani World". Armani world is as follow (see Table 1);

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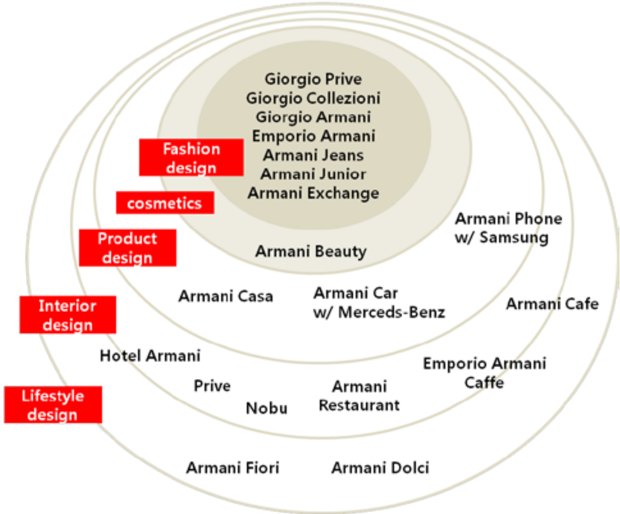
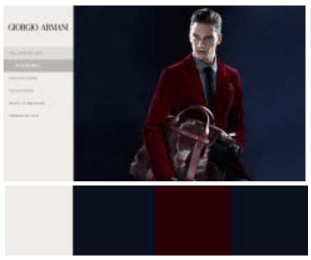
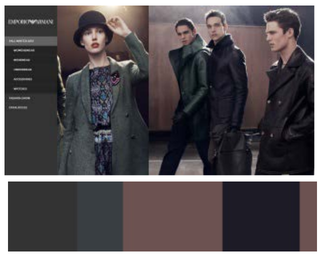
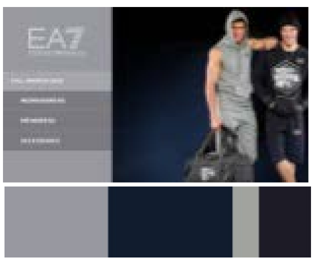
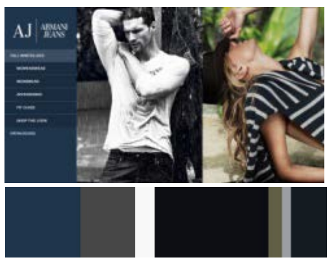


Figure 1. Armani design products

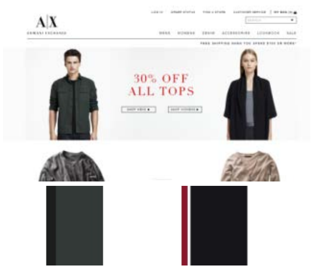
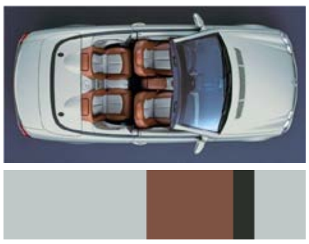
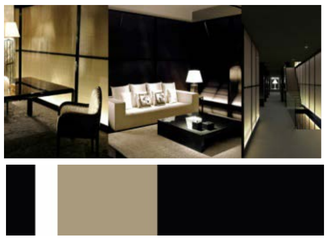
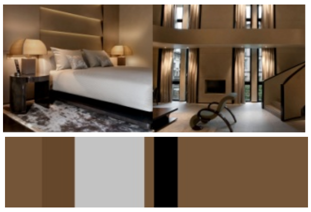
ANALYSIS

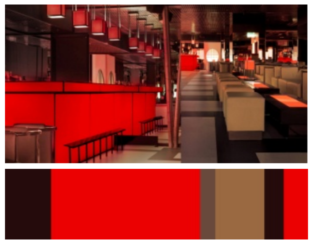
To define the influence of colours on Armani brands' identity, we observed the application of colours and combinations of colours applied. We collected photos of Armani's designs from Armani's official website. With selected photos, we made 24 colour combinations and compared the colours applied. The collected data is as follow (see Table 1);

Table 1: Colors of Armani Clothing Design

fashion design	Armani Collezioni	Giorgio Armani	Emporio Armani
Image/Color combination			
fashion design	**EA7**	**Armani Jeans**	**Armani junior**
Image/Color combination			

Poster paper

fashion design	Armani Exchange	Armani Jeans	Armani junior
Image/Color combination			
product design	Samsung [SCH-W820, SPH-W8200]	Samsung [Night Effect]	Samsung [GT-B7650]
Image/Color combination			
product design	Mercedes-Benz [CLK cabriolet]	Armani Casa	Armani Hotel
Image/Color combination			
Interior design	Armani Hotel Milano	Armani Ristorante	Emporio Armani Caffe
Image/Color combination			
Interior design	Armani Café	Armani Nobu	Armani Prive

Image/Color combination			
Interior design	Armani Fiori	Armani Dolci	
Image/Color combination			

Poster paper

RESULTS

The purpose of this study is to define the influence that colour has on the identity of creator's design activities, and its results are as follow;

First, Armani used consistent colour palette and very limited colours to show his unique look; he used brown as main colour, black and beige as sub colours and red as point colour.

Second, the colour combinations vary depending on the target of the product. For example, Emporio Armani, a fashion brand that targets young and casual consumers, uses a wider range of colours than Giorgio Armani or Armani Prive, targeting to consumers with prestigious lifestyle.

Thirdly, the colour combinations also vary depending on the concept of the product. Armani uses 'beige-brown-black' combination for luxurious design and uses 'brown-black-red' combination for casual and young design. Emporio Armani Caffe use strong and eccentric colours than Armani Cafe to show a more relaxed ambiance.

In this study, we noticed that fashion designers use colours to show its brand identity. This study proposes a new color application method for designers working in collaboration.

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Poster paper PA36

ANALYSIS OF FASHION ITEMS'COLORS IN FASHION IMAGE MAKING PROCESS

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Keywords: Colors, Fashion Items, Self-Image, Image Making Process

This study aims to confirm the need for process development for fashion image making, by analyzing colors using PCDS(Personal Color Design System) to suggest a suitable personal colors, and one's own fashion item colors making their daily fashion image. We used data collected from observing 4 female fashion major students ageing from 20s to 30s, and extracted colors from their daily fashion garments composed main and sub-items.

From the comparison of personal colors and colors of fashion items, we noticed that sub fashion items' colors were selected according to main fashion item colors, and some concordances in hue, but some differences in tone. The tones of garments worn by test subjects were more diverse and broad than ideal color tones that PCDS suggested.

This study contributes in developing new system in fashion image making process, and it requires future research on more sufficient subjects.

INTRODUCTION

Formation and transmission of personal image is indicated as an important communicative activity in Korea. Image affects an individual who gets instantly evaluated on their first look. The personal image is formed based on physical appearances such as clothing, hair, make-up, etc. These non-verbal keys help individual perceived immediately. And people judge one's impression and even social values with these keys. In order to convey their favorable image and express their individuality, people gets interested in and actively conjugate clothing, accessories, make ups, and etc.

Especially when the impression is formed, clothing acts as a transmission media of image, and is one of the key factors affecting formation of visual appearance. Moreover, during the image perception, color is the first factor of design that people strongly react to. As the color holds evident visual effect, it can be commented as the essential part of image formation. During the image formation, when choosing the specific color of one's fashion item, one's personal color must be determined. If the color chosen in the image formation suits the individual, harmonious color scheme is achieved and elevates one's image. On the other hand, selection of inharmonic color scheme won't help one's image to rise.

This study observes 4 female fashion majoring students' clothing for 20 days, and analyzes the recorded data. Consequently, this study aims to clarify the relationship between color of main fashion item and sub fashion item by comparing the color of the fashion item and the personal color.

ANALYSIS

First, we observed the image making process by checking prior factors When you wear clothes based on recorded data. By the analysis, It was found that selecting the clothes to take into account their personal color and T.P.O on a priority basis.

Second, when making an image, color is important in the formation of the individual images, so we ensure that individuals were wearing matching colors. We compared the actual color is consistent with the personal color. The following is an analysis of the 4 subject.

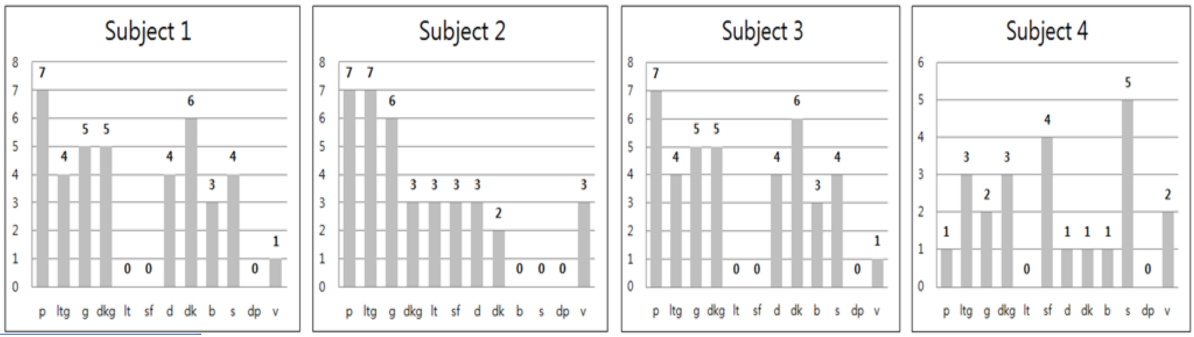

Figure 1 Tone

It is as follows: The analysis of the tone.

According to subject 1's personal tone analsyis results, the most suitable tone was strong and vivid tone. The color tone of clothing that subject 1 wore most often was grayish and dark grayish tone. Then vivid color tone followed. The unsuitable color tones, which were light, bright, and deep tones, did not appear in subject 1's clothing. By the analysis, even though vivid or strong tone is seen, when it comes to the wide area, the strong and vivid tone tend to be considered too much, so the dark grayish or grayish tone is often matched as the point color instead.

According to subject 2's personal tone analsyis results, the most suitable tone was light grayish, soft, grayish and dull tone . The color tone of clothing that subject 2 wore most often was grayish and light grayish tone. Then pale color tone followed. The unsuitable color tones, which were bright, strong and deep tones, did not appear in subject 2 clothing. By the analysis, Generally, while lightness has distributed uniformly, chroma has concentrated in low chroma range. The items that subject 2 actually wore mostly corresponded with subject 2's personal color tone, but there were some colors that broke bound of the personal tone range.

According to subject 3's personal tone analsyis results, the most suitable tone was dark grayish, dark and deep tone. When subject 3 analyzed subject 3's outfits, in terms of the tone, pale tone was most frequent, and dark tone was the next, and others were grayish, dark grayish, dull, light, or strong, which are not greatly different from other tones, and it showed that subject 3 wear various tones of clothes.

According to subject 4's personal tone analsyis results, the most suitable tone was pale, light and bright tone. The color tone of clothing that subject 4 wore most often was strong tone. Then soft tone followed. The unsuitable color tones, which were light and deep tones, did not appear in subject 4's clothing. By the analysis, Pale and Bright tones, each showed 1, and light tone was none. All of the three tones have the common feature of high brightness, and bright color is rarely worn because it gives flat and uncomfortable looks. So, the grayish colors or soft tones are the main.

Full results of the tone analysis, their personal color and their actual wearing color matches to some extent, but We have discovered great difference with their personal tone.

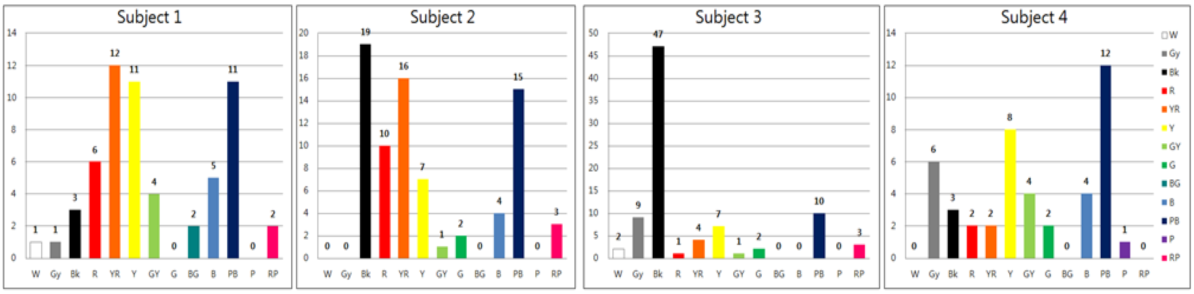

Figure 2 Color

Next, the analysis of color.

According to subject 1's personal color analsyis results, the most suitable color was blue and green color. The achromatic color such as black appeared most frequently, then grey and PB based navy followed. However, achromatic-colored clothes are major, and the color utilization is somewhat inferior. But the choice of color between GY and PB showed much higher frequency comparing to the warm colors between R and Y.

According to subject 2's personal color analsyis results, the most suitable color was red and yellow color. The achromatic color such as black appeared most frequently, then PB and YR followed.

According to subject 3's personal color analsyis results, the most suitable color was green color. It seems that achromatic-colored clothes are highly used as it is the safe choice. Twenty-two times, which is the most frequent, of subject 3's actual costume choices were achromatic colors. For the color, YR and Y,PB showed the highest. G, subject 3's personal color, showed 0 in frequency, and similarly, GY was worn only few times. However, besides, subject 3 showed various color choices such as B or R. Therefore, it showed that subject 3 frequently use different colors with subject 3's personal color.

According to subject 4's personal color analsyis results, the most suitable color red & yellow color. The achromatic color such as PB based navy appeared most frequently, then yellow & gray followed. Colors within GY and PB rather than R and Y were chosen more frequently, so the cold color's wearing frequency was much higher. On the other hand, Y, which is second highest in frequency after PB, holds a higher position in warm colors, and it is probably due to the yellowish skin colors.

Taken together the results of the analysis,, In general, their select the color of the clothes by considering the personal color. But did not exactly match their personal color.

RESULT

This research is a proposal for the image-making that can represent the personality and image of the modern people, and its results are as follow:

First, color is the priority in consideration among different components that affect the choice of items in accordance with T.P.O. It shows that color is the important and influential component in the item choice.

Second, it is shown that one wears similar but wide range of colors with one's personal color & tone. It is because one chooses items that complement one's disadvantages, considering the mutual supplementation of each item's color.

Consequently, the selection of the main item that matches one's personal color is important since it affects the choice of the sub items. It can be assumed that wearing clothes with consideration for colors among items is not only the method to find one's suitable color and express one's advantages, but also the method to complement one's disadvantages to make the image that suits oneself.

It is considered if such the analogue research regarding the image-making and personal color continues in variety, it would not only be utilized as the basic data for the expression of the color and image in the education or industry fields, but also provide the quality information for the personal image management of the modern people. Therefore, this research is expected to be the basic data that can promote effective selection of items with the colors that suit one's image in the process of the image-making.

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EFFECT OF SENSITIVITY LEVELS OF DIGITAL SINGLE-LENS REFLEX CAMERA ON COLOR IMAGE

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Keywords: sensitivity levels, digital single lens reflect, quality of the photo

Photography now is not a difficult job like in the past. However, the good photography requires both knowledge in science and art. Most critical part in photography is calculation of the exposure light. For digital single-lens reflex camera (DSLR), light sensitivity can be variously set. That light sensitivity strongly has an influence on color image quality. This research is then aim to examine the effect of light sensitivity on color image. A color checker composed of 24 color chips was taken by a DSLR setting its color temperature at 5500 K. The images were specifically taken under natural light or sunlight when the color temperature of light is equal to 5500 K. The light sensitivity levels were set at ISO 100, 200, 400, 800, 1600, 3200 and 6400. Shutter speed was adjusted to offset the amount of light in order to obtain normal exposure images. The taken images were output on two media. The first one, the taken images were output on a monitor. The second one, we developed the taken images with C-41 process and printed out on glossy paper. CIELAB of each color chips were measured by a spectrophotometer and compared between each image taken with different ISO. Our results exhibited that most color in the taken image were slightly affected by ISO sensitivity. There is no large difference of each color in each taken image except for red and blue color. At ISO 400 and 800, CIELAB of red and blue were significantly different from reference values.

