

ACA2016 CHINA

Color Driving Power

The 3rd International Conference of
Asia Color Association



21-22 May 2016, Changshu, China

PROCEEDINGS



China Fashion & Color Association



Color Association of China

PROGRAMME OUTLINE

PROGRAMME OUTLINE		Oral session	Poster session	Social activity	General interest
Time	Friday, May 20	Time	Saturday, May 21	Time	Sunday, May 22
10:00 to 18:30	Lobby at 1 st floor of Main Building Registration and FangTa Hall Poster Setting up			8:30	FangTa Hall Color Perception Chair: Wei Ye
		9:30	FangTa Hall Opening Ceremony	9:10	
		10:10	Group Photo	9:25	
				9:40	
		10:30 to 11:50	FangTa Hall Invited Lectures Chair: Haisong Xu	9:55	Break
		12:00	Lunch	10:10	
		13:15	Poster Session (I)	10:25	
		14:00	FangTa Hall Color and Environment Chair: Taiichiro Ishida	10:35	
		14:40		10:50	
		14:55		11:05	
		15:10		11:20	FangTa Hall Color and Communication Chair: Xiandou Zhang
		15:25	Break	11:35	
		15:40		11:50	
		15:50	FangTa Hall Color Appearance Chair: Yuh-Chang Wei	12:05	Lunch
		16:30		13:15	Poster Session (II)
		16:45		14:15	FangTa Hall Color and Imaging Technology Chair: Yu Ma
		17:00		14:55	
		17:15		15:10	
		17:30		15:25	Break
				15:40	Break
				15:50	FangTa Hall Color Universal Design Chair: Boonchai Waleetorncheepsawat
				16:30	
				16:45	
				17:00	
				17:15	Poster Session (III)
				17:30	
18:30 to 20:30	Tulip Hall Welcome Reception	18:00 to 20:00	Tulip Hall Dinner	18:30 to 20:30	TianHua Hall ACA 2016 Banquet Closing Ceremony

CHANGSHU International Hotel



ACA2016 China

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PROCEEDINGS

Editors: **Haisong XU**
Sha ZHU
Xianwei HE
Yunhui CHAI

Co-Hosted by

Color Association of China (CAC)

China Fashion & Color Association (CFCA)

PROCEEDINGS

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by the Organizing Committee of ACA2016 China

The China Fashion & Color Association (CFCA)

The Color Association of China (CAC)

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ACA Coordinator's Message

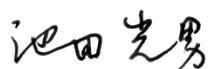
Congratulation for the 3rd conference of the Asia Color Association ACA!!
On behalf of the Asia Color Association I would like to thank the organizing committee of the 3rd conference of ACA who led the conference to success.



As all of you know the ACA was established in 2013 to offer opportunity to young scholars to attend at scientific conferences in the field of color science and design economically and informally. There is the International Color Association AIC where they can attend but it was often pointed out that many of the conferences are held in countries and districts far from Asia and the transportation fare is expensive. The registration fee is not cheap. Many Asian youth cannot speak English fluently and hesitate to present papers in AIC. It was needed to establish an international conference where any Asian people can easily attend at economically and psychologically. So the Asia Color Association ACA was established with cooperation of China, Japan, Taiwan, Thailand, and Korea.

The 1st conference was held at Thanyaburi, Thailand in 2013, the 2nd conference at Taipei, Taiwan in 2014, and the 3rd conference, this time, at Changshu, China in 2016. The ACA is not to compete against the AIC but to cooperate with it. Prof. Tien-Rein Lee at Chinese Culture University who organized the 2nd conference of the ACA serves the vice president of the AIC at present. I myself served the president of AIC some time ago. The ACA is not held in the year when the AIC is held at somewhere in Asia. In 2014 the AIC was held in Tokyo, Japan and the ACA was not held in that year. In 2017 the AIC will be held at Jeju Island, Korea and the ACA will not take place in that year. We all cooperate with each other and colleagues can join conferences in Asia every year if they want. No need to speak fluent English to attend at the ACA. Most of Asian people got used to broken English and are good to guess what is spoken with the broken English. Everybody can be relaxed in conferences with his/her own English.

The ACA wants to encourage Asian young scientists and designers in color and supports activities of that kind. A group of the Color Research Center of Rajamangala University of Technology Thanyaburi, Thailand visited Ho Chi Min City University, Vietnam in 2014 and delivered a visiting lecture on color science, color vision, color technology, and color design for two days with workshop how to measure color with instruments. The group is visiting this year University of Information Technology, Myanmar to deliver a visiting lecture. The ACA supported and supports these two lectures. The ACA is happy to support any activity to encourage scientists, engineers, and designers in Asia so that the color science, engineering, and design will become more active and more people will join the ACA. The ACA does not have the membership system. Any persons, any countries and districts can join the ACA. We are waiting for such people to contact us. My mailing address is kaymitsuo@gmail.com and mitsuoikeda@rmutt.ac.th. We will wait for your response. Thanks.



Mitsuo Ikeda, Coordinator of ACA

Professor, Rajamangala University of Technology Thanyaburi, Thailand

Professor Emeritus, Tokyo Institute of Technology, Japan

Welcome to ACA2016 China

On behalf of the Organizing Committee of ACA2016 China, I would like to welcome all of you to the 3rd International Conference of the Asia Color Association in the historical city of Changshu, China, on May 21-22, 2016.

This conference, co-hosted by the Color Association of China (CAC) and China Fashion & Color Association (CFCA), will provide a unique platform for exchange of views, bringing together leading researchers, scholars, students, artists, architects, entrepreneurs, engineers, designers, teachers, lighting experts, and color practitioners. The theme of ACA2016 has been defined as “Color Driving Power” for all the participants to have the full communications on the color science, color application, and color culture in the various fields of color appearance, color perception, color and communication, color and imaging technology, color and environment, color universal design, and etc.



I would like to express my deep acknowledgements to every participant, and especially to the individual members of the ACA2016 Organizing Committee as well as the International Advisory Committee and the International Technical Committee, whose important contributions make this event a great success. All of your valuable dedications and efforts are sincerely appreciated.

Finally, I hope you all will enjoy the conference and the beautiful season in East China.



Haisong XU, Ph.D.

General Chair, Organizing Committee of ACA 2016 China

President, The Color Association of China

Professor, College of Optical Science & Engineering, Zhejiang University, China

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<i>China</i>	Xiandou ZHANG

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21	IT-03	Comparison of colors of cycling apparels in the market and colors preferred by Korean consumers <i>Young In Kim</i>
25	IT-04	Colors for climate - Study and application of climate-adapted urban colors <i>Hongyu Guo</i>
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Invited Lectures

Color and Light in our living environment: Exploring psychological effects of color of lighting

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ABSTRACT

Color and light can play essential roles in our living environment. Recent advances in LED technology have opened new possibilities for lighting design using colors. Little is known, however, how color of lighting could affect our psychological impression of lit environments. In this talk, I will introduce my recent works on visual impression of color of lighting; effects of color temperature and illuminance, effects of colored light selected from a wide range of the chromaticity diagram, and evaluation of two-color gradation lighting. I would like to take this opportunity to share basic ideas for light and color in our living environment in a new era of lighting.

Keywords: color of lighting, visual impression, LED

1. EFFECTS OF COLOR TEMPERATURE AND ILLUMINANCE OF LIGHTING

Illuminance and correlated color temperature(CCT) are major variables to be considered in illumination engineering and design. They strongly influence not only the way objects are seen, but also our psychological impression of lighting environment. In 1941, when fluorescent lamp had just developed, Kruithof¹⁾ conducted a study on "pleasing" impression of general lighting. He reported that observers found pleasing high CCT at high illuminance and low CCT at low illuminance. Moreover, several studies have shown that a spectral distribution of light influences on our physiological states such as melatonin regulation²⁾ and circadian rhythm. We carried out a study³⁾ to examine the effects of color temperature and illuminance of lighting on our visual impression of lighting environment.

1.1 methods

The experiment was carried out using a scaled model box. The correlated color temperature(T_c) of the lighting was set to one of the following values; 2000, 2300, 2700, 5000 and 8000 K. The illuminance at the center of the floor was set to one of the following values; 10, 30, 100, 300 and 1000 lx. Five subjects participated in the experiment. They observed the inside of the model box and evaluated their visual impressions; bright-dark, active-calm, comfortable-uncomfortable, clear-vague, cheerful-quiet, soft-hard, relaxed-tense, warm-cool, sleepy-stimulative, small-large, like-dislike.

1.2 Results and discussion

The results are plotted in Figure 1. Each panel presents the result of each of 11 evaluation items. The horizontal axis represents the reciprocal correlated color temperature $1/T_c$ and the vertical logarithm axis represents illuminance E . The size of a circle symbol denotes the absolute value of evaluation averaged over 5 subjects. The effects of CCT and illuminance on the visual impression of lighting seem to be classified into three groups. First, the evaluation items such as "dark-bright", "quiet-cheerful" were strongly affected by the illuminance level. High illuminance conditions produced bright impression. Secondly, the item "warm-cool" was clearly determined by CCT. Low color temperature gave warm impression. Thirdly, the items such as "relaxed-tense", "sleepy-stimulative" were influenced by both CCT and illuminance. High color temperature and high illuminance gave stimulative impression. It was also shown that lighting with low CCT at high illuminance evaluated as "comfortable". This results was different from the Kruithof's results.