ASSESSMENT OF LENS SHARPNESS AND DEPTH OF FIELD BASED ON PSYCHOPHYSICAL METHOD

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Keywords: Lens, Sharpness, Resolution

ABSTRACT

This research aims to assess the performance of the lens in terms of image sharpness and acceptable level of Depth of Field of three types of lens which are 18-105 mm f/3.5-5.6G ,50 mm f/1.8D ,and 50 mm f/1.4G. The sharpness performance was measured by comparing the photo details in the resolution test chart. The image sharpness level was examined by taking photos in five different focal distances which were focal length, +/- 10 cm focal length and +/-20 cm focal length. Also, the aperture of photo taking was specified at 8. To evaluate the result, the pairwise comparison method was used to collect the data from ten subjects who were had normal vision or to normal corrected. The performance result of sharpness expression of lens orderly were 50 mm f/1.4G, 50 mm f/1.8D and 18-105 mm f/3.5-5.6G in terms of acceptable sharpness of human eyesight which each lens had different depth of field

INTRODUCTION

The photos were used since the ancient time. There have been a lot of reasons that people would take a photo to follow their individual objectives including for recording the situations, for beauty, for being the teaching media, for evidences, for research benefits, etc. However, the most important point of photo taking is to be a medium functioning of narrating for the photographer's purposes in order to fluently tell the story to the photo audiences as the Chinese idiom saying that "A picture is worth a thousand words." In the present, people accept that images can be communicated better than other auditory nerves according to the psychologist's research reporting that humans can perceive things by five auditory nerves (eyes, ears, nose, tongue, and body touch. On the other hand, the best perceptive auditory nerve is eyes which are 80 percent perceptible compared to other auditory nerves. So, photos are media which help humans to correctly and quickly distinguish. [1]

Currently, the quantity of using 35 mm single lens DSLR camera is relatively high which can be seen from the growth of Nikon circulation in Thailand of 135,000 or 6,000 million Thai baht. Besides, lenses, another additional device that people usually buy, have different prices. Different lens prices affect an image quality which lenses contrarily express. For the quality or sharpness, the photographers have to wisely choose the appropriate lenses for their works. [2]

A factor resulting in the image sharpness is lens quality which is the most vital for the camera. Whether a photo will have a great quality depends on the lens quality. Lens is a transparent material made of glass or plastic in the circle shape with smooth surface and is usually glazed by the blue or brown solution in order to protect the reflecting or refracting light. Cheap cameras frequently have low quality lens. On the contrary, expensive cameras would use high quality lens and are able to highly transmit the light. How much lens quality will produce crystal-clear image relies on lens material quality, composed techniques, and lens arrangement. [3]

As stated, there are a lot of 35 mm single lens DSLR camera users with various sorts. Cameras and lenses, therefore, have diverse prices and qualities. Usage is depended on the photo taking purposes and applications since each photo type needs different sharpness. The researcher, consequently, would like to study the sharpness expression performance and depth of field which are acceptable for the 35 mm single lens DSLR camera.

METHODOLOGY

Table 1. Specifications of lens

Specifications / Lens	Lens Elements	Maximum Aperture	Minimum Aperture	Vibration Reduction System
Nikon AF-S DX NIKKOR 18-105 mm f/3.5-5.6G ED VR	15	3.5-5.6	22-38	Available
Nikon AF 50 mm f/1.8D	6	1.8	22	-
Nikon AF-S NIKKOR 50 mm f/1.4G	8	1.4	16	-

The researchers determined the methodology as follow

1. Study the lens sharpness expression performance by taking photos standard chart of resolution test chart [4] with three types of lenses.The specifications of 3 lenses are shown in Table 1.
2. Study the depth of field of acceptable human vision by taking photos in various focal distances, focal length, +/- 10 cm focal length and +/-20 cm focal length, and equally specifying the used aperture of eight. The in five different focal distances are shown in Figure 1.

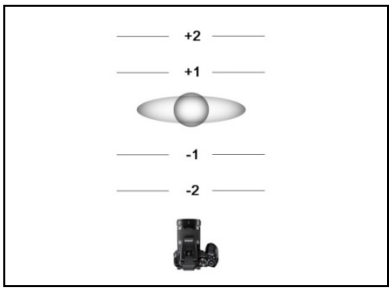

Figure 1. Example of focal length

3. Collect the data by presenting photos to ten samples to evaluate the lens sharpness performance and find the depth of field of acceptable human vision in the pairwise comparison method. Photos were seen to evaluate the sharpness in a room without other materials and the room was controlled the brightness equally every time.

RESULT

The results of the lens sharpness performance of all three studied lens types carry various sharpness expressions. That is, the lenses which have performance of the highest sharpness performance are AF-S NIKKOR 50 mm f/1.4G lens, the Nikon AF 50 mm f/1.8D lens, and Nikon AF-S DX NIKKOR 18-105 mm f/3.5-5.6G ED VR respectively. The Performance of lens are shown in Table 2.

Table 2. Performance of lens in terms of the image sharpness

Lens / Resolutions (Line)	Nikon AF-S DX NIKKOR 18-105 mm f/3.5-5.6G ED VR	Nikon AF 50 mm f/1.8D	Nikon AF-S NIKKOR 50 mm f/1.4G
Center	1200	1400	1400
Corner	1200	1300	1400
Border	1100	1200	1400

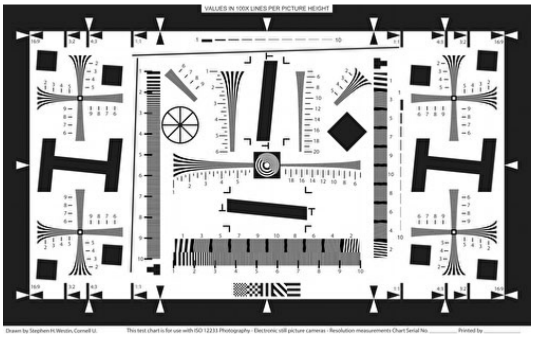

Figure 2. Example of Resolution Test Chart

In the acceptable sharpness length, according to the study, all three types of lens have the sharpness depth of field that is acceptable for human eyesight differently. That is, AF-S NIKKOR 50mm f/1.4G has sharpness length that is acceptable for the human eyesight from -20 cm focal length to +20 cm focal length. Next, Nikon AF 50 mm f/1.8D lens has the acceptable human eyesight sharpness length from -10 cm focal length to +20 cm focal length. The Nikon AF-S DX NIKKOR 18-105 mm f/3.5-5.6G ED VR lens has the acceptable human eyesight from -10 cm focal length +20 cm to focal length.

Table 3. Performance of lens in terms of acceptable level of Depth of Field.

Lens / Focal Length	Nikon AF-S DX NIKKOR 18-105 mm f/3.5-5.6G ED VR	Nikon AF 50 mm f/1.8D	Nikon AF-S NIKKOR 50 mm f/1.4G
Focal Length -20 cm	✕	✕	○
Focal Length -10 cm	○	△	◎
Focal Length	◎	○	◎
Focal Length -10 cm	◎	○	◎
Focal Length -20 cm	○	△	◎

Remark ◎ = "Very good" ○ = "Good" △ = "Acceptable" ✕ = "Poor"

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Figure 3. Example of Acceptable level of Depth of Field images from Nikon AF-S DX NIKKOR 18-105 mm f/3.5-5.6G ED VR (Focal Length -20 cm (-2), Focal Length -10 cm (-1), Focal Length (0), Focal Length -10 cm (+1), Focal Length -20 cm (+2))

CONCLUSION

We found that the lenses with the performance of sharpness expression and highest is Nikon AF-S NIKKOR 50 mm f/1.4G, Nikon AF 50 mm f/1.8D and Nikon AF-S DX NIKKOR 18-105 mm f/3.5-5.6G ED VR respectively.

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UNIQUE ILLUMINATION TO BRING OUT THE ATTRACTIVENESS OF PLANT COLOUR WITH WHITE LIGHT SOURCES OF VARIOUS SPECTRAL DISTRIBUTIONS

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Keywords: White light of different spectral distribution, Change of plant colour, Attractive plant presentation

ABSTRACT

Colour illuminations are able to give physically different colours to illuminated objects. But perceived colour changes of objects are not so effective because we have colour constancy. On the other hand, if the colours of the objects have changed without light source colour change, we should believe that colour appearance changes are the changes of objects colour themselves and colour change would be very impressive. We can realize this situation if we design appropriate combination of spectral distribution of light sources and spectral reflectivity of objects. In this study, we investigated colour changes of plants under the white illuminations with various spectral distributions. As the results of the experiments, we can find out various and distinct perceived colour changes of flowers and leaves under certain combinations of illuminations and plants. If we use this illumination technique to the flower arrangement lighting or to the lighting of the garden, we can enjoy another colour world of plants.

INTRODUCTION

We generally appreciate white lights with the high colour rendering property that reproduces original colour of the object under the sunlight. If we change our point of view, however, colour change of the things is sometimes very attractive for us as in the case of colour design in the entertainment space or in the commercial facilities. In this study, we tried to find out good combinations of white lights with low colour rendering property and corresponding colour materials to induce distinct colour change, using ornamental flower plants, to utilize colour change as good tools to appeal colour of flowers.

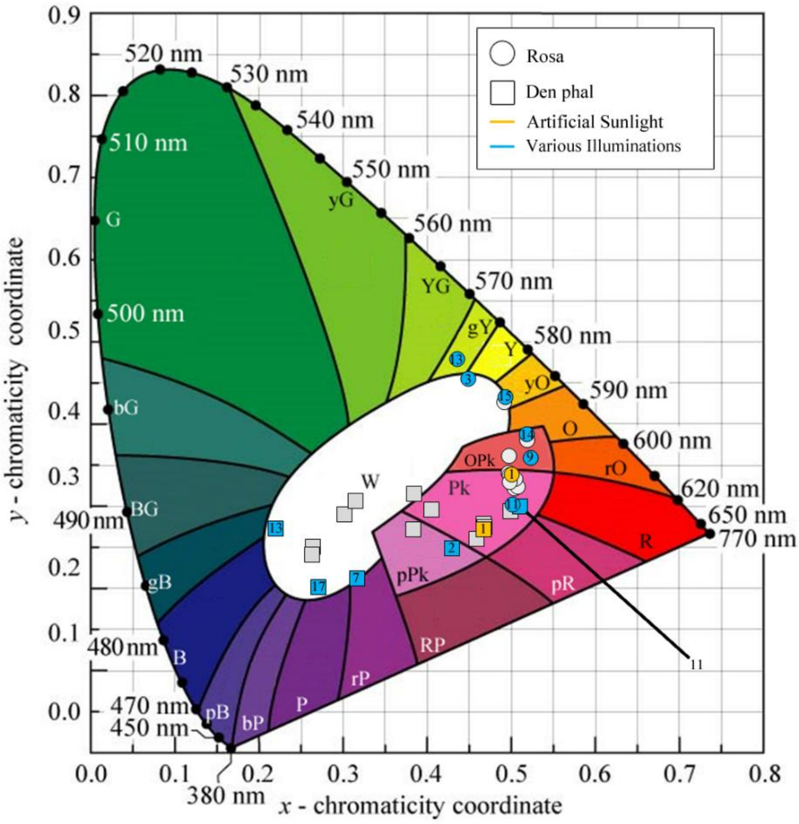
METHODS

To prepare a lot of low colour rendering property white lights, we generate spectral distributions of white lights with 3 or 4 narrow band spectral components on our colour simulator, controlling spectral distribution of lights. We checked chromaticity of the lights with spectral distributions generated on the colour simulator, using high-speed programmable light source (Gooch and Housego, OL490) and colour spectrometer (UPRtek, MK-350). We compared measurement data and the white light data, and selected by regulation of ANSI.C78.377. We can find out prepare 13 low colour rendering property white lights to use, colour assessment of flowers under illumination. On the other hand, we prepared the artificial sun light (XC-100), imitated white LED 1 to 3 which makes refer to Kyosan Corporation LED, Panasonic LED and D65 as the white light having a continuous spectrum. We prepared 17 white lights in all, and using these lights, we made the experiment for two dozen kinds of plants.

In darkroom, OL490 (It delivers an unprecedented level of flexibility and power providing high speed programmable spectral illumination.) irradiated 17 white lights to each experimental objects. The digital still camera (Canon EOS kiss x6i) took pictures of changing colour appearance about objects. ColourChecker Passport (x-rite) adjust a white balance. Using GIMP, we trimmed the photograph of the petal part and recorded a mean RGB level of the range. As to calculate colour difference, we were based on a photograph when I irradiated artificial sunlight XC-100.

RESULT AND DISCUSSION

It also confirmed that the colour appearance of leaves and flowers have changed by white illumination of various wavelength composition. And, dramatically changing of colour appearance was characterized by depending on the combination white illuminations and flowers.



(a)

light No.	Constitution of Light	CCT	CRI
1	Artificial Sunlight	5292K	97
2	Imitated White LED 1	5036K	79
3	Imitated White LED 2	4273K	81
4	Imitated White LED 3	3950K	92
5	440-510-580-630 (95-85-55-40)	4319K	82
6	470-510-590 (80-70-80)	4375K	32
7	470-540-600 (100-70-70)	5090K	67
8	440-480-540-620 (90-50-100-70)	5021K	58
9	460-500-570-630 (40-100-90-70)	3686K	80
10	490-570-620 (95-65-50)	3218K	65
11	470-540-620 (84-70-70)	3823K	54
12	470-560-640 (75-70-60)	4788K	62
13	480-560-610 (50-45-40)	3422K	60
14	480-570-590 (85-30-100)	3363K	17
15	490-570-610 (60-35-35)	2938K	49
16	490-590-680 (80-85-10)	2972K	20
17	540-530-610 (80-100-80)	4028K	66

(b)

Figure 1. Change of the Colour Appearance and Illuminations Property

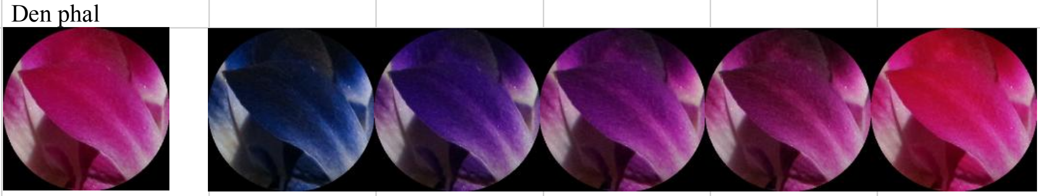
Especially, Den phal and Rosa were observed great change of the colour appearance. Figure 1, Figure 2, and Figure 3 show these change of the colour appearance. As to figure1, we plot the data of the relation white illuminations and the flowers of the colour appearance on the xy chromaticity diagram. Den phal colour appearance varies from greenish blue to pink. Rosa colour appearance varies from pink to greenish yellow. On the right of figure 1 shows the property (illumination number, wavelength constitution, correlated colour temperature, colour rendering index) of the white light. Figure 2 and figure 3 show the practical change of the colour appearance with these photographs. The data of under these photographs show colour, chrominance, illumination number, light constitution, xy-axis of the xy chromaticity diagram.