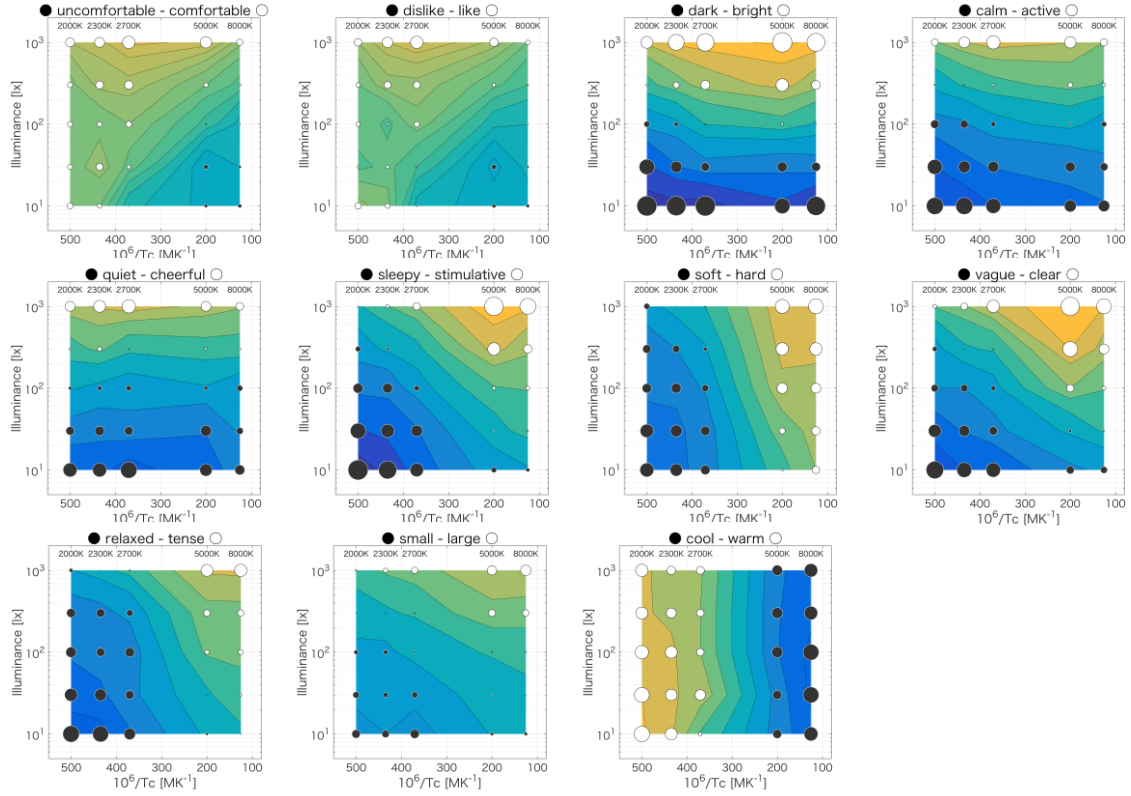


Figure 1. Effects of correlated color temperature and illuminance on visual impression of lighting

2. EFFECTS OF COLORED LIGHT SELECTED FROM WIDE RANGE OF CHROMATICITY DIAGRAM

Progress in LED technology has brought new possibilities to use a wide variety of colored light. Most of the studies on effects of color of lighting have dealt with colors along the blackbody locus. Little is known about the effect of colors selected from a wide area of a color space. We examined visual impressions of a space illuminated by colored light selected from a wide range of a color space⁴⁾.

2.1 Method

We set up a test model space with adjustable color and illuminance and a reference model space with fixed color and illuminance. The test model space was equipped with 11 fluorescent lamps covered with red, green or blue tubes. By adjusting the amount of light emitted from each set of the colored lamps, the inside of the test space was illuminated uniformly by a selected color of light. Subjects observed the inside of the test space and evaluated visual impressions by referring the reference space placed next to the test box. We examined seven impressions of the lighting space: brightness, comfort, openness, activity, warmth, naturalness and stimulation. We chose 36 test colors (Figure 2) from the u^*v^* chromaticity diagram and set three illuminance levels of 30, 100, 300 lx. The reference space was illuminated by the white light (u^*, v^*)=(0.23, 0.51) at illuminance of 300 lx. Seven subjects from the department of architecture participated in the experiment.

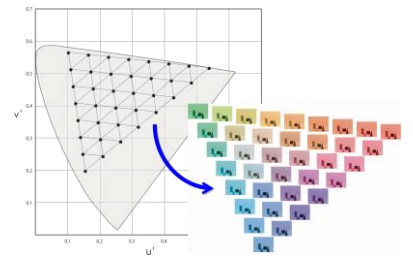


Figure 2. Test colors on the u^*v^* chromaticity diagram

2.2 Results and Discussion

The results are mapped on the chromaticity diagram for each of three illuminance levels in 4(a)(b). Evaluation scores for each of the test colors were averaged among the subjects and plotted for each of the

visual impressions. The size of a plotted circle represents the difference from the average score of all color in three illuminance conditions. Open circles indicate that the scores are higher than the average and filled circles lower than the average. The result map was colored according to the absolute difference from the average as shown in the Figure 3.

The results in Figure 3 present overall changes of visual impressions of the space illuminated by colored lighting. As we can see this plot the effects of colors and illuminance were different for each visual impressions. The sense of brightness seems to be determined mainly by illuminance levels. The space illuminated by the higher illuminance was perceived as brighter. On the other hand, the sense of warmth was strongly influenced by the colors of lighting. The visual impression of warmth The naturalness and the comfort were given high evaluation scores when the color of lighting was close to white. The highest scores for openness were given to the colors with higher color temperature and illuminance. Highly saturated red lightings were judged to be most stimulative.

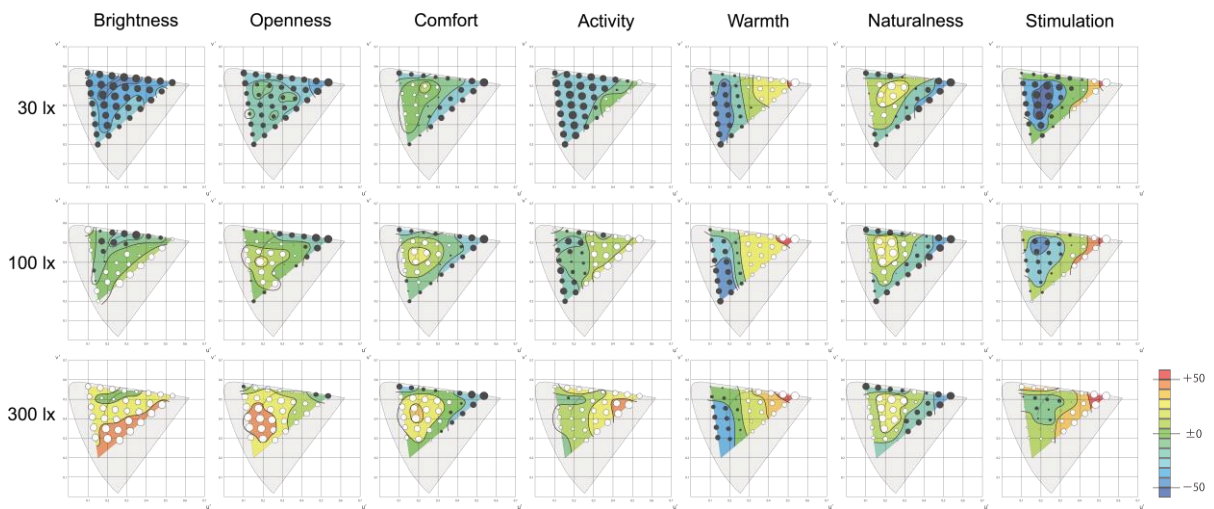


Figure 3. Results of the effects of colored light on visual impressions

3. TWO-COLOR GRADATION LIGHTING

For the third topic, I will introduce our study considering use of multiple colors for lighting. In this study we carried out an experiment to evaluate the psychological impressions for a room space illuminated by two-color gradation lighting⁵⁾.

3.1 Methods

A picture of the two-color gradation lighting was shown in Figure 4. To realize the two-color gradation lighting, we produced a lighting device with LEDs (Konica Minolta Inc.) that emitted two different colored lights separately in front and upper directions. Using this lighting device, a wall and a ceiling were illuminated by two different colored lights changing continuously from the lower part of the wall to the ceiling. We selected 15 test colors as shown in Figure 5; seven hues (red, orange, yellow, green, blue-green, blue, purple) x 2 saturations (high, low) and white light. All combinations of the test colors are shown in Figure 6.

Subjects sat in the room and viewed the interior space and evaluated visual impression of two-color gradation lighting by the semantic differential method. "acceptable - unacceptable", "like - dislike", "lively - calm", "light - heavy", "bright-



Figure 4. Two-color gradation lighting

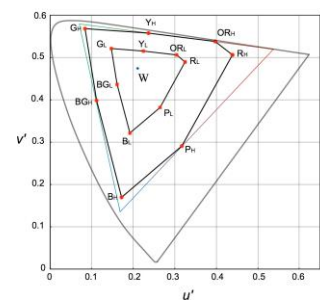


Figure 5. Colors used for the two-color gradation lighting

dim", "tense - relaxed", "awakening - sleepy", "feel like going into action - feel like stopping action", "clear - dull", "concentrated - distracting", "anxious - secure", "excited - boring", "nostalgic - near-future", "natural - artificial", "comfortable - uncomfortable", "warm - cold", "novel - usual", "small - spacious", and "garish - not garish". Six subjects, 3 males and 3 females, students at the Department of Architecture, Kyoto University participated in the experiment.