Moreover, Cyclamen persicum Mill, Celosia argentea, Chrysanthemum, Gentiana scabra var. buergeri, Dianthus superbus, and Hedera helix were observed significant change of the colour appearance.

From this result, we found that the white light without appropriate wavelength composition cannot express an object original colour exactly. Above all, we found that the white light has low colour rendering property express the system colour which is exactly different from an object original system colour.

flower name	Forever Rose					
color-change	Pink	Pink	Orange Pink	Orange	yellowish Orange	Yellow	greenish Yellow
chrominance	0	21	21	39	70	84	99
illumination number	1	12	10	15	16	6	14
CCT(K)	4312	4788	3218	2938	2972	4375	3363
CRI	93	62	65	49	20	32	17
xy-axis	(0.50, 0.33)	(0.50, 0.30)	(0.52, 0.63)	(0.51, 0.39)	(0.49, 0.43)	(0.45, 0.46)	(0.43, 0.48)

Figure 2. Change of the Colour Appearance of Rosa



flower name	Den phal					
color-change	Pink	greenish Blue	Purple	reddish Purple	purplish Red	purplish Pink
chrominance	0	101	68	53	19	15
illumination number	1	14	17	8	12	5
CCT(K)	4312	3363	4028	5021	4788	4319
CRI	93	17	66	58	62	82
xy-axis	(0.47, 0.27)	(0.22, 0.27)	(0.27, 0.20)	(0.32, 0.21)	(0.51, 0.30)	(0.41, 0.25)

Figure 3. Change of the Colour Appearance of Den phal

Poster paper

CONCLUSION

In conclusion, it also confirmed quantitatively that the illuminations of lower colour rendering property have expressed the colour is different from an object original colour under the daily sun light. We have produced the colour appearance quite different from the appearance of the flower original colour under the daytime light of the sun at all by putting wavelength composition of the white illumination light and the spectral reflectance of the pigment of the flower together appropriately. And, as to the flower arrangement and the Ikebana, we confirmed that that result is useful method to bring out the attraction of flower colour structure.

Hereafter, to achieve item ①～③ of Introduction, we will approach paints, dyestuffs, and plant pigments with this research methods. Moreover, we will analyze into chronological change of the sun light spectrum, and we will arrange the association with this study.

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Poster paper PA40

Makeup Color Combination according to FaceTypes of KoreanWomen

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Keywords: Makeup Color, Makeup Color Combination, Face Types, Korean Women

ABSTRACT

The purpose of this study is to extract preferred makeup color range and to suggest makeup color combination according to face types of Korean women.A review of Literature and FGI(Focus Group Interview) was undertaken for this study. Classifications of the face types of Korean women refer to previous study. The results of this study were as follows:

The preferred makeup color range was extracted total 39 colors composed of 23 colors of eye shadow, 6 colors of blusher and 10 colors of lipstick. There was higher ratio of Red/ YellowRed color and light tone for the overall color scheme. By analyzing the characteristic of makeup color combination according to face types, there were mainly in same or similar color schemes and color combination changing in saturation or brightness. In addition, there were differences in makeup color combination that form the face types.

INTRODUCTION

Makeup is the act to having the face as an expression object, and it is an important element that directly affects the way the face looks. Makeup makes it possible for a person to have various face images through the addition of different colors or textures on the face. In particular, color is a significant element to creating an effective makeup look, and harmonious color matching will make the look better. Poor color matching will have a negative effect.

The existing studies on makeup colors to produce specific images mostly consider skin color. Considering that face images consist of combined perceptions of form and color, it is necessary to suggest color matching also considering the morphological characteristics of the face.

Thus, the aim of this study is to determine the colors that Korean women favor, and based on these, to suggest makeup color matches for each face image type.

METHOD

1. **Face image type:** For Korean women's face image type, four types extracted from Baek's (2012) [1)] study were used: youthfulness, classiness, friendliness, and activeness.

2. **Preferred color selection and representative colors**: To select Korean women's preferred colors, previous studies on Korean cosmetics brands' colors and the actual preferred colors were reviewed. Representative color selection was done using three steps. First, the first representative colors were selected based on the results of previous studies, including the study by Youngin Kim (2003)[2)]. After this, the second representative colors were selected by

combining similar colors and giving these colors to three color specialists, who have a minimum of Ph.D. Finally, to verify the selected colors' compatibility and how they fit in the cosmetics color trends for Korean women in their 20s, five makeup specialists, who have a minimum of a master's degree, selected a total 39 colors: 10 lipstick colors, 6 blusher colors, and 23 eye shadow colors (see Figure 1).

3. **Producing Tool for makeup color combination image selection** : As a tool for makeup color combination image selection, the COS color system, which is Korea textile standard that uses color sampling produced and based on the Munsell color order system, was used to extract the samples for each colorimetric to produce the samples. Each sample's size was 2.5×2.5 cm, and for exact color distinction, they were attached to a medium grey board (N5) (see Figure 2).

4. **Makeup color combination image selection**: To extract makeup color combination images for each face image type, a focus group interview (FGI) was executed with 12 experts with over 10 years' experience. After analyzing the frequency of 60 color combinations for each image extracted using the FGI, tone was extracted in the first stage. In the second stage, the colors were extracted to create five color combination images for each face image type. Tone and color at each stage were extracted in order of frequency.

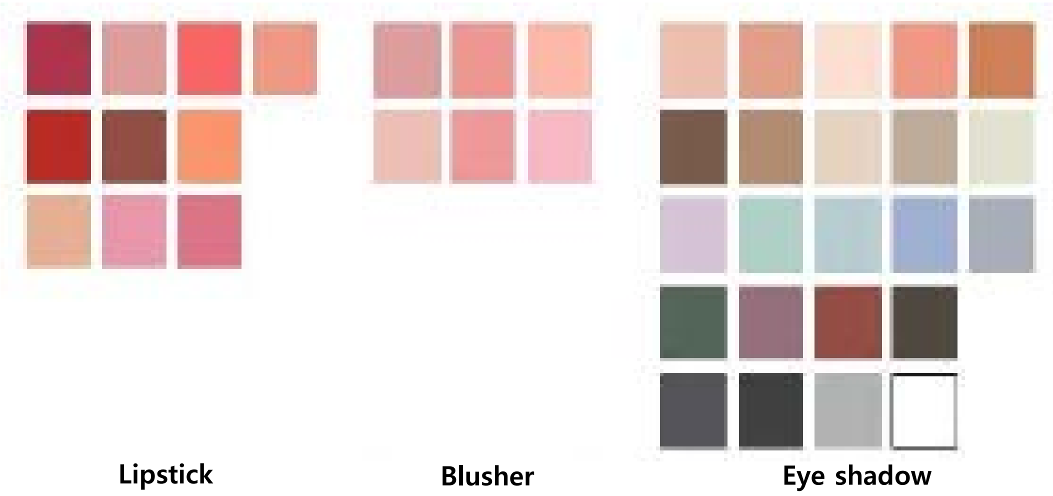

Figure 1 Selected color palette for each product category

RESULTS

1. As a result of reviewing Korean women's makeup colors, for the eye shadows, Red, YellosRed, and RedPurple colors, which can match yellow skin color, were shown in bright and soft medium/low saturation, such as p, lt, sf, and so on. On the other hand, GreenYellow, Blue, and BlueGreen colors, which can have a strong makeup effect, and vivid colors, such as v and s, have low frequency but various color scopes, and some achromatic colors were used. The color scope was narrow for the lipsticks and blushers, unlike eye shadows, so mainly Red, YellowRed, and RedPurple of p, lt, and sf were used. In particular, the lipsticks had more in Red colors and the blushers had more in YellowRed colors.

2. To produce youthfulness, based on RedPurple and Red, p, b, and lt and similar colors were mainly used. Similar colors usual matched, but sometimes there was color matching with saturation change. In particular, there was lip point makeup, which gave a point on the lip by using b colors, which have high saturation; at the same time, the eye shadows and blushers had p and lt colors that expressed softness.

3. To express classiness, there were two characteristics in color matching. First, by using colors with low saturation and high brightness and colors with low saturation and low brightness, contrast of brightness matching was used. Low brightness colors were used on the eyes to emphasize them. Second, utilizing saturation contrast, high saturation color was used on the lips to emphasize them. When comparing these two color matching methods, for the brightness contrast method, Red and YellowRed colors with low brightness and low saturation were used to emphasize the eyes. For the blushers and lips, natural sf and lt colors were used to express intelligent and urban images. On the other hand, for the saturation contrast method, the eye shadows and blushers had RedPurple and Red with low saturation, and the lipsticks had Red colors with high brightness to express beautiful and feminine images.

4. To express friendliness, overall color brightness was higher than Korean women's skin, which belongs to the medium to low scope. While part of color matching is low saturation, it still maintains high brightness, which was different from the sophisticated makeup that used low saturation with low brightness colors. For this type, rather than using point makeup, Red colors and p and lt tone colors were used, as colors were closer to the women's skin color, to express friendless and naturalness.

5. To express activeness, Red and YellowRed of lt, b, and sf colors and achromatic colors were used, and there were two types of color matching. First, the eye shadows and lipsticks used nude colors to reduce the colors as much as possible, and the blushers had high saturation colors to create a healthy look. Second, for the eye shadows, achromatic colors, low brightness or low saturation colors were used to express strong images. Different from the sophisticated look, the lipstick colors had lower brightness and saturation and YellowRed colors were used rather than Red colors, which reduced the redness on the lips to reduce the feminine look.

CONCLUSION

As a result of reviewing makeup color matching images for each face image type, it was found that Korean women's makeup color combination uses similar or identical colors with changes in saturation or brightness.

According to face image type, there were different color matching characteristics. When producing face images with makeup color combination, colors were the main element used to determine femininity, brightness was used to determined strength or softness, and saturation was used to determined naturalness and artificialness.

Where the color combination was applied was different for each image. Lips express femininity, and eyes can express strong images. For healthy and natural images, cheeks can be emphasized.

The results of this study suggest effective makeup color matching methods for each face image, and the results can be utilized as material for developing coloring products.

ACKNOWLEDGEMENT

Thank you to all fashion and makeup related researchers who participated in the specialist interviews (FGI).

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Poster paper PA41

Corrosion of Printing Cylinder on Intaglio Press

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Keywords: corrosion, printing, cylinder, intaglio, press

ABSTRACT

The Intaglio process is a security printing technique in which printing ink is carried in the grooves of a plate, accordingly, the excessive ink is wiped off to ensure that solely ink retained in the grooves has been transferred to the printing substrates. The wiping process, thus, is a very vital step consisting of the wiping solution and the blade allowing a direct contact between the wiping solution and the printing cylinder. Consequently, the wiping process affects greatly not only the printing quality but also the cylinder's life. One major problem possibly found is the corrosion caused by the reaction of iron and oxygen in the presence of water or moist environments resulting in a tremendous deterioration and damage to machinery. Accordingly, different types of wiping solutions including proper percentages of their two main compositions, namely sodium hydroxide and sulphonated castor oil were studied. The outcome shows that tap and soft water have the most influences on the rust formation while an increase in sodium hydroxide concentration in the range of 0.5 - 1% together with 0.5% of sulphonated castor oil can significantly inhibit the steel corrosion.

INTRODUCTION

The rusting of iron is formed by the reaction of iron with oxygen in the presence of water or moist environments. The chemical composition is typically hydrated iron (III) oxide ($Fe_2O_3.nH_2O$) with its appearance of brown mass. Rusting is an electrochemical process that the different parts of the iron surface act as cathodes and anodes and the moisture on the surface of iron plays a role of electrolyte between cathodes and anodes. Its phenomenon is shown in Figure. 1 and 2, and the electrochemical changes are as follows;

At the anodic site;
- Iron loses electrons (is oxidized) to form iron (II) ions. (Eq. 1)
- In the presence of oxygen the iron is further oxidized at the anode (loses electrons) to become iron (III) ions. (Eq. 2)

$$Fe\ (s) \rightarrow Fe^{2+}\ (aq) + 2e^- \qquad (1)$$

$$Fe^{2+}\ (aq) \rightarrow Fe^{3+}\ (aq) + e^- \qquad (2)$$

At the cathodic site;
- The oxygen in the air combines with water to form hydroxide ions. (Eq. 3)
- The iron (III) ions and the hydroxide combine to form rust (flaky brown substance). (Eq. 4)

$$O_2\ (g) + 2H_2O\ (l) + 4e^- \rightarrow 4OH^-\ (aq) \quad (3)$$

$$2Fe^{3+}(aq) + 6OH^-\ (aq) \rightarrow Fe_2O_3(s) + 3H_2O\ (l) \quad (4)$$

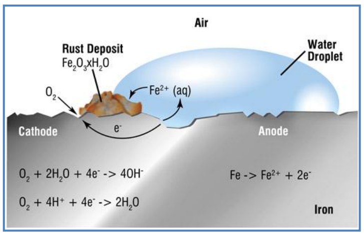


Figure 1. The formation of rust on iron or alloy

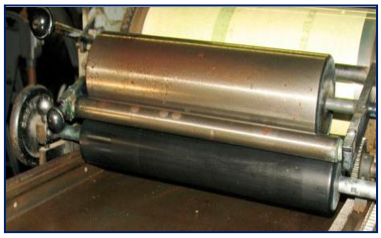


Figure 2. The formation of rust on printing cylinder

EXPERIMENT & EVALUATION

The experiments were carried out as follows,

Specimens	Steel sheets with a size of 5 mm x 30 mm x 38 mm
Wiping solution	NaOH + SCO + Soft Water
Experimental procedure	Steel sheets were immersed into the wiping solution Daily, then retrieved & let dry at room temperature

Evaluation criteria :

1. Evaluation criteria for rust formation and the wipability of the wiping solution

The evaluation criteria was categorized into 10 levels as shown in Figure 3.

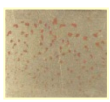
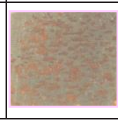
Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8	Level 9	Level 10
									

Figure 3. Evaluation criteria for rust formation

2. Evaluation criteria for the wipability of the wiping solution

$$\%\text{Wipablility} = \frac{(W_2 - W_1)\ x\ 100}{W_2}$$

W_2 = Ink on chrome plate before testing
W_1 = Ink on chrome plate after testing

Standard criteria:

Pass = Wipablility > 80%

RESULTS AND DISCUSSION

1. The Influence of tap water and soft water on the rust formation

The results showed that the corrosion of steel sheet occured rapidly when contacting with tap and soft water. The rust formation by tap water is severe than that by soft water (Figure.4 and 5).

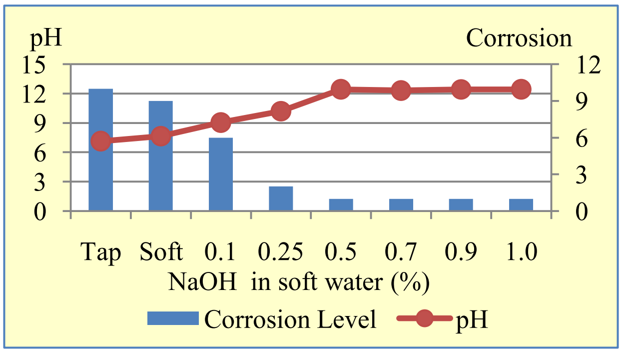
Tap Water	Soft Water
	

0.1% NaOH	0.25% NaOH	0.5% NaOH	1% NaOH
			

Figure 4. Iron rusting by pure tap water, pure soft water and different concentration of NaOH in soft water

2. The Influence of NaOH on the rust formation

An increase in the concentration of NaOH up to 0.5% resulting in a rise in a pH value to 12 helps reduce the rusting (Figure.4 and 5) as a high alkalinity prevents the iron from losing electrons to form iron (II) ions [1].



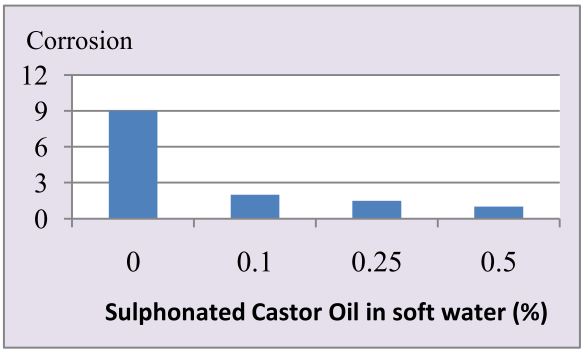


Figure. 5 Corrosion Level and pH value at different conc. of NaOH (%)

Figure. 6 Corrosion Level at different conc. of SCO(%)

3. The Influence of Sulphonated Castor Oil (SCO) on the rust formation

The effect of SCO was investigated, the result illustrated that, with its property of anionic surfactant, SCO could deter the rust formation by obstructing the functionality of oxygen[2,3] and be able to increase the wipability of the wiping solution. It was found that an addition of 0.5% SCO or more could prevent the rusting for the duration of one month, as demonstrated in Figure.6 and 7.

0%SCO	0.1%SCO	0.25%SCO	0.5% SCO
			

Figure. 7 Iron rusting at different conc. of SCO(%) in soft water

4. Rust formation and wipability

The pH value of the wiping solution is varied directly with the concentration of NaOH. Thus, at 0.5% NaOH, with a pH value of approx.12, the rust formation is greatly restrained as illustrated in Figure.8 and 9.

The wiping solution consisting of 0.5 - 1% NaOH and 0.5% sulphonated castor oil can prevent the rusting (level 1) while still possesses an excellent wipability as illustrated in Figure. 9.

0.5% NaOH / 0.5% SCO	0.7% NaOH / 0.5% SCO	1.0% NaOH / 0.5% SCO
		

Figure. 8 Iron rusting and NaOH (%) in wiping solution

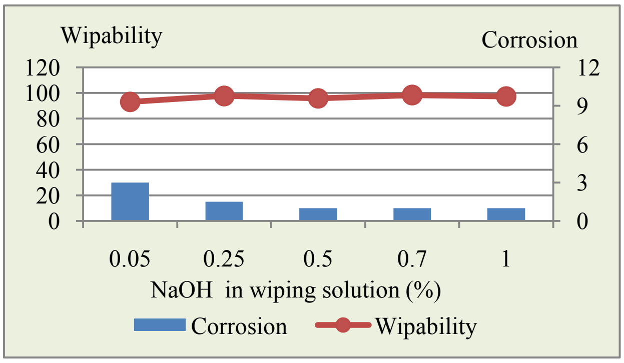


Figure 9. Corrosion level and wipability

CONCLUSION

The rust formation is occurred by the reaction of iron or an alloy containing iron, for example the steel printing cylinder, exposing to oxygen and moisture for a certain period. The usage of sodium hydroxide concentration in the range of 0.5 - 1% together with 0.5% sulphonated castor oil can greatly hinder the steel corrosion (level 1) for duration of a month while the wiping solution presents an excellent wipability.

ACKNOWLEDGMENT

The authors wish to thank Production Support Machinery Section , Note Printing Works for their support and steel sheets for the corrosion study.

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Investigation of Memory Color of Facial Flesh Using a Person's Own Picture

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Keywords: Memory color, Facial flesh, Person's own picture

ABSTRACT

Preferred flesh colors were evaluated using a person's picture as a sample to discuss the dependence of these colors on the memory color. First, the subjects were asked to color the face in their own picture (1) on the basis of their memory, (2) with reference to the reflection of their face in the mirror, and (3) with a preferred color. No clear correlation was observed between these colors and the measured facial color of the subjects. The memory color was correlated with that used in the second case mentioned above but not with the preferred color, i.e., the third case.

INTRODUCTION

In the preceding studies on the memory color of facial flesh, color patches or standard portrait photographs were used as samples for a subjective evaluation. However, it has often been pointed out that patches are different in terms of the color appearance from the portrait photographs and that the results of an evaluation using samples of a portrait photograph depend on the features of its model. Because memory color is an individual standard of the recollection for familiar objects, it is easily conceived that a person's own picture can be used as a sample for a memory color evaluation.

In this study, subjects were asked to color the facial flesh in their own picture on (1) the basis of their memory, (2) with reference to the reflection of their face in the mirror, and (3) with a preferred color, and the colors used by the subjects were compared with the measured facial color. Further, the correlation between the colors was discussed.

EXPERIMENT

Preparation of samples: We took a photograph of a subject's face from the front with careful attention to avoid shading, blown-out highlights, and reduction of his/her forehead.

Coloring the samples: The subjects (8 females and 12 males) were asked to color their own picture on a display (EIZO Flex Scan SX3031W) under 700 lx of D50 light by controlling the RGB values using Adobe Photoshop in the following process:

1) Reproduction of a flesh color that the subjects recall as their own flesh color (referred to as "Memory" from here on)

2) Reproduction of the flesh color of their face from a mirror reflection (referred to

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as “Mirror” from here on)

3) Reproduction of a preferred color (referred to as “Preferred” from here on)

The colors used by the subjects were measured directly on the display by using a spectrophotometer (Gretag Macbeth Spectrolino).

Color measurement of subjects’ facial flesh: The subjects’ facial flesh color was measured using their photographs by the same method with the colors made. Five parts from the regions between the eyebrows, under the eyes, and on cheeks were selected for color measurement by reference to a report on an analysis of visual lines during color matching operations using an eye-tracking system[1]. The average of the five colors was employed as the representative color (referred to as “Real” from here on).

RESULTS AND DISCUSSION

The correlation among “Memory,” “Mirror,” “Preferred,” and “Real” in the case of the female subjects is listed in Tables 1(a), (b), and (c) for L*, a*, and b*, respectively. The cells of correlation with significance probability of less than 5% are filled. L* revealed a strong correlation between “Real” and “Memory” and “Memory” and “Preferred,” a* revealed a correlation between “Real” and “Preferred,” and b* revealed the correlation between “Mirror” and “Memory.” The results suggest that the lightness of a subject’s skin is recalled in association of their own skin, and this results in the subjects’ individual standard of preference. However, the hue of the memory color is not associated with the subject’s real skin. Because almost all of the female subjects had applied heavy or light makeup, “Real” refers to the color of makeup; this also suggests that the subjects select the makeup color from their preference of redness not from that of yellowness.

The results obtained in the case of the male subjects are totally different from those obtained in the case of the female subjects. All values of a*, b*, and L* revealed a strong correlation between “Real” and “Memory.” Because the male subjects did not wear makeup and had a steady unpainted face, their memory color could be formed from this everyday experience.

(a)	L*	Real	Mirror	Memory	Preferred
Real	Correlation coefficient	1	.225	.822*	.696
	significance probability		.592	.012	.055
Mirror	Correlation coefficient	.225	1	.281	.178
	significance probability	.592		.500	.674
Memory	Correlation coefficient	.822*	.281	1	.956**
	significance probability	.012	.500		.000
Preferred	Correlation coefficient	.696	.178	.956**	1
	significance probability	.055	.674	.000	

(b)	a*	Real	Mirror	Memory	Preferred
Real	Correlation coefficient	1	.561	.368	.772*
	significance probability		.148	.369	.025
Mirror	Correlation coefficient	.561	1	.610	.601
	significance probability	.148		.108	.115
Memory	Correlation coefficient	.368	.610	1	.043
	significance probability	.369	.108		.919
Preferred	Correlation coefficient	.772*	.601	.043	1
	significance probability	.025	.115	.919	

(c)	b*	Real	Mirror	Memory	Preferred
Real	Correlation coefficient	1	.493	.483	.172
	significance probability		.214	.225	.683
Mirror	Correlation coefficient	.493	1	.781*	.284
	significance probability	.214		.022	.495
Memory	Correlation coefficient	.483	.781*	1	.354
	significance probability	.225	.022		.390
Preferred	Correlation coefficient	.172	.284	.354	1
	significance probability	.683	.495	.390	

Table 1. Correlation between “Memory,” “Mirror,” “Preferred,” and “Real” of (a) L*; (b): a*; and (c): b*. **: Significance of less than 1%; *: significance of less than 5%.

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THE USE OF COLOR IN THE DWELLINGS OF THE INFORMAL SETTLEMENT "LA PERLA" IN SAN JUAN, PUERTO RICO

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Keywords: Color in architecture, informal settlements, self-built dwellings, slum tourism, San Juan P.R.

ABSTRACT

This paper aims to explore the importance of color in a particular self-built informal settlement called La Perla in San Juan, Puerto Rico. The neighborhood is located next to the historic attractions of this important tourist island, but is not incorporated within the tourism industry even though its vernacular architecture may have strong appeal among tourists. The artistic use of color by its inhabitants makes La Perla an area with high tourism potential. The objective of this research is to present partial results of a color survey in the settlement and to understand what are the main colors used in the façades of La Perla. Photographs of the façades of the dwellings were analyzed using image color summarizer software and the main colors of the façades were calculated. The results show how La Perla is very colorful and also the important use of bright colors. Future research is necessary to complement this pilot study and to understand also the use of colors in the public areas.

INTRODUCTION

Puerto Rico, a Caribbean island, is a semi-independent country linked in a "commonwealth" relationship with the United States. San Juan, the country's capital, is a sprawling city with a metropolitan area population of about 2.5 million inhabitants. Puerto Rico is one of the most visited islands of the Caribbean and among its top attractions is Old San Juan, a historic colonial neighborhood protected as an UNESCO World Heritage area. Between the north ramparts of the city of San Juan and the ocean there is a stretch of land with a strong topographic inclination on which is located a slum or informal neighborhood called La Perla. "The term *informal settlement* usually refers to a piece of land that is invaded by settlers who build dwellings without an urban plan or building permits. As with many other informal settlements, La Perla has been socially segregated from the rest of the city and some of the inhabitants of San Juan are apprehensive about the level of criminality of this neighborhood due to its very bad reputation.

La Perla has many social urban problems; however its location between the only beach of Old San Juan and the city ramparts is unrivaled among any other neighborhood of the island. La Perla also has the inner beauty of its colorful vernacular architecture. (Fig.1)

This research is exploring the use of color in the La Perla dwellings. Color is an ubiquitous yet essential part of the city, it help to create and shape the urban form. [1]. La Perla has been studied by a small number of scholars and there are few articles, mostly related with health issues or popular music have been published about the neighborhood. One article related with the housing conditions and residential satisfaction of the neighborhood has been published by the author [2], in addition to a second article related to the tourism potential of the sector [3]. There are no publications concerning the use of color in La Perla, therefore this research is justified.

Color has been used in some informal settlements in order to ameliorate the image of the neighborhood. Some researchers criticize projects such as the one of the suburb Jalousie in Pétion-Ville, Haiti, where informal dwellings, in very bad condition and lacking proper services, were painted in bright colors. [4]. Colorful paint will not improve the dwellings, however, in the case of La Perla the use of color is not generated by an external funds but is part of the artistic idiosyncrasy of the inhabitants.

Fig. 1. La Perla is located between the city ramparts of Old San Juan and the ocean.

COLOR IN LA PERLA

La Perla has been traditionally inhabited by artists. Several popular singers and musical groups were born in La Perla, which also boasts many plastic artists. This fact has transformed La Perla from a crowded poor neighborhood of dilapidated wood houses during the 50's to the colorful community it is today. Most of the houses in La Perla are lively, painted and colorful murals occupy the surfaces of most of the neighborhood community areas. To the surprise of visitors many urban elements in the neighborhood are painted, abandoned houses, dwelling roofs, the floor of the basketball court: anything can be transformed into a canvas. (Fig.2) The colorful neighborhood could be the perfect complement to the historical buildings of Old San Juan.

Fig. 2. Graffiti's in La Perla abandoned dwellings.

OBJECTIVES

This article is part of a bigger research project aiming to improve the standards of living in the neighborhood of La Perla. The interesting vernacular architecture of La Perla and the use of bright colors in the neighborhood are catalytic elements that have the potential to transform "La Perla" into a tourist area. The fact that La Perla is next to the main attractions of San Juan and it is the only neighborhood in the area with access to the ocean is also an important factor to consider for the development potential of the neighborhood. This article is the first step to understanding the variety of colors presents in the neighborhood of La Perla. The use of chromatic surveys in architecture has been studied in the past in historical sites, [5] but no research in slums was founded. Here are presented results related with the main colors of the façades of private dwellings in La Perla. Future research will present the rest of the survey and will explore the use of color in the public areas.

METHODOLOGY

As previously explained this paper describes only a limited part of a large research project in the neighborhood of "La Perla" that involved many other surveys. For this study, the author with the help of students and teacher assistants, conducted photographic surveys in La Perla between September 2012 and May 2013. The group took photographs of the visible façades of all dwellings of the informal settlement in order to do a chromatic survey. The pictures of about 400 dwellings were analyzed using image color summarizer software. It measured the RGB, HUE, saturation and other colors values. In order to have a more comprehensive research the different tonalities of each color are not presented in this paper.

RESULTS

For each one of the dwelling façades several factors were analyzed including the RGB colors as in the example of figure 3. Thereafter the main color of the façade of each dwelling was classified.

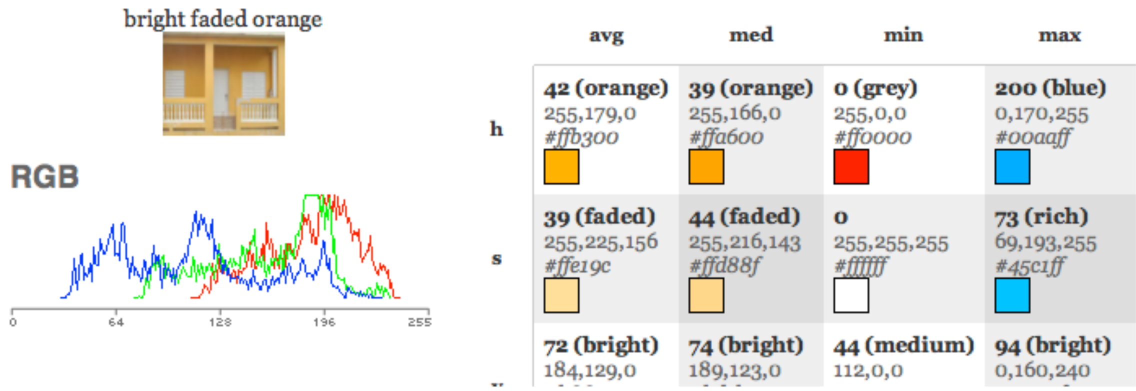

Figure 3. Example of RGB summarizer of façades in La Perla.

Table 1 represents an example of the color summarizer on one façades. In this article only the main color of the dwellings façades are presented, There is a strong presence of bright colors.

Main color of dwelling façades	Percentage of dwellings
Blue	21
Green	18.5
Yellow	16
White	15
Orange	10.5
Pink	6
Red	4
Other colors	2
Purple	1.5

Table 1. Main color of La Perla dwelling façades.

According to table 1, the most commons colors on the dwelling of La Perla are: blue (26%), green (18.5 %) and yellow (16%). Jointly orange, red and pink comprise of 20.5% of the dwellings. The percentage of white, the most common color in the rest of the city of San Juan, is a mere15% in La Perla. Tourists visiting La Perla for the first time are always impressed by the presence of bright colors in the neighborhood. As evidenced in table 1, with the exception of the 15% of white dwellings, the majority of dwellings are in color and many of those colors are bright. (Fig.4). Apart from the colorful dwelling façades of La Perla, the sector also has many public areas covered by murals. The strong presence of artists in La Perla has always generated the production of art.