3.2 Results and Discussion

The results of the factor analysis indicated that psychological evaluation of the two-color gradation lighting were composed of three factors; we referred them as follows; "comfort", "activity" and "temperature". The comfort factor corresponded to the evaluation items such as "like-dislike", "relaxed-tense" or "natural-artificial"; the activity factor "excited-boring", "awakening-sleepy"; the temperature factor "warm-cool", "nostalgic-near future".

Averaged score of all two color combinations are plotted for each of three factors in Figure 7; colored symbols indicate positive value (comfort, active, warm) and gray symbols indicate negative value (discomfort, calm, cool). The results suggest that "comfort" was related to saturation and hue of the colored light; combinations of low saturated colors and bluish colors were highly evaluated as comfort. The activity factor was strongly influenced by saturation of the colored lights; highly saturated red, orange and yellow gave active impression. The temperature factor was strongly influenced by hue of the colors. It is interesting that a color emitted to front direction mainly determined overall impression of the temperature.

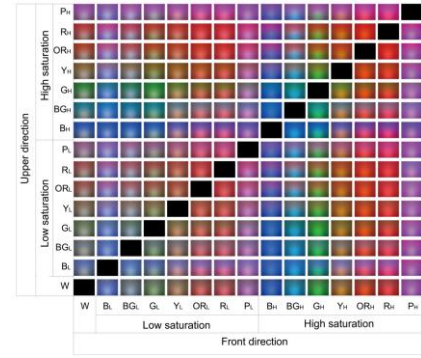


Figure 6. All conditions of the two-color gradation lighting

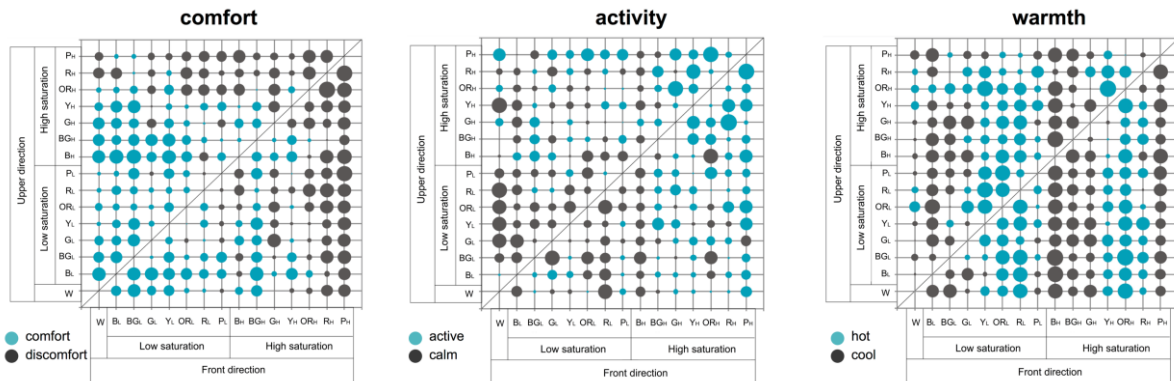


Figure 7. Results of visual impressions of the two-color gradation lighting

ACKNOWLEDGMENTS

This work was supported by JSPS Grant-in-Aid for Scientific Research(C) 15K00685.

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Establishing optimal visual parameters: illuminance, correlated color temperature and color of packaging for the elderly in a supermarket-type illuminated environment

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ABSTRACT

This research aimed to establish the optimal visual parameters, including illuminance, correlated color temperature (CCT) and color codes, of packaging for the elderly in a supermarket-type illuminated environment. Five illuminance levels (1100, 900, 700, 500 and 300 lux) were employed, where 700 lux was the average illuminance level found in five supermarkets in Bangkok, using light emitting diode (LED) light sources with a CCT of 6500 K, 5000 K and 3500 K. Packaging and labels were divided into the two groups of (i) colored packages with the product name and (ii) white packages with black text. Ten Munsell hues with a value/chroma of 5/6 and a TF Pimpakarn text-font of 17.5 points were selected for the first group. For the second group a black TF Pimpakarn font of 17.5 points on a white package was used. Thirty elderly (60–74 years old) and five young (21–22 years old) subjects, who had never changed their crystalline lens, were submitted to the following four procedural steps. (i) Their color discrimination was tested under a standard light booth and under a LED, both at 900 lux and a CCT of 6500 K. (ii) They were then given a random shopping list of 20 items and the explanation of color for each package was performed under the standard light booth (900 lux, 6500 K) before (iii) they were moved to the simulated supermarket, next to the standard light booth, and (iv) then attempted to select the 20 indicated items on their shopping list under one of the 15 different lighting conditions, repeating until all lighting conditions had been evaluated. The number of incorrectly picked (WP) items, total time spent (TTS) for picking and total error score (TES) of Munsell 100-hue test were recorded. No significant difference in the WP or TTS was noted with different illumination or CCT levels (or their interaction) in the elderly or the young subjects, but the two groups had significantly different WP and TTS levels between them under all lighting conditions with the elderly group taking just over two-fold longer to select their products

Keywords: Illuminance, correlated color temperature, elderly, color discrimination

1. INTRODUCTION

Illumination is one of the important factors that help people to visually recognize objects. Object characteristics, such as the shape, texture and size, are tactilely and visually perceptible, whereas color is visually sensible. Color is a tool for various functional uses in the design of product packaging. One of the useful functions is the brand and type classification of products. Customers should be able to discern colors easily in order to correctly choose the desired product(s). In practice, the surrounding factors that enhance our visual system must be taken into account for allowing customers to be at ease in selecting products. Some previous research has investigated the effect of the lighting system in stores on the color perception and color discrimination in elderly people^{1–3}, where it was found that elderly customers may experience some difficulties in searching for and selecting colored products. In this research we established the optimal visual parameters, including the illuminance, correlated color temperature (CCT) and color, for packaging for the elderly.

2. EXPERIMENTAL

2.1. Experimental Room Setup

An area of a smart room environment was converted to a simulated supermarket with a 2 m high x 1 m wide metal shelf, a 1.3 m high x 1.1 m wide wood shelf and a wood table. The ceiling illumination was provided by a light emitting diode (LED) light, which could be adjusted to an illuminance of 1100, 900, 700, 500 and 300 lux, measured at 1 m from the floor, and a CCT of 3500, 5000 and 6500 K for each

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individual illuminance level. The metal shelf was a four-level type, of which only the first three top levels were used and the three-trip LED was installed at the ceiling of each shelf to reduce the contrast of shadow and illuminated areas of products on the shelf.

2.2. Preparing Colored Objects

Packaging and labels were divided into the two groups of (i) colored packages with the product name and (ii) white packages with a text name. Ten Munsell hues (5R, 5YR, 5Y, 5GY, 5G, 5BG, 5B, 5PB, 5P and 5RP) with a value/chroma of 5/6 and a TF Pimpakarn text-font of 17.5 points were selected for the first group. Six types of colored packages were made to give a total of 60 different colored packages. Each type of product in the six different colors was written with the same product name. All 10 colors were included in the shopping list for each condition. For the second group, a black TF Pimpakarn font of 17.5 points on white packages was used and a total of 47 white packages with different product names were made.

2.3. Subjects and Procedures

Thirty elderly subjects, aged 60–74 years old, and five young subjects (aged 21–22 y old) who had never changed their crystalline lens, were submitted to the following four procedural steps. (i) Their color discrimination was tested under a standard light booth with stimulated daylight 6500 K, and under a LED of 6500 K and 3500 K, all with an illuminance of 900 lux. (ii) They were then given a random shopping list of 20 items, 10 of colored packages and 10 of white with black text, and an explanation of the color for each package was performed under the standard light booth with simulated daylight of 6500 K and 900 lux illumination. (iii) They were then asked to move to the simulated supermarket section, next to the standard light booth and (iv) to select all 20 items on their shopping list under one lighting condition. After that, they were given a different hopping list and continued the selection of products but under a different lighting condition. After each test the 20 selected products were returned to the shop shelves before the next trial in new random positions. This process was continued until all 15 lighting conditions had been evaluated for each subject. The number of incorrectly picked (WP) items, total time spent (TTS) for picking and total error score (TES) of the Munsell 100-hue test were recorded.

3. RESULTS AND DISCUSSION

The WP and TTS results are summarized in Tables 1 and 2 and discussed below in sections 3.1 and 3.2.

3.1. The Number of WPs

Among the elderly subjects, there was no statistically significant difference in the mean number of WPs at different illuminance or CCT levels (Tables 1 and 2), nor was the interaction between the illuminance and CCT levels significant (Table 2). Similarly, among the young subjects, there was no statistically significant difference in the mean number of WPs at different illuminance levels ($p = 0.289$) or CCTs ($p = 0.430$) or the interaction between illuminance and CCT ($p = 0.511$).

A two-sample independent t-test analysis of the mean number of WPs by the elderly and the young groups revealed a significant difference ($t(20) = 11.5$, $p < 0.05$) between the elderly (3.0 ± 1.7) and the young (1.1 ± 1.1).

For the 20 items on the shopping list, the elderly subjects picked up two more wrong items than the young subjects. These wrong items were mostly colored packages, with the WP of colored packages being 29.4% and 1.7% for the elderly and the young subjects, respectively, whereas that of white packages with black text were 0.8% and 0.4%, respectively. The most confusing color pair under either LED 3500 K or 5000 K illumination was 5BG-5G, while under LED 6500 K illumination it was 5BG-5B.

When we included subjects into the experiment, we filtered them only by age. However, one subject could not read the product name on the white packages and so we recorded only his TTS for picking the colored packages and did not include this data in Table 1. The colored packages were preferred in his case. We added one more subject to have total elderly subjects of 30.

3.2. The TTS Searching

Next, we investigated if the TTS for picking up specific products between the elderly and the young was different and if the illuminance and CCT had any effect on the TTS. The two-factor analysis of variance showed no significant main effect for the illuminance ($F(1,446) = 0.13$, $p > 0.05$), CCT ($F(1,446) = 3.32$, $p > 0.05$) and the interaction between them ($F(1,446) = 0.001$, $p > 0.05$). This was similar to that observed with the young subjects, except that the illuminance factor showed a significant effect on the TTS ($F(1,71) = 17.11$, $p < 0.05$).

The two-sample independent t-test analysis revealed a significant difference ($t(26) = 14.0$, $p < 0.05$) in the TTS between the elderly (5.0 ± 2.4) and the young (2.4 ± 1.0) subjects. The elderly spent just over twice as much time as the young for picking up 10 items. In addition, the subjects picked up the white packages with black text much quicker than the colored packages.

Table 1. The number of incorrectly picked (WP) items and the total time spent (TTS) searching for the item by the elderly ($n = 30$) and young ($n = 5$) subjects under 15 different light conditions.

Illuminance (lux)	CCT (K)	Elderly		Young	
		WP (items)	TTS (minutes)	WP (items)	TTS (minutes)
1100	6500	2.8 ± 1.6	5.4 ± 3.3	2.0 ± 1.6	4.0 ± 1.5
	5000	2.6 ± 1.4	5.2 ± 2.7	0.6 ± 0.9	2.7 ± 0.9
	3000	2.8 ± 1.6	4.9 ± 2.5	1.6 ± 1.1	2.9 ± 1.3
900	6500	3.2 ± 1.5	5.2 ± 3.3	1.8 ± 1.6	2.7 ± 1.0
	5000	3.1 ± 1.8	4.8 ± 2.6	0.2 ± 0.4	2.2 ± 0.5
	3000	3.4 ± 1.8	4.6 ± 2.1	1.6 ± 1.1	2.6 ± 1.2
700	6500	3.6 ± 2.1	5.9 ± 2.3	1.0 ± 1.0	2.1 ± 0.7
	5000	2.9 ± 1.5	5.2 ± 2.1	0.6 ± 0.9	2.3 ± 0.7
	3000	2.5 ± 1.9	5.0 ± 2.1	0.2 ± 0.4	2.2 ± 0.4
500	6500	3.2 ± 1.7	4.6 ± 2.0	0.8 ± 0.8	2.1 ± 1.0
	5000	3.1 ± 1.6	4.3 ± 1.8	1.6 ± 0.5	2.1 ± 0.8
	3000	2.9 ± 1.7	4.7 ± 2.0	0.8 ± 0.8	2.1 ± 0.7
300	6500	2.9 ± 1.7	5.6 ± 2.4	0.6 ± 0.9	1.9 ± 0.7
	5000	3.1 ± 1.9	5.1 ± 1.8	1.6 ± 0.9	1.9 ± 0.5
	3000	3.0 ± 1.6	4.8 ± 1.8	0.8 ± 0.8	2.1 ± 0.8
Total	6500	3.2 ± 1.7	5.3 ± 2.7	1.2 ± 1.3	2.5 ± 1.2
	5000	3.0 ± 1.6	4.9 ± 2.2	0.9 ± 0.9	2.2 ± 0.7
	3000	2.9 ± 1.7	4.8 ± 2.1	1.0 ± 1.0	2.4 ± 0.9

Data are shown as the mean $\pm$ 1 SD

Table 2. ANOVA of the WP number by the elderly subjects under 15 different illumination conditions.

	df	Sum sq.	Mean sq.	F-value	p-value
Illuminance	1	1.4	1.361	0.477	0.490
CCT	1	3.9	3.853	1.350	0.246
Illuminance: CCT	1	0.0	0.000	0.000	1.000
Residuals	446	1272.6	2.853		

3.3. The TES of the Munsell 100-hue Test

The TES results are summarized in Table 3. The two-sample independent t-test analysis revealed a significant difference ($t(3) = 5.0$, $p < 0.05$) in the mean TES between the elderly and the young subjects.

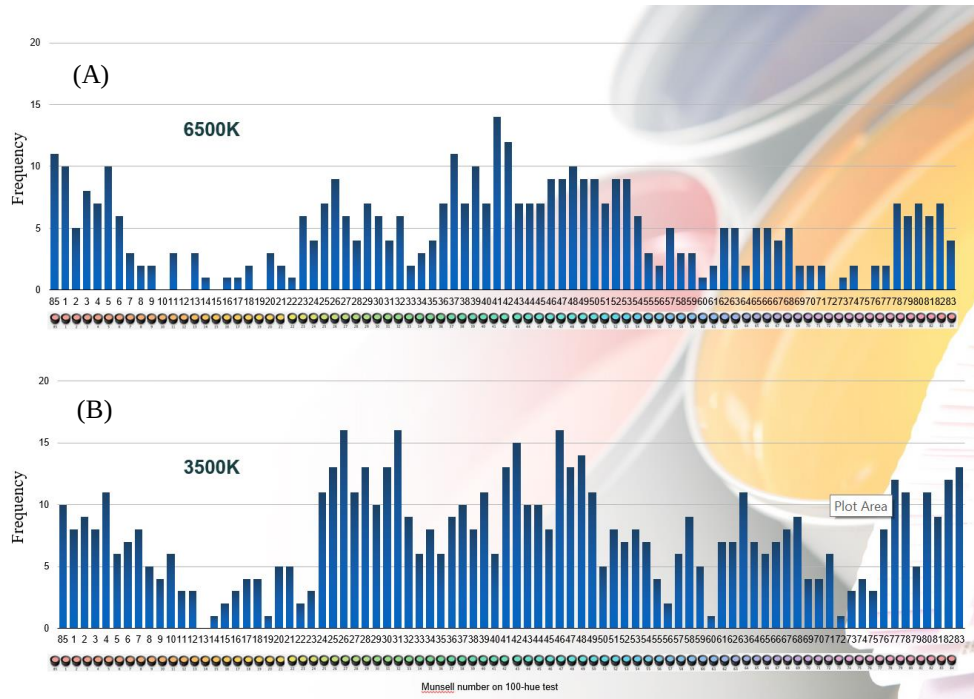
The TES indicates the color discrimination ability of the subjects. People with normal color discrimination have a TES between 20 to 100. From Table 3, it was found that the elderly subjects in this study were in the low color discrimination category, with a TES of > 100 .

The frequencies of colors that increased the TES are shown in Figure 1. The most confusing colors under a LED 3500 K illumination were No. 24–31, No. 39–49 and No. 77–83, while under LED 6500 K or simulated daylight 6500 K illumination they were No. 36–42. The colored package pairs that caused the most confusion in section 3.1 were exactly within these color ranges, and so the TES results and the confusion colors obtained from simulated daylight 6500 K and LED 6500 K illuminations were congruent.

Table 3. The TES value for the elderly (n = 30) and the young (n = 5) subjects for three different illumination conditions.

Illumination	Elderly	Young
Simulated D65	115.5 ± 71.4	43.2 ± 26.9
LED 6500K	114.0 ± 78.4	30.4 ± 27.2
LED 3500K	158.5 ± 82.6	60.8 ± 39.23

Data are shown as the mean ± 1 SD

**Figure 1.** Frequencies of Munsell 100-hue test colors arranged by the elderly subjects that gave TES scores greater than 5 under (A) LED 6500 K or (B) LED 3500 K illumination. Data are shown as the mean ± 1 SD, derived from 29 subjects.

4. CONCLUSIONS

No significant difference in the WP and TTS was observed for elderly or young subjects choosing the right products according to the given shopping list with a varying illuminance range of 1100–300 lux and a CCT range of 3500–6500 K from a LED light source. However, the number of WPs and TTS by the elderly subjects were significantly larger than those for the young subjects. The most frequently confused color was 5BG for all lighting conditions. The TESs obtained for the elderly subjects were similar under simulated daylight 6500 K and LED 6500 K illumination.