Figure 4. Colorful façades in La Perla.

CONCLUSIONS

Many tourists are surprised with the intensity of colors in the Caribbean islands. The use of color in informal settlements can be considered a positive element to improve the appearance of a neighborhood; however, it can also be considered superficial. In the case of La Perla, color has been used as an expression of the culture of the neighborhood; it is not an external creation that is applied like a make-up to improve the appearance of the informal neighborhood. In La Perla color is the manifestation of the artistic abilities of a community. In the neighborhood, color is also used in murals as an instrument to express the feelings of the inhabitants and, in the case of many of the murals, to celebrate the neighborhood's idiosyncrasy. This extended abstract is only a first endeavor at future research that will investigate more about the artistic expressions of La Perla inhabitants. Without a doubt the use of color in La Perla has made the neighborhood more attractive and can be an important factor in the incorporation of the settlement in the tourist economy of the city of San Juan.

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Poster paper PA44

Façade Color of Shop-houses in Historic City in Asia

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Keywords: Façade color, Shop-house, field survey, Historic city

ABSTRACT

Shop-houses are traditional buildings in Southeast Asia, commonly with a shop on the ground floor and residence above the shop. Malacca is one of the historic cities in Asia, and designated as a World Heritage Site. In this study, we conducted the field survey on the façade color of shop-houses in Malacca, and discussed the façade color of shop-houses in Malacca and town-houses dwelling with shop called Machiya in Kyoto comparatively. As a result, low saturated colors were used on Machiya façade in Kyoto, on the basis of "Design standard for buildings and others" including color design standards. It was shown that façade design of shop-houses in Malacca was different in each era, and many colors were used in the late era of England colony. It was also shown that façade of some shop-houses were repainted in vivid color, and these façade might detract the landscape in Malacca.

INTRODUCTION

Shop-houses are commonly seen in Southeast Asia. They were built in large numbers from the 17th century thorough the early 20th century. Their structure is two or three stories in height, with a narrow frontage but long depth backward. They have one or two internal courtyards, and have a public arcade called "five-foot way" or "veranda-way". They are commonly with a shop on the ground floor and residence above the shop. The design of the façades of shop-houses is very versatile by age because it is influenced by the culture of the ruling country. They have formed a unique landscape of the city, while receiving the culture of the Western European countries by colonial rule and culture of indigenous. Malacca has been designated a World Heritage City in 2008 since it became a colony Portugal, Holland, England and has left heavily culture of these countries. The townscape consisting of old shop-houses was to be preserved by Antique Act (1976), Town and Country Planning Act (1976) and Restoration and Conservation of Cultural Heritage Enactment of State of Melaka (1988). But these laws and regulations do not define the color of the façade of shop-houses concretely.

On the other hand, Kyoto is one of the historic cities in Japan, and designated as a World Heritage Site in 1994, since Kyoto has a substantial number of historic buildings and has the largest concentration of designated Cultural Properties in Japan. There have been many traditional shop-houses called "Machiya". Kyoto city enacted a "Design standard for buildings and others" in 2007 [1]. In this standard, the use of the color, the R and YR over Chroma 6, Y over Chroma 4 and other Hue over Chroma 2, are prohibited, except the original color of wall materials. It was reported that the bright colors of plaster wall and mud wall were rated highly, and the dark colors of the red iron oxide (Bengara), bricks and wooden wall in the historical district, and also that the landscape color in Kyoto became brighter in recent years, but it is necessary to think about the landscape colors in Kyoto which make the best use of the characteristics in the historical deistrict [2].

In this study, for the purpose of understanding the color and design of shop-houses facade that make up the landscape of historic city in Asia, we surveyed the façade color of the 45 shop-houses in the preserved historical districts in Malacca, and discussed the façade color of shop-houses in Malacca and Machiya in Kyoto comparatively.

TYPOLOGIES OF SHOP-HOUSES IN MALACCA

The shop-houses of Malacca are divided into 4 types, Netherlands style, Transition style, England early period style and England late period style[3]. The facade design of shop-houses is different in each style. Figure 1 shows the 4 types of façade design of shop-houses in each. The shop-house in Netherland style has a lower base and small windows and the outside wall of them is non-decorated. The shop-house in Transition style has a lower base as in the case with Netherland style but has large windows as in the case with England style. The shop-house in England previous period does not have a lower base and second floor is overhung like a terrace. The decoration of the façade is mostly simple but outside wall under the windows of the second floor has some patterns. The shop-house in England late period has some tall windows with fanlights. The second floor of them in England late period is overhung similarly to those in England early period, and the outside wall and pillars are decorated brilliantly such as flowers, fruits or icons in myth.

a) Netherland style **b) Transition style** **c) England early period style** **d) England late period style**

Figure 1. Typologies of shop-houses in Malacca

METHODS OF THE FIELD SURVEY

In this study, we focused on a variety of facade design of shop-houses of the historic city that is specified as the core zone in Malacca. Before this field survey, we took photos of 232 shop-houses in the core zone as a preliminary survey, and we narrowed the range of survey area and focused on the targeted shop-houses in terms of the façade style and the usage conditions. We conducted the field survey on the façade color of the 45 shop-houses along Tun Tan Cheng Lock street (called Heeren street), Hang Jebat street (called Jonker street) and Bukit China street. Herren street and Jonker street are in the area many tourists visit, and we can see a variety types of shop-houses along these streets. Bukit China street is in the area where many overseas Chinese have lived, and most of the shop-houses along Bukit China street are in England late period style. We conducted the visual color measurement of outside wall, pillars, shutters, door, eave and floor of veranda way with JIS Standard Colour Charts. We also investigate the design of the decoration on the outside wall and on the floor of veranda way.

RESULTS AND DISCUSSION

We could see many colors in the core zone in Malacca. Figure 1 shows the results of the visual color measurement of the outside wall. The shop-houses with white or gray outside wall accounted for approximately half. It was shown that the outside wall in Munsell Value over 6.5 accounted for 86%, and in Munsell Chroma under 3.5 accounted for 90%.

According to the results of the color survey on the façade of Machiya in Kyoto[4], the colors of the outside wall was not so colorful, and they were only Y, YR and N. The lightness of the outside wall of Machiya in Kyoto was somewhat lower than that of the shop-houses in Malacca, and the Chroma was low as in the case in Malacca.

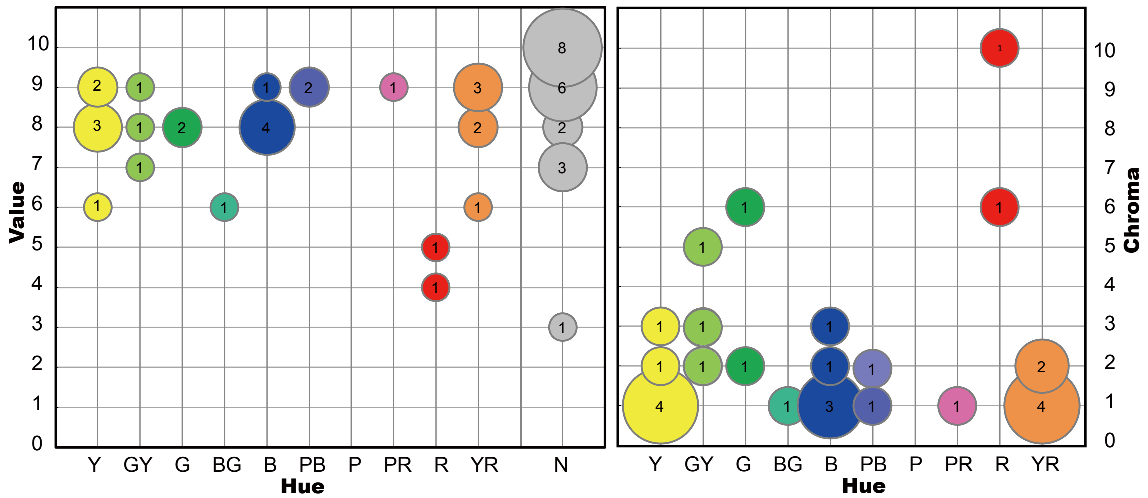

Fig.1 Results of the visual color measurement of outside wall.

Figure 2 shows the veranda way and the design of the floor of the shop-houses. The color of veranda ways of shop-houses in Netherland style and Transition style was mostly achromatic, but the color of those in England early and late period style was reddish or yellow reddish. It was cleared that the colors of design elements of shop-house façade differed in the façade style, since they were influenced by the culture of the ruling country.

Fig.2 Veranda way & design of floor

Fig.3 Rebuild or repainted outside wall of shop-houses

We could also see some shop-houses which were rebuild or repainted in vivid colors in Malacca. Figure 3 gives examples of rebuild or repainted façade in high saturated color. It was shown that the shop-houses in Netherland style or Transition style were often repainted, since the façade was aged and non-decorated. It was considered that high saturated color of the façade might detract the historical landscape in Malacca.

CONCLUSION

We could understand the landscape color in Malacca and discuss the façade color of shop-houses in Malacca and Machiya in Kyoto comparatively. The façade color of shop-houses in Malacca is very important because they have formed a unique landscape of Malacca. Actually, the shop-houses in Malacca should be fascinated to tourist and also be of great interest in business appeal for owners. Therefore, some kind of regulations or standards are required to define concretely the landscape color in Malacca in a quantitative way.

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Poster paper PA45

COLORCORRECTION FOR LED PANEL UNDER DIFFERENT ILLUMINANT ENVIRONMENT BASED ON CIECAM02

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Keywords: Color correction, LED, CIECAM02

ABSTRACT

A series of psychophysical assessment data for investigating the color appearance in LED panel influenced by the level of ambient illuminant were accumulated. The perceptual attributes of test color patches, displayed in LED panel under bright, average and dark environments respectively, were evaluated. The experimental results indicate that the lightness and brightness are larger when viewing in dark and the lightness and brightness are smaller when viewing in bright sunny day. The visual data were used to compare with the corresponding data predicted by CIECAM02, and a modified CIECAM02 color appearance model with condition parameters correction is developed. A paired comparison experiment is carried out to verify the perceptual attributes predicted by the proposed CIECAM02 have good performance in various levels of illuminant.

INTRODUCTION

LED display panels with high luminous are widely used as billboard in outdoor public area and viewed in day and night. However, it always glares the pass-by pedestrians and makes them uncomfortable because the color appearance of LEDs is significantly influenced by the luminous of the surroundings. It is necessary to investigate how the color appearance changes with the surrounding luminance level and develop a color appearance model for LED panels to accurately adjust the light of RGBLEDs resulting in the same color appearance in various luminance environments. The effect of surround luminous levels on the color appearance in various media has been studied by many researchers.JM Kim et. al.[1] focused on the appearance in small size of mobile display. It found the color gamut of a mobile display is decreased and perceived darker, less saturated by increasing the luminance of environment. Choi et al. [2] conducted a psychophysical experiments using 42-inch Plasma Display to investigate the changes in color appearance in various surround ambient conditions.

The color appearance model CIECAM02, providing equations and methodologies to predict the color appearance in different viewing conditions, has been successfully applied in many fields [3]. The color appearance prediction in various viewing condition, including different luminance levels, ranging from dark, dim and average, can be obtained by CIECAM02. However, the color appearance prediction in bright illumination is not included in CIECAM02. Previous studies indicated that CIECAM02 performed poorly to predict the color appearance in bright ambient [4][5][6]. Park, Y.et. al.[7] investigated the color appearance in mobile under varied soundings. Based on the experiment results, a refined version of CIE-CAM02, called Refined CIECAM02, was developed for mobile displays to be viewed under different surround conditions. The viewing parameters of *Nc*, *F*, and *c* from surround ratio, which is used to define surround conditions in the CIECAM02, are able to calculate accurately.

In this study, the color appearance in full-color LED panel under different luminance level environments, including dark, average and bright is accumulated to test the performance of CIECAM02, and surrounding parameters in CIECAM02 are adjusted to have good predictions for various levels of luminous ambient. Finally, paired comparison experiments are conducted, in which observers compare the color appearances of uncorrected and corrected colors predicted by model in one viewing condition with viewing in the other luminous level. The experimental results showTestCAM02 has good performance in LED panel, especially for the predictions under bright surround condition.

EXPERIMENTAL

A perceptual attributes assessment, including lightness, colorfulness, brightness and hue, was conducted under dark, average and bright environments, in which the values of surround ratio S_R were 0, 0.35 and 3.3, respectively. A color patch, produced by high luminous full-color RGBLED chips with visual angle 6°, is presented in the front of observers and is assessed in color attributes. The absolute luminance and CIExy coordinates of primaries R, G, B and white of used LEDs are shown in Table 1.Total eighteen test colors, uniformly spreading in CIELAB a*b* plane, are shown in Figure 1, where the neutral contains three different levels in lightness. The experimental setup is shown diagrammatically in Figure 2.

Table 1: The color coordinates xyY of primaries RGB and white in full-color LED

	x	y	Y (cd/m^2)
R	0.691	0.304	489
G	0.160	0.719	1103
B	0.136	0.056	174
W	0.3125	0.3277	1646

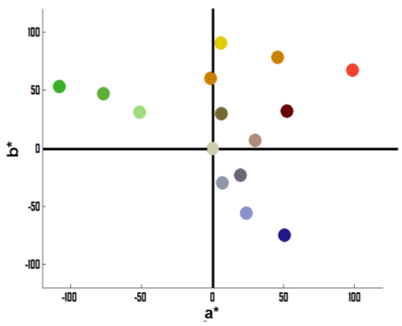

Figure1.Location of the LED test colors CIELAB a*b* plane

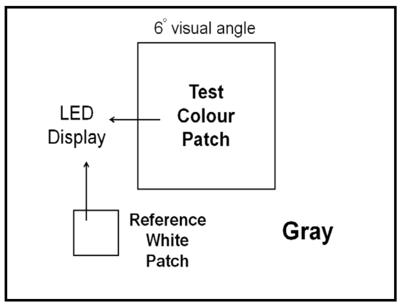

Figure2.The layout of the psychophysical experiment diagram

RESULTS AND DISCUSSIONS

The visual data of color appearance in RGBLED panel under dark, average and bright were obtained. The corresponding color perceptual attributes were calculated using CIECAM02, in which the luminous levels of dark and average are considered and the surround parameter c, F, N_c are defined. The surround parameters for bright was not considered in CIECAM02 and in this study they were set as the same as the values for average to evaluate the performance of CIECAM02. The predictions obtained from CIECAM02 model were plotted against the corresponding visual data under dark, average and bright individually. The datum points should be located on the line of 45^{o} if the predicted values agree with the experimental values. The results indicate the values of lightness in LED predicted by CIECAM02 under dark and average conditions are lower than the visual assessments. The colorfulness has better predicted performance for dark and average and a little over-estimation for bright. For the brightness, CIECAM02 gave bad predictions for all the conditions, especial the over-evaluated values under bright surround. According the results, the surround parameters c, F, N_c used in CIECAM02 were adjusted in this study to the corresponding predictions are close to the visual assessments based on RMS (Root Mean Square) method. The modified surround parameters values for dark, average and bright are shown in Table 2. The attributes in brightness Q also is modified to divide a constant 2.93 as shown in Equation 1.