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Comparison of colors of cycling apparels in the market and colors preferred by Korean consumers

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ABSTRACT

The purpose of this study is to create bicycle wear that effectively doubles as everyday wear through color by consumer survey. Using the frequency of cycling and fashion involvement as standards for typifying consumers who purchase bicycle wear, my study was able to classify consumers into the groups of potential consumers, casual cyclists with low fashion involvement, casual cyclists with high fashion involvement, and frequent cyclists with high fashion involvement. After researching each consumer's general color preference, seasonal clothes' color preference, seasonal bicycle wear color palette, and intersections between the preferred colors of everyday wear and bicycle wear, this study concluded that in all groups, the vast majority of consumers highly preferred low saturation and monochrome palettes. The most significant differences in preferred color tended to be amongst the frequent cyclists with high fashion involvement, as they preferred colors that seemed contrary to the trend, or preferred more diverse and nuanced color palettes. Also this study was able to analyze a correlation between preferred color in the groups of potential consumers who did not currently ride bicycles and casual cyclists with high fashion involvement. After gauging the relevance of preferred color by item, there was a significant relationship between the color of jumper tops and pants amongst all types of consumers. When planning to manufacture bicycle wear, this study found it necessary to consider the basic color of the jumper's top and pants. In addition, a trend is observable between preferred color of male and female tops and pants in the case of frequent cyclists with high fashion involvement. A comparable trend also exists between the preferred colors of male and female tops in the group of casual bikers with low fashion involvement.

Key words: bicycle wear consumer groups, color trends, color preference, seasonal wear color preference

1. INTRODUCTION

The Korean government enacted the "Promotions of the Use of Bicycles Act" to address the various traffic and environmental problems in the automotive-centered traffic system in Korea in 1995. The government has been also endeavoring to foster a social and cultural atmosphere for regular cycling. In addition to these efforts, the increased spare time with the implementation of 5-day-per-week working trends and the trend of wellbeing dominating the Korean society, the Koreans' interests in nurturing healthy and enjoyable lives have considerably heightened. Against this backdrop, cycling in Korea is not merely a means of transportation anymore; it has become one of the most enjoyed pastimes owing to its health benefits. In fact, more than 50% of all Korean citizens owned a bicycle by 2008 (Korea Environment Institute, 2007).

As cycling became a regular pastime for many people, consumers began to display individuality via cycling wear and products, and especially for cycling wear, people began to prefer designs with considerations for both function and sensitivity (Eum, 2012). Such demands for unique designs that appeal to consumers' emotions raised the significance of using appropriate combinations of colors. Among the factors that compose design, that is, shape, material, and colors, color is the most emotional factor, as it acts as an effective visual language that intuitively imparts season and trend information as well as the design concept. Furthermore, as cycling apparel must retain certain styles appropriate for

cycling, for cycling wear brands, colors are the strategical means to distinguish their brand from others in addition to fulfilling consumers' emotional needs. For these reasons, the present study seeks to survey the colors currently dominating various cycling apparel brands to compare these colors to those preferred by Korean men and women in their 20s-40s as their daily wear plus cycling wear.

2. Research Method

To identify the colors preferred by consumers, we administered an online questionnaire to 186 men and women in their 20s-40s from January 16-28, 2015 via social media and a web link.

It is difficult to group cyclers into distinct groups in terms of their preferred colors because cyclers tend to prefer individuality. Hence, we collected information regarding the frequency of cycling and attitudes toward fashion in order to divide the subjects into market segmentation groups displaying similar tendencies. We also administered the questionnaire on a control group (i.e., non-cyclers) (N=60) to analyze and verify the features of the colors preferred by cycling consumers.

We referred to the Natural Colour System (NCS) to extract 88 colors for the color and tone analysis. The colors comprised: the base colors of red (R), yellow (Y), blue (B), green (G), black(S), and white(W), and the colors between the base colors (excluding achromatic colors) orange (Y50R), purple (R50B), blue green (B50G), and light green (G50Y); in addition, for each of the colors, we chose colors that represent the 10 nuances—toned light gray, light clear, brilliant, deep chromatic, dark deep, toned dark gray, clear, deep, toned gray and grayish chromatic; finally, 8 achromatic colors were added, resulting in a total of 88 colors. The questionnaires were analyzed using the IBM SPSS Statistics version 22. To analyze the consumer groups based on cycling frequency and involvement in fashion and accessories, we used the Ward's method to calculate the intergroup distances and performed a hierarchy cluster analysis; the results of the analysis were verified via a one-way ANOVA. In addition, we performed a frequency analysis and chi-square test to analyze the colors and nuances of the colors preferred by the consumer groups.

To analyze the colors used in cycling apparels currently in the market, we selected brands with high brand awareness among Korean consumers from 287 cycling apparel brands that participated in EUROBIKE—the world's largest bicycle trade fair opened in Friedrichshafen, Germany—for at least three times since 2011. Brand awareness was determined based on three focus group interviews with 14 cyclers in their 20s-60s who ride a bicycle at least three times per week; the interviews were conducted from July 2014 to October 2014. The final brands that were selected are: Rapha, Castelli, Santini, Outwet, NSR, and 2nd WIND.

We collected a total of 1,532 color samples from the product images posted on the websites of the six brands. Each color sample was measured in RGB values using Adobe Photoshop CS5 and was converted to NCS values. The color conversion was conducted using the navigator convert function available on the NCS website.

3. Results

3.1 Item-specific product color analysis

We categorized the images according to item categories in order to analyze the colors of the cycling apparel products currently circulated in the market; the item categories we used were the ones stated on the product websites and catalogues. Furthermore, for foreign brands, we only categorized using item categories, not seasonal categories; the consumers were able to choose apparels appropriate for particular seasons, so we excluded the factor of season from the analysis.

As shown in Table 1, the colors currently used in the market for cycling wear were largely limited regardless of item categories. In particular, for pants, colors other than black (9000-N), white (0500-N), and brilliant red (1060-R) were rarely used, clearly displaying a use of limited colors compared to other items.

Table 1. Comparison of product colors and colors frequently worn

N(%)

Item Frequency	Jumper	Tops	Pants
1	 black	 white	 black
	130 (30.3)	219 (23.8)	71 (38.8)
2	 white	 black	 white
	55 (12.8)	189 (20.5)	44 (24.0)
3	 brilliant red	 brilliant red	 brilliant red
	53 (12.3)	124 (13.5)	16 (8.7)

3.2 Comparison of product colors and preferred colors

1) Comparing with the colors of cycling wear frequently worn in each season

Table 2 shows the colors that are actually frequently worn by consumers of cycling wear. All consumer groups showed a common preference for black (9000-N), and the occasional cyclist group also preferred white (0500-N) in addition to black (9000-N). However, one notable result is that the colors preferred by the consumers do not match the colors currently in market.

Table 2. Comparing with the colors of cycling wear frequently worn in each season

Group season & item		Casual cyclists with low fashion involvement	Casual cyclists with high fashion involvement	Frequent cyclists with high fashion involvement
Spring	Jumper	black	black	white black
	Tops	white black	white black	black
	Pants	black	black	black
Summer	Jumper	white black	white black	black
	Tops	white black	white black	black
	Pants	black	black	black
Fall	Jumper	black	black	black
	Tops	white black	white black	black
	Pants	black	black	black
Winter	Jumper	black	black	black
	Tops	white black	black	black
	Pants	black	black	black

2) Comparing with the colors of the season-specific cycling wear

Table 3 is an illustration of the comparison of the preferred colors and product colors for Spring/Fall jackets, which were significantly different among the three consumer groups.

Table 3. Comparison between product colors and preferred colors for Spring/Fall cycling jackets

group	Potential consumers	Casual cyclists with low fashion involvement	Casual cyclists with high fashion involvement	Frequent cyclists with high fashion involvement
color	black	—	—	black

4. Conclusion

The following is a summary of the results of this study. First, based on cycling frequency and fashion involvement, we were able to divide consumers into the following market segmentation groups: occasional cyclers with low fashion involvement, occasional cyclers with high fashion involvement, and frequent cyclers with high fashion involvement.

Second, we divided the cycling consumers' preferred colors into colors of season-specific, frequently worn apparels and colors of season-specific preferred apparels and found that all groups showed a strong preference for black. Groups exhibiting high fashion involvement showed a preference for a wide spectrum of colors and nuance, and less frequent cyclers tend to prefer low chromatic colors.

Third, the colors currently used for actual products in the market were mostly black, white, and brilliant red regardless of item category.

Fourth, when we compared the consumers' preferred colors and the actual product colors in the market, none of the colors, with the exception of black and white, especially the chromatic colors, matched in all groups. This shows that current products have failed to attend to the emotional needs of their target consumers.

The findings of this study signifies that each cycling apparel brand should clearly define their target consumers and employ colors that satisfy the emotional needs of their target consumers in today's market, where consumers are increasingly inclined to display individuality through cycling wear. To this end, each brand should establish databases for preferred colors of their target consumers as a reference for product development.

This study is meaningful in that it empirically analyzed and verified the aspect of color—the factor that appeals to the emotions of consumers—in cycling wear, a professional and specialized domain of sportswear, ultimately establishing a research model that could be applied to other specialized professional apparels.

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Colors for Climate- Study and application of climate-adapted urban colors

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ABSTRACT

The urban color is the most intuitive presence of the materialistic urban space. The color presence suitable for a city should be such color system as is jointly worked out by local cultural and natural environment and inherently grown. This research studies the properties and expression of urban color regional attribute based on the color-geography theory, from the perspective of climate environment. With extensive urban color planning examples, this research in-depth analysis the climate adaptability of urban color and demonstrates that the specificity of the urban colors come from the climate environment; meanwhile, the strategy and methodology of climate-adaptable urban color practices are proposed herein by referencing multiple urban color planning and design, including: calibrate the range of recommended urban color spectrum via temperature climate analysis, guide architectural color planning with photopic attribute of the color and daylight climate factors, etc, look forward to establish dedicated color system for the city by virtue of science and technology.

Keywords: Urban Color; Climate Adaptability; Urban Color Spectrum; Urban Color Planning and design

1. COLORS OF NATURAL ENVIRONMENT THAT FOSTER LOCAL PREFERENCE

The climate environment is the environmental factor retained with certain aboriginality under the globalization tendency and the most unique creation condition for urban color. The sunlight, temperature, humidity, haze and other conditions within the climate environment will definitively impact the indigene's color preference and significantly impact the urban color.

For example, exposed to the strong sunlight at low latitudes, the object with high luminous reflectance will give out dazzling reflected light, which will cause frequent blinking of nonnative, while the native blinks less than the nonnative as the retina has been adaptable to such strong stimulation thanks to the genetic inheritance. To accommodate the light color adjustment demand of optic nerve system exposed to strong sunlight for a long time, people also actively adjust the color, such as applying the color with high chroma to realize well-balanced color in strong light. That is the so-called "local eye" and local color preference resulting from the local colored light source in the indigenous climate environment.

Covering a territory of 9,600,000km², China features diversified physiographic environments and geographic latitudes, crossing frigid, temperate and tropical zone, which forms the lighting climate zones at five gradients with soils, rocks, waters and vegetations in different colors and various color presence. Take the daylight environment as the case. Located on the Yunnan-Guizhou plateau, Lijiang City (26°86'N and 100°25'E; elevation of 2,418m) of Yunnan province, falls into the 1st daylight environment zone in China and features typical mountain and plateau climate, i.e. sufficient and strong sunlight, high reflectivity and free of cloud and mist. The sunny climate results in bright and saturated color preference. The brilliantly colored ethnic minority costumes as well as white screen wall, reddish brown column and colored relief and pattern that are popular in traditional architecture are found with narrow hue range yet wide application of bright primary color with passionate and strong tone, which typically responds to the strong daylight environment. Despite of the inevitable cultural metaphor in the color of traditional architecture and costumes, the daylight environment plays an important role in the selection of collective color sense.

On the contrary to the sunny Lijiang, Chengdu (30°67'N and 104°06'E), located in the west of Sichuan Basin, adjacent to West Sichuan Plateau and suffered from the cold air descending in the mountains, is cloudy and foggy with less sunshine. With the annual sunshine duration of only 1,239.3 hours, Chengdu is one of the areas with most rainy days in China¹. Therefore, Chengdu falls into the daylight environment zone at the lowest gradient, i.e. the 5th daylight environment zone. The typical climate features low temperature in spring, short summer with thin sunlight, cool and rainy autumn and cloudy and foggy winter. With poor daylight environment, the sky looks cyan-blue grey with low

saturation even in sunny day and the vegetations look in green grey with medium and medium-low brightness. As a result, the color of sky, waters and vegetations in Chengdu features medium saturation and medium-low brightness. The varied brightness and saturation such as the river water occasionally appearing turquoise-blue in the spring sunshine, the verdant tender bamboo leaves basking in broken sunshine of summer and the celadon-green holly leaves calmly wetted by the drizzle in autumn and winter are sufficient to accent the cold grey tone of Chengdu. In such color environment, the optic nerve is able to clearly perceive color without strengthening saturation, thus develop the native's color preference and adaptability of admiring color variation of low saturation in the daylight environment with medium-low brightness. To respond to the color of natural environment, the dwellings in West Sichuan are constructed by local materials and composed of black-tiled roof, livid bricks and brown windows, doors, beams and columns in nearly unified color. Such color combination with low saturation presents neutral-cold grey moderate color, while the dotted greyish white painted walls increase the reflectivity, adjust the visual perception in poor daylight environment and effectively improve the day lighting. The color relation seems as natural as the yellow-and-white gardenia interspersed in the emerald bamboo forest (Fig. 1). So the architecture color of dwellings in West Sichuan is not only attributable to the restraint of local materials, but also attributable to the restraint and portray by the climate environment.

The climate environment indispensable for human unconsciously develops the native's color physiological perception, also called as color psychology basis, thus establish the regional color system with climate adaptability.



Figure1. Architectural Colors of Dwellings in Chengdu (GUO Hongyu, ZHU Yong Ting)

2. CALIBRATE THE RANGE OF RECOMMENDED URBAN COLOR SPECTRUM VIA TEMPERATURE ENVIRONMENT ANALYSIS

The physiological and psychological reactions to color under all kinds of temperature conditions have been elaborated by a lot of experience. For example, warm colors make people feel hot, while cool colors calm people down. Likewise, people in subtropical and tropical cities, with a blazing sun overhead every day, will certainly not accept warm colors, leaving only cool tones for urban color spectrum; while frigid cities with blowing cold wind can only choose the recommended urban color spectrum within the warm color range. Some of these statements are born of sensory experience, while some are merely perception-based deduction. It is inevitably biased to decide the recommended urban color spectrum by such conclusions.

In one of the special research on Integration of Urban Planning Technologies of Low-carbon City[△], which the author directed under Important Science and Technology Program of Guangdong Province, one of the important contents is to, by means of climate-adaptive approach, study how to use architectural colors of different hues, values and chromas to build low-carbon eco-city built environment. The research, in combination with the urban color planning project of Guangzhou[✦], employs the real-time analysis function of the Eco-TECT ecological analysis software to build a database of external thermal environmental conditions based on Guangzhou's geographic latitude and the perennial temperature, solar radiation and other statistical data released by Guangzhou Meteorological Bureau; and sets up a simplified ideal architectural model to study the relation between the building's thermal environment and architectural color by conducting temperature simulation and analysis by time interval and season, in a bid to realize empirical study of the recommended urban color spectrum. It chooses in particular two

[△] Integration of Urban Planning Technologies of Low Carbon City under Important Science and Technology Program of Guangdong Province (No. 2012A010800011)

Project Principal: GUO Hongyu, Main Researchers: GUO Hongyu, LEI Xuan ZHANG Fan, JIN Qi, WU Chufeng, LIU Qing;

✦ Urban Color Planning of Guangzhou, Project Principal: GUO Hongyu, Main Researchers: GUO Hongyu, CAI Yunnan, LI Jinghai, Zhu Yongting, Chen Hong;

important time nodes for external thermal conditions^{2,3}, i.e. the summer solstice and the winter solstice, to analyze and compare the temperature data throughout the day, test and analyze the internal thermal temperature⁴ on the building facades caused by typical hues of a 10-hue color cycle, and analyze one after another the indoor temperature index resulted from the value and chroma variation of the typical hues.

The test proves that the reason to the impact of hue on the building's internal thermal environment is the surface albedo of the color⁵, and the indoor temperature is directly proportional to the chroma of the architectural color and inversely proportional to the value of the architectural color; in terms of temperature difference, the variation in hue and chroma causes greater warming effect than cooling effect, and the warming effect caused by value variation is greater than the cooling effect caused by chroma variation. The variation of chroma, even by 5 grades, causes no greater impact on the variation of indoor temperature than the variation of value by 1 grade. The chroma has the same impact on the building's internal temperature as the hue, of which the variation of chroma in purplish red, red, purple, bluish purple and blue systems, as well as the variation of value in yellow, yellowish green, bluish green, orange and green systems is more likely to cause evident variation of indoor temperature. This obviously differs from the speculation that bluish purple and blue will not increase the indoor temperature. As per the impact on the building's indoor temperature in ascending order, the color systems rank in the sequence of yellow, yellowish green, bluish green, orange, green, purplish red, red, purple, bluish purple, and blue.

Using such test to calibrate the urban color planning of Guangzhou comes to the conclusion that is very close to the spectrum recommended by the Guangzhou Urban Color Planning. Specifically, it proves that under the temperature conditions of Guangzhou's typical subtropical maritime climate, colors in low chroma and medium to high value, including yellowish gray, yellowish red gray, greenish red gray, and bluish green gray are appropriate urban colors because they tend to foster suitable indoor temperature. In addition, test in combination with the temperature effect of building materials shows that, smooth stone, concrete and face brick materials in medium to high value are more suitable to achieve water resistance and self-cleaning on building facade under hot and humid climatic conditions. The research applies the method of temperature environment analysis to the calibration and testing of the urban color spectrum system, aiming to provide a reference range and proofs for the selection of the urban color spectrum.

3. GUIDE ARCHITECTURAL COLOR PLANNING WITH PHOTOPIC ATTRIBUTE OF THE COLOR AND DAYLIGHT CLIMATE FACTORS

The selection of the recommended urban color spectrum is not merely based on the deduction of the temperature environment. In fact, the daylight climate has greater impact than the temperature and humidity on people's perception and selection of colors. The research uses the daylight climate effect that is scientifically quantified in the color vision theory to study such influence rule, expecting to reveal the objective variation of urban color under different daylight climate conditions by means of scientific measurement and analysis. Of which, the daylight climate refers to the average natural light conditions formed by direct sun light, sky diffused light and ground reflected light, namely the general term that describes meteorology that causes the variation or change of natural light. The light climatic effect is mainly reflected by the photopic attribute (including the stability of color observation and the photopic distance) and color stability.

Based on Urban Color Planning for the Olympic Center Area of Jinan★, the Urban Color Planning for the West Railway Station★, and the Urban Color Planning for Beihu Area★, the research employs the color vision theory and daylight environmental analysis to extract local-fitting recommended urban color spectrum and propose appropriate guidelines for architectural color design.