Table 2: The modified surround parameters c, F, Nc

	Dark	Average	Bright
c	0.28	0.4	0.56
F	0.8	1	1
Nc	0.72	0.76	0.55

$$Q = \frac{\left[\left(\frac{4}{c}\right)\left(\frac{J}{100}\right)^{0.5}(A_W+4)F_L{}^{0.25}\right]}{2.93} \qquad (1)$$

The perceptual attribute in lightness and brightness predicted by the CIECAM02 model with modified surround parameters, called TestCAM02, were plotted against experimental visual results to test the performance of model. It indicates datum points spread along the lines of 45^{o} and the predictions are almost agreed with visual assessments. The lightness and brightness estimation fromTestCAM02 have a good performance.

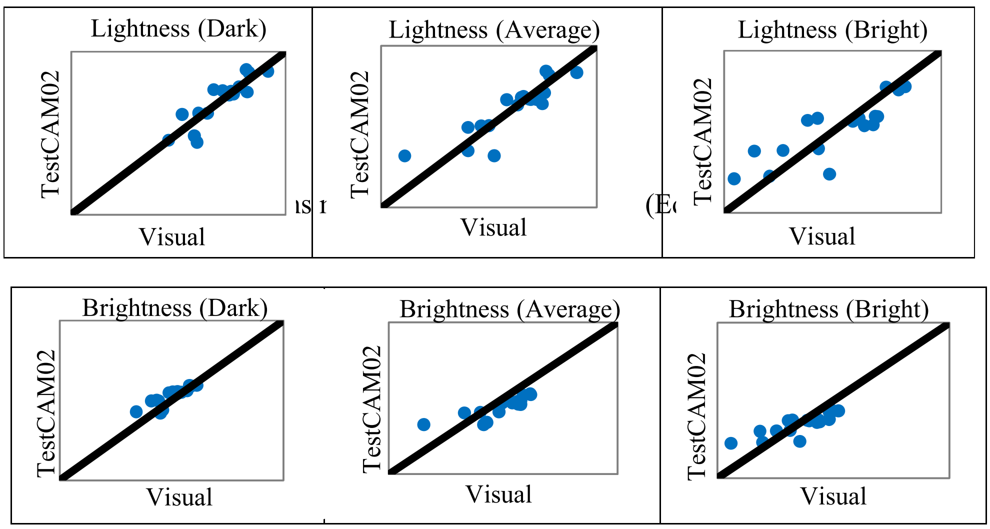

Figure 3. Diagrams of the TestCAM02 predictions plotted against experimental data

Paired comparison experiments were carried out to verify the efficiency of proposed model TestCAM02. The main advantage of color appearance model application is to correct color

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stimuli displayed in LED panel to have the same color appearance in different luminous level ambient. The corrected color images were produced through the processes of the inverse CIECAM02, and TestCAM02 in dark and bright. The corrected and uncorrected images viewing in the corresponding luminous levels were compared with the original image in average environment by observers. The observers are forced to choose which one had more similar color appearance with the original in average surround. The z score were calculated to rank the performance of CIECAM02, TestCAM02 and the result is shown in Table 3.

Table 3: The z score from the paired comparison experimental results

	uncorrected	CIECAM02	TestCAM02
Original		132	170
CIECAM02	176		196
TestCAM02	138	112	
Sum	314	244	366
Z-score	0.0494	-0.5288	0.4793
Rank	2	3	1

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Investigating the Wrong Decision of Fashion Designers on the Creativity of Color Combination for Apparel

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Keywords: Apparel, Psychophysical Experiment, Color Imagery, Originality

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ABSTRACT

Designers usually choose a lot of color combinations to match their originality of fashion apparels in conformity with their own subjective sensations. But, it may frequently result in against what they expected. Therefore, an experiment including a semantic differential method and the color psychophysical method Magnitude Estimation Method[3] was conducted in this study to explore how a designer's error is in the selection of color to give a specific creation color-meaning to her/his new apparel works compared with what people actually respond to those works. The result shows that fashion designers would have about 20% error in the selection of colors to match their originality of fashion apparels being away from those color imageries of the observers examined. It also indicates that an effective color imagery model is needed to be a good tool for designers in creating new color fashion.

INTRODUCTION

In general, from the beginning of human in prehistoric times, there exist four major original function purposes of clothing, the modesty, immodesty, protection and adornment. But, nowadays, art-work has already gravitated from the individual "Originality" of highly expressive artists to Mass-produced vision-perceptual semiotic games that facilitate audience participation and consumption.[1] Meanwhile, the role of the ultimate consumer in the fashion business is an important one and, in the final analysis, controlling. The controlling role of the consumer is not unique to the fashion industry. Every business that serves the public has to guide its operations in the light of consumer demand. Consumer demand becomes the guide to intelligent production and merchandising. A knowledge of the fundamental facts of what consumers want and why is clearly of the first importance to those who design the product, prepare the advertising and sales promotion, sell the goods and make the collections, etc.[2]

The originality on the works created by artists, in fact, frequently cannot match with the perception and demand of consumers completely. It is a great problem for fashion industry at present to have to be solved due to the importance of the role of

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consumer as depicted above. And, especially, the color imagery of consumers on fashion apparel with color combination is the first important factor among all those perception and demand ones. Therefore, the authors conducted an experiment by means of a semantic differential method and a psychophysical experimental method Magnitude Estimation Method[3] to examine the wrong decision of designers on the creativity of color combination for apparel.

EXPERIMENTAL

Two types of apparel and five fashion colors were created and employed by two designers participating in this study as shown on Figure 1. The originalities of these fashion colors for those apparels were also provided and indicated in the Table 1 before they all were arranged in the psychophysical experiment of color-imagery assessment conducted in this study.[3] And, in the visual assessment of scaling color imagery, 10 color-image specimens of apparels with fashion colors respectively described above having a large size of 3×3 square inch subtending 10^0 visual angle, shown on a flat display in a dark room. Each sample was assessed twice by a panel of ten observers including five female and five male ones, within the ages of 20 and 35. And, fifty-two pairs of semantic differential words were also used. Totally, 10400 assessments were obtained.


(a)


(b)

Figure 1 Two examples for two types of fashion apparels respectively were created by the designers in this study, (a) the first type and (b) the second type ones.

Table 1 The CIEL*a*b* coordinates of color samples tested and the related originalities given by the designer in this study.

Color Sample No.	CIE L*,a*,b* Coordinates	Originality of Designers
1	42, 2, 6	Elegant and Mature
2	43, 5, 2	Sweet and Lovely
3	44, 8, 5	Soft-beauty and Harmonious
4	62, 4, 1	Pure and Fresh
5	56, 2, 2	Graceful and Beautiful

Table 2 The mean results of visual color imageries are listed for five fashion colors tested respectively. The abbreviated CSN indicates Color Sample No., MV Mean Value and SDPW Semantic Differential Pair of Words. The symbol "+" indicates that the word with "+" has the positive meaning of color imagery, on the other hand, the other one the negative.

SDPW \ MV \ CSN	1	2	3	4	5
(+) Beautiful-Ugly	-15	26	21	21	19
(+) Complicated-Simple	-35	-20	-30	-31	-27
Relaxed-Tense (+)	-7	-34	-24	-29	-11
Mature-Young (+)	-33	21	35	19	-13
(+)Fashionable-Unfashionable	-16	32	27	7	11
(+) Respectable-Contemptible	-7	26	34	28	28
(+) Natural-Affected	-11	-11	-10	30	-4
(+) Perceptual-Reasonable	6	20	25	-3	-12

RESULTS and DISCUSSIONS

There were fifty-two pairs of semantic differential words being used in the psychophysical assessment experiment of color imagery as described previously. And, a normal repeatability of observers with the mean value of 79 in the unit of coefficient of variation (CV %) was obtained. According to the selected ratio value for every pair of semantic differential words obtained from visual results,[3] eight ones having the selected ratio value larger than 99% are chosen, and their mean results of visual color imageries are listed in Table 2 for five fashion colors tested respectively. The results indicate that the observers feel Relaxed, Simpler and Mature, but Ugly, Unfashionable, Contemptible, Affected and little Perceptual to the No. 1 fashion color tested as shown in Table 1, but this result is almost against the originality for the No. 1 given by the designers in this study.

For the rest four fashion colors No. 2 to No.5 examined, the visual results of color imageries may nearly completely match with those originalities by designers respectively, with the exception of the imagery sensation Affected. Finally, on the whole, it is obvious that a fashion designer would generally have about 20% wrong decision on the selection of color combination for his/her own creativity of fashion apparel. Further and more field trials may be needed to verify this finding.

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CONCLUSIONS

Designers determine to choose a color combination to match their originality of fashion apparel usually in conformity with their own subjective sensations. But, it may frequently result in against what they expected. The wrong decision of fashion designers was examined using an experiment with the semantic differential and the psychophysical methods conducted and carried out in this study. And, two types of apparel and five fashion colors proposed by two designers and fifty-two pairs of semantic differential words were also employed. Each sample was assessed twice by a panel of ten observers. The conclusions can be obtained as follows: a normal repeatability of observers with the mean value of 79 in the unit of coefficient of variation (CV %) was obtained. Most fashion colors tested can match with those originalities by designers. But, there still exists about 20% wrong decision on their selection of color combinations for their creativity of fashion apparels. It also indicates that an effective color imagery model is needed to be a good tool for designers in creating new color fashion.

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WASTEWATER TREATMENT FOR FLEXOGRAPHIC PRINTING FACTORY BY ADSORPTION WITH CORN COB CHARCOAL

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Keywords: Wastewater, Flexographic Printing Factory, adsorption, corn cob charcoal

ABSTRACT

The objectives of this research are 1) to study the treatment of wastewater from flexographic printing factory by using corn cob charcoal in adsorption process and 2) to examine the efficiency of corn cob charcoal in color compared with activated carbon. The wastewater from R United Printing (Public) Co., Ltd. was examined and shown that absorbance value was 3.055 at wavelength 214 nm. The wastewater was then pre-treated by precipitation with 20-g alum. The reddish color was remained in water with the absorbance value at 572 nm of 0.037. The residue contaminant was removed by adsorption with corn cob charcoal by stirring with 5 and 10 g, respectively. The treated water after adsorption with 10-g corn cob charcoal was the best which could reduce the absorbance value at 0.025 or 99.18% color removal. It was indicated that the efficiency of 10-g corn cob charcoal was near 5-g activated carbon which could reduce better than corn cob charcoal with the efficiency of 99.41%.

INTRODUCTION

Flexography printing is popular in the printing and packaging industry that used for printing the print media and corrugated box packaging. The printing use water base inks and has wastewater from the washing machine process that impact on amounts of waste water. So, researchers should recognize about waste water treatment from printing and corrugated box packaging industry. In this research, we studied the waste water from R United Printing (Public) Co., Ltd. by passing through the process of sedimentation with alum in the amount of waste water by weight and used dye adsorption process agricultural waste such as corncobs that are burned to charcoal which helps to absorb chemical contaminants and the disposal of waste, including reduce the cost of waste water treatment. So, it used as a way to organize appropriate waste water system and reduce environmental pollution down.

METHODOLOGY

1. Preparation of wastewater

Preparation of wastewater is taken from the washing flexography printing machine within R United Printing (Public) Co., Ltd. by collecting the water samples from the clarifier that use bucket on water surface and must stir water before.

1.1 The study of characteristics of wastewater from flexography printing

Measure the light absorbance or color strength of the waste water using spectrophotometer.

1.2 Treatment by sedimentation

Precipitated by alum 20-g in wastewater 1000 cubic centimeters and stirred solution for 2 minutes, with agitators and leave for precipitation about 30 minutes, then filtered through filter paper to separate water and sediment for analyzing pH and light absorbance.

2. The study of wastewater treatments by color absorption with stirring solution

Taking the water 1000 cubic centimeters when passing precipitation put in beaker and preparing agitators and magnetic stirrer for stirring solution by adjusting the rotation at 8 and put charcoal cob powder 5-g and 10-g, then stir and leave for 2 hours to separate the water after absorbing out from charcoal cob by filtration through filter paper and analyze pH value and light absorbance.

3. The analysis quality of water after color absorption.

3.1 Monitoring pH value

Take the water passing absorption process to measure pH value by pH meter about 3 times and find total average.

3.2 Monitoring the color

Take the treated water to check the color by measuring light absorbance of water. The graph is shown the absorbance in wavelength range 400-700 nm and the absorbance (Abs) at a wavelength of that color.

4. The analysis and data interpretation

4.1 The statistical Analysis of this research is mean as shown:

$$\overline{X} = \frac{\sum_{i=1}^{n} Xi}{n}$$

4.2 Percentage

$$P\% = \frac{f \times 100}{N}$$

RESULTS AND DISCUSSION

1. Properties of wastewater from process of flexography printing

Figure 1 shows the wastewater from the washing flexography printing machine does not precipitate. Found that the turbidity of the water is dirty and has a lot of sediment. The pH value is 6.73. It indicates that the property is a weak acid. And Figure 2 shows the absorbance in the wavelength 400-700 nm with spectrophotometer. It’s shown that absorbance value was 3.055 at wavelength 214 nm.

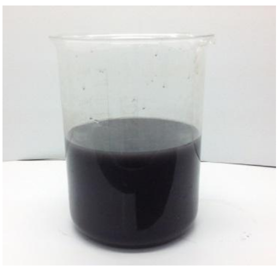

Figure 1. The wastewater from the washing flexography printing machine does not precipitate.

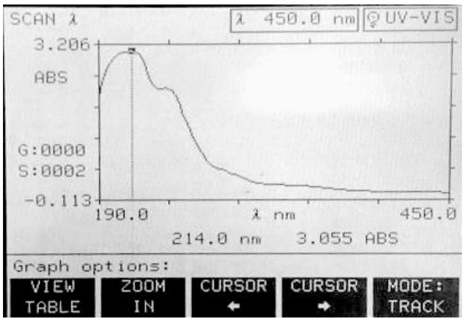

Figure 2. The wavelength and the absorbance value of the wastewater from spectrophotometer.

Precipitated by alum 20-g in wastewater 1000 cubic centimeters and stirred solution for 2 minutes, with agitators and leave for precipitation about 30 minutes, then filtered through filter paper to separate water and sediment. It was found that the water was more clear and sediment were decreased in Figure 3

Figure 3. the wastewater was filtered through a filter paper.

2. The adsorption for color removal by stirring

Measure the pH value and absorbance measurements to examine the efficiency of corn cob charcoal in color compared with activated carbon by stirring with 5 and 10-g, respectively. Figure 4 and Figure 5 show pH value and the absorbance value of the treated water after adsorption for color removal by corn cob charcoal and activated carbon. It indicated that the activated carbon and the corn cob charcoal could reduce acidity of the treat water and the absorbance value also decreased. 10-g of activated carbon could reduce better than corn cob charcoal with the absorbance value at 0.003.

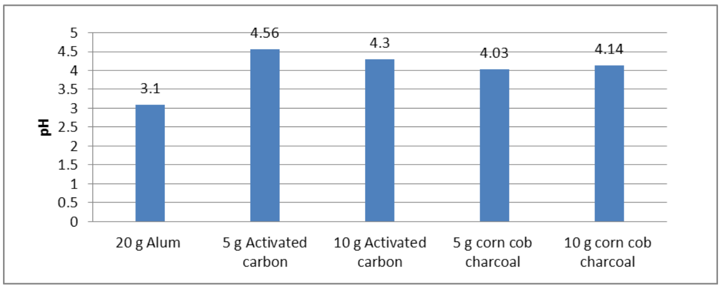

Figure 4. The pH value of the treated water after adsorption for color removal by stirring with activated carbon and corn cob charcoal.

Poster paper

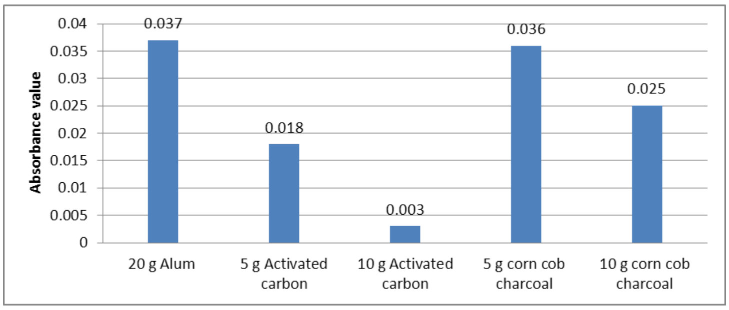

Figure 5. The absorbance value of the treated water after adsorption for color removal by stirring with activated carbon and corn cob charcoal.

The efficiency of corn cob charcoal in color compared with activated carbon was examined and was shown in the table 1. It shows that the efficiency of activated carbon in color removal is better than the corn cob charcoal. However, 10-g corn cob charcoal could reduce the absorbance value with the efficiency of 99.18% color removal. It was near 5-g activated carbon which could reduce better than corn cob charcoal the efficiency of 99.41% color removal. However, both activated carbon and corn cob charcoal could reduce the acidity of the treated water as well.

Table 1: The efficiency of color removal

Quality	Corn cob charcoal		Activated carbon		Difference	
	5-g	10-g	5-g	10-g	5-g	10-g
pH value	4.03	4.14	4.56	4.30	0.53	0.16
Color removal (%)	98.82	99.18	99.41	99.89	5.73	0.71

CONCLUSION

Agricultural waste is an option that can reduce the cost of wastewater treatment. The treated water after adsorption with 10-g corn cob charcoal was the best which could reduce the absorbance value at 0.025 or 99.18% color removal. It was indicated that the efficiency of 10-g corn cob charcoal was near 5-g activated carbon which could reduce better than corn cob charcoal with the absorbance value at 0.003 or the efficiency of 99.41%. However, both activated carbon and corn cob charcoal could reduce the acidity of the treated water as well.

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CHITO-CHITO: CHITOSAN AS TURBID-COLOR ADSORBENT ON "*TEMPE*" INDUSTRIAL WASTEWATER

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Keywords: Chitosan, adsorbent, *tempe* wastewater, fisheries waste

ABSTRACT

Citeurep is *tempe* industrial center in Bogor, consisting of 300 crafters. *Tempe* industry will produce waste 3000-5000 liters/ton of products [1]. *Tempe* wastewater has TDS (25,060 mg/l), TSS (4,012 mg/l), pH (4.16), *temp*erature (75ºC), NH3N (26.7 mg/l), BOD (31,380.87 mg/l) and COD (35,398.87 mg/l) and has turbid/brown color which has passed the quality standard for environmentally safe waste [2]. Fisheries industry in Indonesia reached 5.3 million tons/year that will produce wastes such as shrimp shells which reached 65%-85% of the mass [3][4]. Shrimp shells can be processed into chitosan as an effective adsorbent for reducing aquatic-pollutant using Suptijah methods [5][6]. The results showed that chitosan has good performance at pH 6.6 to 6.8 and 175-225 ppm. In these conditions, chitosan can lower the value of 94.33%-95.17% turbidity, TSS 95.10%-95.82%, BOD 72.09%-79%, COD 76.72%-79.40%, TKN 12.50%-27.82%, NH3 80.84%-82.56%, NO2-N 47.69%-54.74%, NO3-N 19.39%-40.14% [7].Thus, addition chitosan on *tempe* wastewater before disposal can reduce environmental pollution.

INTRODUCTION

Indonesia is an agricultural country with a population growth rate reached 1.56% annually [8]. The high population growth in Indonesia, led to an increase in the need for food to meet the nutritional needs of the Indonesian people. Soy is one of chosen food by Indonesian people to meet the vegetable protein. Indonesia needs two million tons of soybeans per year until 2008. 1.2 million tons of soybeans consumed as *tempe* and 0.8 million tons of soybean as another processed food with soy consumption growth rate reaches 7.22 % per year [9]. Thus, the *tempe* production will be produced harmful waste 3000-5000 liters/tons product [1]. It means, Indonesia will produce 3.6-6.0 billion liters of *tempe* wastewater every year with the addition of waste volume up to 0.43 billion liters per year.

The *tempe* wastewater has passed the quality standard for environmentally safe waste and harmful for the environment [2]. The waste has *temp*erature 75º C that can damage aquatic habitats. The content of TDS (Total Dissolve Solid) reached 25.060 mg/l, TSS (Total Suspended Solid) reached 4.551 mg/l , pH 4.16 , BOD (Biological Oxygen Demand) reached 31,380.87 mg/l and COD (Chemical Oxygen Demand) reached 35,398.87 mg/l.

On other hand, Fisheries industries in Indonesia has produced waste up to 5.3 million tons/year [10]. The high abundance of the fisheries wastes must be utilized especially in reducing the negative effects of *tempe* wastewater. Fisheries wastes treatment primarily of chitin from shrimp shells that reached 65-85 % of the total mass can be modified to chitosan and used as pollutant adsorbent in *tempe* waste water to makes it safe to be discharged into the environment [3][4].

RESEARCH METHOD

In this research is used meta-analysis method. Its refers to methods that focus on contrasting and combining results from different studies, in the hope of identifying patterns among study results, sources of disagreement among those results, or other interesting relationships that may come to light in the context of multiple studies.

TEMPE WASTEWATER

Tempe is one of favorite food for the Indonesian people with the level of consumption reached 1.2 million tons annually [9]. The high demand for *tempe* would also increase *tempe* waste water that harmful for the environment.

Table 1: The Content Analysis Results of *Tempe* Liquid Waste Water

No.	Parameter	Unit	Standard Safe Waste Water Quality	Liquid from Stew Soybean (Average)	Liquid from Immersion Soybean (Average)
1.	*Temp*erature	^{0} C	45	**75**	32
2.	TDS (Total Dissolve Solid)	mg/l	5.000	**25.060**	**25.254**
3.	TSS (Total Suspended Solid)	mg/l	500	**4.012**	**4.551**
4.	pH	-	5 - 9	6	**4,16**
5.	NH_3N	mg/l	20	16,5	**26,7**
6.	NO_3N (Nitrate)	mg/l	50	12,52	14,08
7.	BOD (Biological Oxygen Demand)	mg/l	300	**1.302,03**	**31.380,87**
8.	COD (Chemical Oxygen Demand)	mg/l	600	**4.188,27**	**35.398,87**

Source: Wiryani, Erry. *Analisis Kandungan Limbah Cair Pabrik Tempe*. Semarang: Fakultas Matematika dan Ilmu Pengetahuan Alam Universitas Diponegoro.

Based on Table 1. The wastes potential to contaminate the surrounding water environment. *Tempe*rature of liquid wastes derived from boiled soybeans reached 75^{O}C, it will endanger the lives of aquatic organisms. The optimum *tempe*rature for the living things in water is 25-30^{0}C. River water *tempe*rature rise will disrupt the lives of animals and plants because water dissolved oxygen levels will drop along with the *tempe*rature rise [11]. Plants will stop growing at water *tempe*ratures below 10^{0}C or above 40^{0}C. There is a reciprocal relationship between dissolved oxygen and the rate of breathing creatures live. Rising *tempe*ratures will lead to increased respiratory rate and decreased mortal dissolved oxygen in the water. The rate of decline in dissolved oxygen (DO) caused by organic waste will be faster because of the increased pace of breathing creatures higher [12].

Wastewater from the process of boiling and soaking soybeans, has a value of TDS and TSS were far beyond standard effluent quality standard. Effect of suspended solids (TSS) and dissolved solids (TDS) varies, depending on the chemical nature of the suspended material nature. Harmful effects on fishes, zooplankton and other creatures in principle is clogging the gills by particles that cause affixation. Besides, it also have an effect on fish behavior and the most common is a rejection of the murky water , ate barriers as well as increased search of shelter. Patterns found in rivers that receive most of the suspended solids, in general is the reduced number of species and number of individual living beings [12].

Acidity of wastewater from soybean water quality standard has been exceeded standard. Waste water and effluents from industrial activities are discharged into waters will change the pH of the water, and may affect aquatic organisms. Normal water are eligible for life has a pH ranging between 6.5-7.5 [11]. Waste from *tempe* production is included in the biodegradable waste that can be destroyed by microorganisms. Organic compounds contained in it will be destroyed by the bacteria even though the process is slow and often accompanied by the release of a foul odor. Ammonia concentration of 0.037 mg/l was able to cause the stinging smell of ammonia. In domestic waste, most of the organic nitrogen is converted to ammonia in anaerobic decay and become nitrate or nitrite on aerobic spoilage [13].

Tempe waste water turned out to nitrate is below the threshold, but the free ammonia from waste soy marinade has exceeded the threshold, it can certainly harm the marine environment. Biodegradable waste material is a nutrient for aquatic plants [14]. Biodegradable waste ingredients high in water can cause eutrophication that results in a population of some plants blooming water such as Algae , Phytoplankton and Water Hyacinth (*Eichhornia crassipes Solm*) [11]. Lead to an increase in local benthic eutrophication dissolved oxygen shortage will widen. This can reduce the amount of suitable habitat for fish and can cause a decrease in the overall number of fish [12].

Values of Biological Oxygen Demand (BOD) of the effluent is so high that the amount of oxygen required by microorganisms to degrade in the waste waters is very large. Organic materials will be broken down by microorganisms into CO_2, H_2O and NH_3 gases. NH_3 gas is causing foul smell. Likewise, the number Chemical Oxygen Demand (COD) is very high so it will require a very large oxygen so the waste can be oxidized through chemical reactions. In this case the organic waste will be oxidized by *potassium bichromate* ($K_2Cr_2O_7$) gas into CO_2 and H_2O and chromium ions [11]. The wells of water used in the process of making this *tempe* has criteria still meet water quality standards of class B, which is colorless, tasteless and odorless normal as well as turbidity, dissolved solids and pH are still health qualify .

CHITOSAN

Chitosan is a natural resin that can be made from the skin, head and leg shrimp. Moreover chitosan is derived from chitin which is a natural polymer found in shrimp shells or waste about 10% -25%. Chitosan is derived from chitin modified chitin *diacetylation*. These compounds can be processed and used as absorbent material heavy metals generated by industrial waste. Chitosan is a natural polymer that is non- toxic, environmentally friendly and more easily degraded naturally. The nature and function of chitin and chitosan are very diverse. Chitin is very prominent in his ability as an absorbent, whereas chitosan stands out in its ability as a binding or chelating the coagulation and flocculation process, but it also serves as a stabilizer, thickener, filler, pen-gels, films and other packaging, so much needed in the industry drugs, cosmetics, food, paints, adhesives, paper, sewage treatment, fertilizer and others [15].

One of the utilization of shrimp shells is to be processed into chitosan. Chitosan is a cationic polyelectrolyte and polymer chain length, has a large molecular weight and reactive because of the amine and hydroxyl groups that act as electron donors. Because of the properties, chitosan can interact with colloidal particles contained in the waste water through a process of bridge between flock particles (coagulation) [16]. The turbidity of waste water was able to reduce by adding chitosan as a coagulant [17]. Long molecular chains of chitosan is able to trap particles suspended in solution and makes agglomeration, thereby functioning as a coagulant [16].
Chitosan has the properties of a good soak and agglomerate. These compounds can be used as an absorbent material heavy metals generated by industrial waste including waste from the printing industry [18].

Manufacture Of Chitosan

A. Manufacture chitin

Deproteination
This process is carried out at a *tempe*rature of 60-70° C using a 1 M NaOH solution with shrimp powder with NaOH ratio = 1:10 (g powder / ml NaOH) while stirring for 60 minutes . Then the mixture was filtered to separate the sediment taken.

Washing and drying
Sediment washing is done by using distilled water until neutral pH. Then filtered and dried sediment to be taken.

Demineralization
Mineral removal is done at a *tempe*rature of 25-30 ° C using 1 M HCl solution with a ratio of the sample with a solution of HCl = 1:10 (g powder / ml HCl) while stirring for 120 minutes . Then filtered to take sediment.

Decoloration
Demineralized sediment extracted with acetone and be bleached with 0.315 % NaOCl (w / v) for 5 min at room *tempe*rature. Comparison of solid and solvent 1:10 (w / v)

Washing and drying
Sediment washing is done by using distilled water until neutral pH. Then filtered, and the precipitate dried

B. *Deacetylation* of chitin into chitosan

Chitin that has been generated in the above process included in the NaOH solution with a concentration of 20, 30, 40, 50 and 60 % (by weight) at a *tempe*rature of 90-100°C, while stirring constant speed for 60 minutes. The result is a slurry was filtered, the precipitate was washed with distilled water and then added that dilute HCl pH neutral and then dried. Then formed chitosan. Furthermore chitosan were analyzed using FTIR method to determine the degree of *deacetylation* (DD). Powder samples in KBr pellets were made later determined spectrum [19].

USING CHITOSAN

Processed fisheries waste in the form of chitin into chitosan can be used as an absorbent to lessen environmental pollution due to *tempe* wastewater. It also will double impact on utilization of fishery waste that is not has benefit. The main pollutant in *tempe* wastewater will be minimized by the addition of chitosan powder as much as 175-225 ppm and adjust pH between 6.6-6.8 to obtain the most effective of chitosan adsorbent.

Poster paper

Visually, *tempe* waste water has brownish liquid resulting from suspended particles such as proteins and fats. These particles are able coagulated by [16]. Suspended particle coagulation of *tempe* wate water processed will produce translucent color. Besides a result of the suspension of protein and fat, brown liquid waste *tempe* also due to suspended materials such as sand, silt, organic matter, inorganic and other microscopic materials causes the increasing in effluent turbidity values [6]. Further *Dunnett's* test gives the best results for turbidity impairment waste up to 95.17 % with chitosan concentration of 200ppm [6].

Turbidity of the waste is also caused by the value of total suspended solids (TSS). Suspended solids are matters that cause turbidity of the water, insoluble and does not precipitate directly. Suspended solids composed of particles smaller size and weight of the sediment, such as clay, certain organic materials and certain cells of microorganisms. *Dunnett's* test further stated that mixing chitosan with a concentration of 200 ppm would reduce TSS up to 95.82% [6]. It means that the value of the original TSS reached 4,551 mg/l will be reduced to 190.23 mg/l.

Other contaminants indicator is the value of BOD (Biochemical Oxygen Demand). Higher the BOD value indicates that water quality is getting worse. Further *Dunnett's* test results with chitosan treatment concentration value of 200 ppm would reduce BOD by 75 % means that the original content of effluent BOD *tempe* reached 31,380.87 mg/l will drop to 7,854.21 mg/l, whereas for liquid waste from soy marinade will reduce BOD values up to 327.00 mg/l. COD (Chemical Oxygen Demand) is also an indicator of water pollution, the higher the COD value indicates that the water contains a lot of organic materials and inorganic. Further *Dunnet's* test showed that the addition of chitosan with COD concentration of 200ppm would reduce up to 79.40 %, Mean COD will decrease up to 7291 mg/l.

Total value *Kjehdahl* Nitrogen / TKN, the method of analysis to identify the amount of organic nitrogen contained drafts of the materials in the form of protein, ammonia, nitrite and nitrate [20]. The addition of chitosan with 225 ppm concentration will reduce TKN values up to 27.82 %, 82.56% ammonia, 54.74% nitrite and 40.14% nitrate. The nitrogen content would be harmful to the environment and health if the water content exceeds safe limits.

CONCLUSION

The results showed that chitosan has good performance at pH 6.6 to 6.8 and 175-225 ppm. In these conditions, chitosan can lower the value of 94.33%-95.17% turbidity, TSS 95.10%-95.82%, BOD 72.09%-79%, COD 76.72%-79.40%, TKN 12.50%-27.82%, NH_3 80.84%-82.56%, NO_2-N 47.69%-54.74%, NO_3-N 19.39%-40.14% [7].Thus, addition chitosan on *tempe* wastewater before disposal can reduce environmental pollution.