Jinan City is located in Zone III among China's daylight climate zones. It ranks medium level for the average annual total illumination in China. The annual amount of solar radiation in Jinan is high from May to July and low from November to February. Judged merely from the amount of sunlight, it is a region with bright sunshine and high degree of color recognition. However, Jinan City borders on Taiyi Mountains on the south and the Yellow River on the north. Its land is sloped to the north. Since the Yellow River on the north is an aboveground river, the urban flood control dam is 20m higher than the urban ground, resulting in lowlands in the urban area, poor natural ventilation in the city, and hazy

★ Urban Color Planning for Olympic Sports Center Area of Jinan awarded with the 7th China Color Grand Award; Project Principal: GUP Hongyu; Main Researchers: GUO Hongyu, LEI Xuan, TAN Jiayu, JIN Qi, ZHANG Fan, ZHU Yongting, CHEN Hong, LONG Zijie, CHEN Zhong, HE Yu, XU Hongfu;

★ Urban Color Planning for West Railway Station Area of Jinan; Project Principal: GUO Hongyu; Main Researchers: GUO Hongyu, TAN Jiayu, JIN Qi, ZHANG Fan, LEI Xuan, CHEN Hong, HE Yu, MAI Yongjian, XIAO Yunlin, ZHENG Quan;

● Urban Color Planning for North Lake Area of Jinan; Project Principal: Guo Hongyu; Main Researchers: GUO Hongyu, TAN Jiayu, JIN Qi, ZHANG Fan, LEI Xuan, CHEN Hong, HE Yu, MAI Yongjian, XIAO Yunlin, ZHENG Quan;

weather in Jinan. Based on statistical analysis of the report data of the meteorological station and the physical quantities data handled by MICAPS since 2001, the obstacles to vision in Jinan and peripheral areas are dominated by fog (63%) and smoke haze (smoke screen, haze) (28%), in particular the fog; other obstacles such as dust, blowing snow and precipitation are relatively infrequent (9%). Analysis shows that, most of the fog in Jinan is of radiation type, which is formed under sunny and windless or weak wind conditions, when the sharp decrease in surface radiation temperature at night causes water saturation and condensation; in the background of relatively stable circulation, particularly in autumn and winter, it can easily create a wide range of continuous bad fog weather. Autumn and winter is a period of low solar radiation, thus can greatly reduce the degree of urban color perception. Coupled with pollution of urban construction, hazy weather has become a factor that affects the urban color perception in Jinan in recent years.

Therefore, when there is poor natural ventilation, large amount of atmospheric dust, serious air pollution, drought and less rainfall, and excessive radiation fog, the dust and suspended particles in the air scatter more natural light and weaken the power of the natural light, which reduces the shadow contrast and the value of the urban color sample, create gray sky, gray buildings, and an overall blurred background with low chroma, blurred faces and less changes. The architectural color tends to form a cold dark gray tone. And the completed large-volume buildings with metallic roof and glass curtain walls further exacerbate the reflected daylight environment and the gray visual effects. Hence it can conclude that Jinan is a city with a moderate energy daylight environment in terms of urban color.

On top of the aforesaid daylight environment analysis, the research uses the color vision theory and the basic statistical analysis of the equivalent value difference to quantitatively analyze the impact of the daylight climate factor on urban color perception, and reaches a conclusion for color design: Where the observation distance, material and other factors are constant, the area of color has large impact on the color photopic attribute, but such impact is far less than that is caused by the variation of value by 1 grade; the color vision stability is greatly affected by value, i.e. it basically drops when the value drops; factors affecting the photopic attribute in a descending sequence are: relative humidity, SO₂ concentration, NO₂ concentration and PM₁₀; the light climate effect of colors in cool hues are evident while those with neutral to warm hues are not; in addition to light climate and weathers that hinder color perception, the building volume and observation distance also have major impact on color perception; the impact of light climate on color vision stability is the most evident at the observation distance of 500m.

Based on the above test analysis, recommended urban color spectrum fit for local conditions is extracted from the urban color planning for a number of key areas in Jinan, and target-oriented guidelines for architectural color design are proposed. The guidelines include, for example, use colors in moderate to high values; use color combinations with moderate value contrast; in view of the flat light filterability in the region, it is necessary to develop vertical lines and sculptural facade for the buildings to avoid flat building surfaces, and apply colors by layer and section to enhance the architectural form; propose perception-based color design guidelines and spectrum proportion suggestions for building interfaces at key sections in combination with the urban design path and node space, in particular the distance factor that is employed in the analysis of light climatic effect (Figure 2); develop guidelines for color value and chroma in consideration of the building height; reduce the use of large high-reflectivity coated glass and metallic reflective roof/wall.

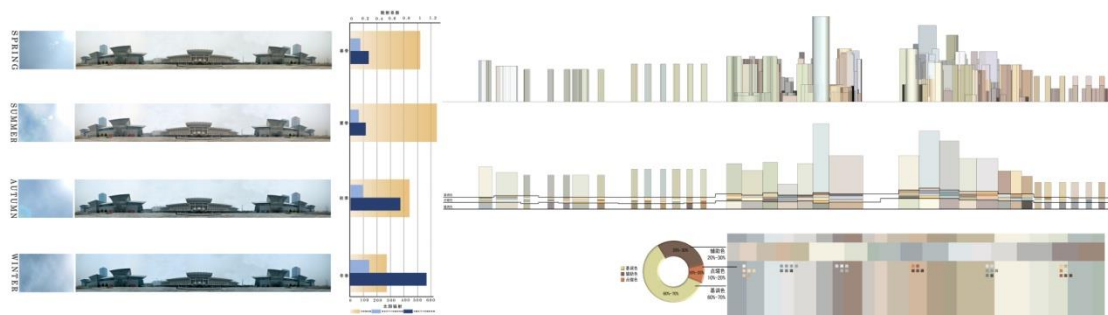


Figure2.Color Design Guidelines and Recommended Color Spectrum Proportion for Building Interfaces at Key Sections (Excerpted from Urban Color Planning for West Railway Station Area of Jinan City)

Thereafter, our team used the Eco-tect light simulation technology in Nanchang urban color planning project*. We simulated the typical sun path and intensity of sunlight of seasons, analyzed light climate

* Nanchang urban color planning project; Project Principal: Guo Hongyu; Main Researchers: GUO Hongyu, TAN Jiayu, JIN Qi, CHEN Hong, HE Yu, MAI Yongjian, XIAO Yunlin, ZHENG Quan

characteristics of the key sections in the city, to provide the urban color design guidelines which comply with the color photopic attribute of riverside architectural interface((Figure 3).

The work of seeking architectural color spectrum system and color design proposals that are fit for the local daylight environment through scientific and quantitative analysis of the daylight climate effect has made aspiring progress. Of which the Urban Color Planning for the Olympic Center Area has borne the palm at the 7th Color China Award Ceremony.

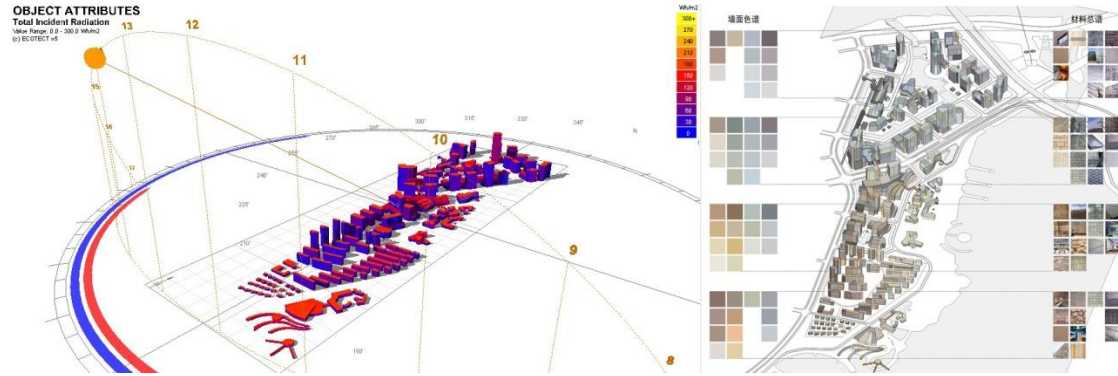


Figure3.Urban color design for Building Interfaces at Key Sections (Excerpted from Nanchang urban color planning project)

4. CONCLUSION

In recent years, the scientific nature of urban color has been gradually recognized by people, and the technical means and scientific ideas applied in the urban color practices have been increasingly strengthened. This is an inevitable requirement for the development of urban color science. But after all, urban color is neither pure technical experiment nor mathematical deduction, and even the impact of daylight climate on urban color perception is composed of two parts, i.e. physical color and psychological color. Physiology and psychology, as well as culture and technology, always need and support each other. To such a research object as urban color, it is also important to emphasize its artistic characteristics, because urban color is not only scientific, but also cultural and aesthetical. This research proposes to study the urban color from the perspective of climate adaptability to provide rational coordinates and paths for the emotional urban color ideal, and, by virtue of science and technology, seek a dedicated color system and regional attribute color environment for the city. This is the ideal objective of urban color, meanwhile, an important way to develop the city's unique charm against the historical background of global convergence.