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Poster paper

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PROCESSING QPM CORN 'SRIKANDI PUTIH' VARIETIES AS A STAPLE FOODS SUBSTITUTE FOR RICE WITH LONG DURABILITY WITHOUT PRESERVATIVES

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Keywords: Corn, staple foods, instant, white, durable.

In Indonesia, the use of corn (*Zea mays*) as a staple food source is low. Communities argues that corn is the food of the lower classes, in contrast to paddy (*Oriza sativa*). This is because the value of fresh corn are quite low with a different texture to the rice, though corn has a higher nutritional value than rice. Adding value to corn as a qualified staple food in the community is required by processing corn into ready-made household products, such as instant rice. Corn used for manufacture is corn with high protein quality (QPM), namely the 'Srikandi Putih' varieties. Unlike yellow corn, texture of 'Srikandi Putih' instant rice like white-colored grains. White color will give the impression of sterile food. This color will attract the public to food diversification because white are symbolizes purity, cleanliness, and freedom. Instant rice from these materials can survive for more than five years.

INTRODUCTION

Although the background of corn as a Indonesia's second largest food commodity, the use of corn as a staple food has not been popular. Corn is commonly used as animal feed ingredients. Whereas the production of corn in Indonesia is currently 18,327,636 tons of dry beans per year, up by 697,888 tons (3.96%) than in 2009. Meanwhile Angka Ramalan II (ARAM II) of corn production in 2011 was last year estimated at 17,392,246 tons of dry beans, down as much as 935,390 tons (5.10%) than in 2010. Decrease in production is expected to occur due to a decrease in harvested area covering 225,925 hectares (5.48%) even though productivity rose by 0.28 quintal / ha (0.63%) [produksi jagung yang html]. With the productivity of this magnitude, corn can be used as a staple food source for the Indonesian society, not just fodder.

Table 1. The Nation **Comparison of Farmland Width, Productivity, and Production of Corn.**

DESCRIPTION	2009	2010	2011 (ARAM II)	IMPROVEMENT			
				2009-2010		2010-2011	
				ABSOLUT	%	ABSOLUT	%
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Farmland Width (ha)	**4.160.659**	**4.121.676**	**3.895.751**	**-38.983**	**-0,94**	**-225.925**	**-5,48**
Productivity (kuintal/ha)	**42,37**	**44,36**	**44,64**	**1,99**	**4,70**	**0,28**	**0,63**
Production (ton)	**17.629.748**	**18.327.636**	**17.392.246**	**697.888**	**3,96**	**-935.390**	**-5,10**

Disinterest of Indonesian society to consume corn as a staple food due to corn marketed without any added value. To get value-added, corn should be processed into other forms. One of them is processed into instant corn rice that can survive more than five years in dry and not damp atmosphere. In addition to advantages in terms of durability, instant corn rice practical enough for public consumption, only brewed with hot water and stirred for approximately three minutes.

The use of QPM corn 'Srikandi Putih' varieties as a base for the manufacture of instant corn rice will give more value in terms of nutritional value and shape. QPM corn varieties are native to Mexico are free of synthetic essence group. Age of plant varieties for the physiological range between 105 to 110 days. Potential yield 8.09 tons / ha seed beans with an average per harvest 5.89 tons / ha beans seed. QPM corn varieties recommended for planting in the lowlands during the rainy season. In nutrient content, 'Srikandi Putih' corn has a composition of nutrients that is more complete than the rice. 'Srikandi Putih' corn varieties currently examined by the Assessment Institute for Agricultural Technology (BPTP), Central Java, along with varieties of Synthetic Maros-2 (MS-2).

Figure 1. 'Srikandi Putih' Corn Varieties
http://iaard.go.id/varietas/one/463/

METHODOLOGY

Materials used in the manufacture of durable instant rice made from QPM corn 'Srikandi Putih' varieties is QPM QPM corn 'Srikandi Putih' varieties seeds, water, bowl, grinding machines, corn sheller tools, tarps to mat drying, the drying, enclosed storage areas, sifter , steamer, and sunlight. To improve the efficiency of time, then made the release of seed corn from the cob performed using a corn sheller. Corn to be processed to be done the corn rice with comminution process.

Ways of making instant rice corn is coarsely ground corn kernels, and then sieved using a sieve with 1.4 mm hole size. The fraction that passes is the chaff sieve, then ditampi to remove impurities, then washed and soaked for about three days, then drained until the water runs out. Immersion aims to obtain rapid and uniform absorption of water (Tawali et al.2003). Then the fraction of seed corn that is milled again large enough to obtain a small fraction of a grain of sand. After that the grains of the fraction of seed corn steamed for approximately two hours. Then the steamer is cooled. The next step for the preservation of rice made of corn drying in the sun for two days with sufficient light intensity. Rice that has been dried corn can be used at any time by pouring hot water and stirred for about approximately three minutes.

RESULT

Corn processing results in the form of rice with a small fraction of the size of the sand is white. With this method, the preparation of rice maize, calculated over the five days will be shortened to three minutes. This is because the method used on target to make instant rice is durable without preservative. This product is not easily damaged if treated in the room is dry and not damp. From the literature review, acquired a number of nutrition for these products such as: energy (150,00 cal), protein (1.600 g), fat (0,60 g), calcium (2,00 mg), phosphorus (47,00 mg), fiber (0,40 g), iron (0,30 mg), vitamin A (RE 30,00), vitamin B1 (0,07mg), Vitamin B2 (0,04 mg), vitamin C (3,00 mg), niacin (60mg), with a carbohydrate content of 74,26 g per 100 g edible portion of a total of 365 kcal of energy That is potentially as an alternative staple food.

Figure 2. Instant Corn Rice

'Srikandi Putih' corn varieties which has white color chosen as raw material for instant corn rice because white is the dominant color. White color is preferred by the people of Indonesia because the white color reflects purity. White on food by the people of Indonesia are considered as a symbol of cleanliness and sterility food. With white color on instant corn rice is expected to Indonesian people love this product for diversification so that Indonesia no longer need to import rice from other countries.

CONCLUSION

Corn is a commodity that can be added resale value. QPM corn 'Srikandi Putih' varieties can be used as raw material for the manufacture of instant corn rice with a small fraction of the size of the sand. In terms of nutritional value, instant corn rice with the basic material is quite high, even higher than the rice (paddy). This is because QPM corn 'Srikandi Putih' varieties was honored with several treatments that contain more nutritional value. Instant corn rice can be made in a very easy and practical as well as the estimated time very quickly. Simply mixed with hot water and stir until three minutes. Indonesian society paradigm that currently prefers rice (paddy) as food, staple will gradually be reduced by looking at these products are practical, durable, and affordable, so the food diversification program in Indonesia will be much better. It is necessary to address food security problems of Indonesia. White color on this instant corn rice give the impression of freedom and openness is expected to be the beginning of Indonesian freedom for food sovereignty

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SUNDANESE AS A COMPULSORY SUBJECT AT SCHOOL FOR THE FORMATION OF IDENTITY AND CHARACTER TO YOUTH

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Keywords: youth, vernacular, sundanese, globalization, behaviour, character

Character is a system of beliefs and practices that direct the actions of an individual. Experience and habits of life form the entire program of the human mind, the mind is a major factor forming the character, including the use of language to communicate. Sundanese is one of vernacular that spoken by at least 38 million people and is the mother language with the second largest number of speakers in Indonesia after the. Vernacular as one of the cultural heritage, and also a wealth of each region is the one that characterize a particular area, because of its diversity. In the current era of globalization, the balance of the use of language is a problem in itself. Especially among young people, many thought no longer important receipts Sundanese, as outdated. Position of the vernacular lately is not just showing identity of a particular area, but also can form a positive character to its users, with utter smoothness, choice of words appropriate interlocutors, dialect spoken, it is a unique creation that is actually a media to form character, behavior, manners and life learning tool. Sundanese language teaching in schools is a surefire steps to help build the character of youth.

INTRODUCTION

In this globalization era, users of national language and vernacular is decreasing. Many factors can give effect like that. But, by teached in School, especially vernacular like Sundanese will make it balance between good informatioan or new cultures that come to us and we could keep preserve our own cultures such as vernacular. Sundanese is one of 546 vernaculars in Indonesia (the results of research from the Ministry of Education and Culture: 2012) Sundanese is the language of about 39 million people from the West Java society or about 15% of the Indonesian population. Sundanese language has three levels namely basic manners. *Lemes* (Thoroughbred) , *Loma* (colloquially) and Ribaldry language. In additional there is pattern of Lemes that use for ourself. Sundanese including regular languages and has a lot of manners. Those Speaking manners are highly valued and their use completely unnoticed users own laguage which is Sundanese.

Lemes used in certain situations and is used for a particular speaker . *Lemes* bases used by the lower position of the interlocutor of higher social status , such as the person who is respected , the younger to the older and is used also to everyone who's just known . *Lemes* is also used for greetings , in the writing of a variety of personal writing (letters , etc.) as well as when speaking in a formal state or in public.

Loma used for everyday life, used between friends or peer to friends who have known each other or familiar . *Loma* is also the harsh language , but of the Sundanese do not think so as long as the context is still in loma situation (familiar) . Anything as outrageous as if the peer , it will not be a problem , even quite odd if using *lemes* in the situation.

Ribaldry Language, Usefulness of abusive language usually for animals and also to express anger and derogatory interlocutor . Abusive language differences with *loma,* it's rougher than *loma* , despite some ribaldry language vocabulary may be used in situations *loma* (Usak-Usuk Basa Sunda , 1997) .

FORMATION OF IDENTITY AND CHARACTER FOR YOUTH

A person's character is not formed in a matter of seconds, but requires a long process and through certain business. Language is media for communiaction, it is a reflection of one's personality, it means we can know personality and character through language, (Pranowo, 2009:3). How great you are communicating, give indicatioan how good your character, Languange also has central purpose on developing of intellectual, social, and emotional students. And by learning lamguage, students are aslo expected to know more about their culture, another culture, as realization what character is all about. indeed it is, language is one of the pillars which plays an important role in the formation of character. In addition, language is also one of cultural heritage, which must be conserved its use, because language is one of the main identity of certain regions.

Sundanese is the second largest vercnacular in Indonesia has a unique variety of uses. It has three tiers as we know it. The use of words in Sundanese that spoken can not be arbitrary, How to use *Lemes* in certain situations and is used for a particular speaker, or *Loma* used for everyday life, used between friends or peer to friends who have known each other or familiar and Ribaldry Language, Usefulness of abusive language usually for animals and also to express anger and derogatory interlocutor . Here's some example of using words in a sentence "I will go to market" in Sundanese.

Lemes	Loma	Ribaldry
Abdi bade ameng ka pasar	Urang bade ulin ka pasar	Aing bade ulin ka pasar

Table 1. Example of how yo use three levels language in Sundanese

In Sundanese, it's governed how we use words when we talk to other person, when we talk to older, or someone who's just know, we must use *Lemes.* Because we have to be very respectful to them. Beside that, *Lemes* can be used too when we talk to childern. Because, we need to teach them and give a good example about how we use words for talking to other person.

The second pattern is *Loma.* It is a way that we can use for daily activity with our peers. Iit's very inappripriate if we use *Lemes* for talking to my friend in class, it's gonna be awkward. And also, we couldn't use Ribaldry for this. Ribaldy is pattern we have to know that but that we need to avoid it. So, we can be carefull because of that. Moreover, use of different words like the example in the table , dialect pronounciation will also be very different . It really reflects how we behave .

When we could get used to using the appropriate word , , learned in school and keep continues to be practiced, it will be used to. so this is one of long process to form the character of the students and also preserve local identity

SUNDANESE AS A COMPULSORY SUBJECT AT SCHOOL

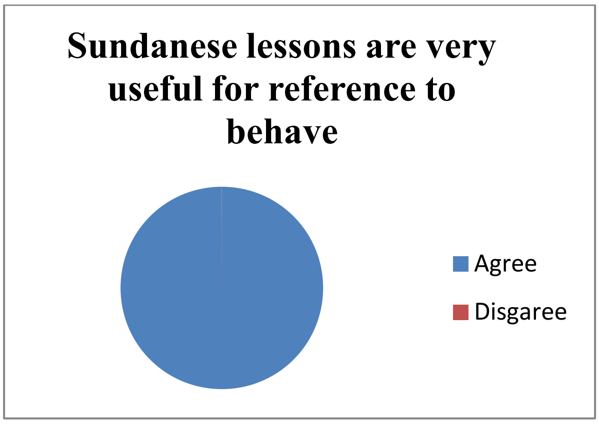
National education aims to develop the potential of students, one of them is having a good character and manners. Sundanese language, is one of the compulsory subjects in schools, especially West Java, government policy through Dept. of Education circulars West Java Province with No. 423/2372/Set-disdik dated March 26, 2013 about Local Content Local Language Learning in Elementary Level (SD / MI), Junior High School (SMP / MTs), Senior Hugh School (SMA / SMK / MA) is a very appropriate step to solve this problem. while still preserving the heritage of language, the use of Sundanese language itself is very influential on how to behave so as to good character.

School Level	Number Of Students
Elementary School	4.414.227
Junior High School	1.733.332
Senior High School	1.136.992
TOTALS	7.284.551

Table 2. Total sutdents Elementary School to High School in West Java Province (Source : recent data from Department of Education West Java Province http://disdik.jabarprov.go.id)

Total students above is 16% of Population in West Java that is 45.423.259 peoples. they are the future generation , who are prepared to build a nation , a generation of good character and identity prepared , one of them through the sundanese teaching in schools.

Authors did a research about how the students's opinion about this topic. Here's the figure.



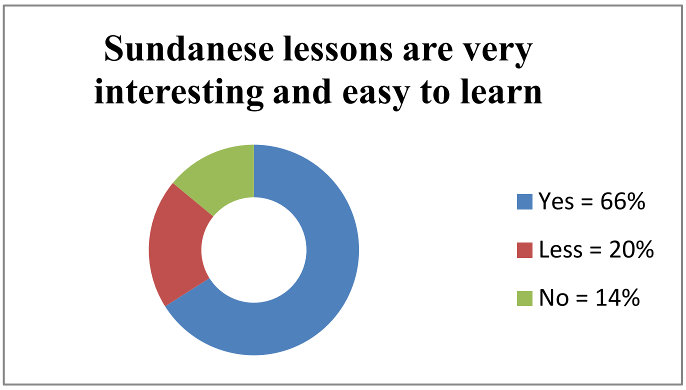


Figure 1. Students's Opinion

From 50 respondents, which is senior high school students in west Java. they argue that they agree 100% that Sundanese very useful to learn. whereas when questioned how Sundanese learning experience at school, 35 respondents enjoyed and did not encounter any trouble. whereas, 10 respondents admitted a little trouble, grounded as they come from Cirebon area, one of the districts in West Java which used to use other vernacular, namely cirebonese. And the other students answer is really hard to learn Sundanese language, because of those students come from outside of West Java.

CONCLUSION

West Java government policy through Dept. of Education circulars West Java Province with No. 423/2372/Set-disdik dated March 26, 2013 about Local Content Local Language Learning in Elementary Level (SD / MI), Junior High School (SMP / MTs), Senior Hugh School (SMA / SMK / MA) is a very appropriate step to formation Identity and Character for youth, as a future generation. views of any student opinion, their enthusiasm is very good, and agree with this decision.

Thus, it can be maintained and in order to be found attractive method for the foreseeable future. and should also be applied in other provinces. Ultimately created identity generation, and good character

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