ACKNOWLEDGMENTS

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Color Correction Practices in Heritage Digitization

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ABSTRACT

The cultural heritage digitization seeks high resolution and high fidelity of the shape, color and surface texture of the object. The digitization of color is challenged by varying types of objects: the ancient paintings and calligraphy require high accuracy of color rendition; the Tibetan murals often bear high gloss surface; the global uniform texture and color are pursued for 3D objects. In order to achieve the highest quality of the cultural heritage digitization, several new techniques and methods have been applied in our projects. This report will introduce the technical process and practical results of those projects; some unresolved technical issues will also be discussed.

Keywords: Heritage Digitization, Color Correction

1. INTRODUCTION

The cultural heritage is the evidence of evolution of human civilization which contains a wealth of historical value, artistic value and scientific value. Heritage has a non-renewable characteristics. Therefore, other than the extensive development of cultural heritage protection, careful recorded digital protection of cultural heritage is gradually concerned by people. The current scope of digital protection of cultural heritage is mainly focused on recording paintings, murals, and other planar cultural heritage in the form of high resolution image, recording the 3D shape and surface color of bronze, gold, silver, wood and other relics in 3D models, mapping archaeological excavation site, caves, ancient buildings and other large sites and recording their shapes and surface color. Only a small amount of work use CT tomography, X-ray scan, microscopic photography, hyperspectral, infrared and ultraviolet photography and other technical means to record information about the internal structure and microscopic information of artifacts. In the protection of heritage, information like relics material composition acquired by non-destructive probing or sampling analysis methods can be integrated with relics image information and achieve a more comprehensive data archive.

For recording the images of heritage, fine, accurate color is a demand in principle. Otherwise, the application value of digital protection of cultural heritage will be considerably restricted or even lead to misunderstandings about heritage properties. With the advancement of technology related to digital photography, the performance of digital camera in image resolution, color depth, and other aspects of thermal noise suppression is getting better. The integrated use of different techniques have been able to get a very detailed color image artifacts. However, the performance color reproduction of digital artifacts image is still not stable yet. Among many works of digital protection of cultural heritage, digital color calibration controls rely mainly on the subjective judgment of professionals and the same problem in the field of publishing and printing are more common.

The author launched a series of technical research and engineering practice in the field of heritage digitalization since 2000, mainly in the field of ancient murals, grotto sites, and cultural heritage in

museums. For accurate color restore problem in heritage digitalization, the author carried out targeted technical exploration in different types of cultural heritage digitalization. Related progress is described in the following chapters.

2. RELEVANT TECHNICAL REVIEW

In the field of digital protection of cultural heritage, techniques to enhance color fidelity can be divided into two categories, one is active accurate measurement method and the other is passive measurement method using reference substance. Equipments like spectrophotometer and colorimeter are used in the method of active accurate measurement. They can measure high fidelity of Lab color values, or even high resolution spectral curves, and work in wide range of gamut. In addition to calibration of input devices' color feature such as cameras and scanner, they can be used in calibration of output devices' color feature such as printer and monitor. But these methods require that the circular measurement area of about 10 mm is uniform in color. Besides, typically such devices need to use built-in fixed angle lighting during measurement, so it's unable to flexibly adjust the angle to adapt to highly reflective surfaces. Passive measurement method using reference substance usually use standard color card, one of the most commonly used is 24-color standard color card produced by x-Rite. Each color on the color card has very accurate color value in production. Differences of color value captured by camera or scanner in the color card and standard value can be used to compute color deviation feature of input devices. Passive methods are easy to use and cheap. They are widely used at present. But due to limitation of color type represented by color card and decrease of accuracy, it's very difficult to achieve highly accurate color correction.

Device color feature calibrated using different methods can be used in correction of devices' color performance through the form of ICC profile, and be unified in different operation systems and software. Moreover, software like DNG Profile Editor can be used to achieve color correction for a particular file by correcting image color. For line scanning device, the color look-up table (LUT) technology with the underlying processing hardware is usually used in the scanning process to achieve color correction directly.

3. COLOR CONTROL UNDER THE DIGITAL PHOTOGRAPHY MODE

While digitizing murals, grottoes, ancient architectures and three-dimensional cultural relics, digital photography is the most convenient means for collecting color information, because the depth of field within the scope of collection is large, the position and angle of camera need to be transformed flexibly and the equipment working in the field needs to be portable and dustproof.

Color instability in digital photography is mainly manifested in the changes of the temperature and angle of light source, the reflective properties of surface material of cultural heritage and so on. In order to achieve a higher degree of collection for the surface color information of cultural heritage, the first priority is to improve the quality of light source. Through the practical comparison of different equipment of light source, such as three primary colors cold light lamp, LED lighting, flash and so on. On account of the best ensemble performance in the arrangement of convenience, color stability, the spectral energy distribution and so on, flash has been selected as the device in a lot of work. However, the energy of flash will be excited at the moment during working, in order to reduce the light radiation to cultural heritage. In principle, we need to use flash with ultraviolet (UV) filter bubble. In order to ensure a uniform and stable light condition in the case of indoor collection, we need to shelter the effect of other light sources and use softbox or reflected light when lighting. When collecting large format

mural or painting heritage, in order to achieve the overall illumination of uniformity and homogeneity, we should maintain the relative position and angle of the camera and lighting. In addition, standard color card is required to calibrate the color restore parameters before the official collection of color information of cultural heritage, the method named DNG Profile Editor which has a better performance in restoring and correcting color, is able to integrate RGB values of 24 color blocks to calculate the optimum parameter of color correction. Through a large number of practices in Sumeru Grottoes, Yungang Grottoes, White Pagoda of Hangzhou, Tholing of Tibet, Dunhuang Grottoes, Qingzhou Museum and so on, technics mentioned above achieve good effect.

In practice, however, we also find that the digital image color rectified by DNG Profile Editor is on the basis of the approximate correction value obtained by the calculation of the color values deviation trend, and it is able to obtain a smooth corrective effect in the entire color range of collecting devices. However, as a result of such approximate corrective action which leads to the result is not standard result of correction, identified deviation still exists after correction in the case of poorly controlled lighting conditions. Meanwhile, the change of the shadow caused by the change of angle of illumination and shooting in collection makes it difficult to unify and correct color.

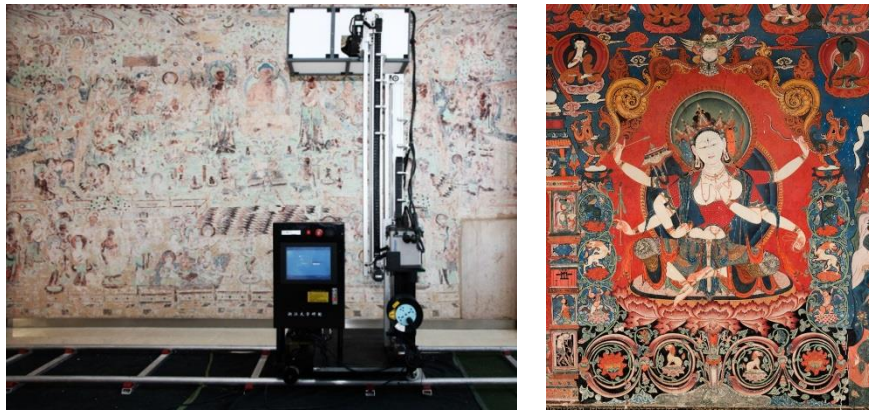


Figure 1. The mural filming device (left) and digital results of the mural (right)

4. COLOR CONTROL UNDER THE LINE-SCANNING MODE

Silks, paintings and other artifacts due to its ability to be expanded into a flat surface, using a high-resolution line-scanning device behave better in aspects of light stability, acquisition resolution, and work efficiency than digital photography. Existing large-format, non-contact scanning devices in the market, but in portability of the device, the maximum scanning resolution, stability of color reproduction, still cannot well meet the unique demand of digital heritage areas.

To meet the unique needs of silks, paintings and other artifacts digitized collection work, the author developed a portable line-scanning device. The device integrates a high-resolution line-scanning camera, professional cameras, customized LED light source, high-precision slide, high-precision linear motor and other components, and highly integrated structure is formed for a portable working ability. When working in 1000dpi resolution settings, the device can complete the 420mm×800mm format scanning in one minute, the total number of pixels up to 520 million. In addition to high-precision motion control, automatic geometric calibration and other aspects of technological breakthroughs, but in terms of lifting the color reproduction we mainly pay attention to the work of customized high color rendering index LED light source, the lighting distance and angle adjustable, dynamic setting of LUT work.

Using line-scanning to complete the image artifacts digitized collection, each row of pixels of data are produced under the same lighting, shutter and color control conditions, improving the overall consistency of the image. Framing scanned images using similar photo stitching technology can be put together into a more large-format image. The large format silk relic's length has reached more than 50 meters.

Currently, the greatest difficulty in the LUT way to complete the color correction under line-scanning mode is the scanning-reflective surface texture adaptability. LUT calibration data based on a standard color card are mainly under diffuse light conditions, when faced with satin surface with more obvious reflection, and surface in undulating shape, the device status between the acquisition and calibration beforehand is different, and color correction may result in a big deviation.



Figure 2. Portable line-scanning device (left) and results of silk relics (right)

5. COLOR CONTROL UNDER THE COLOR PRINTING MODE

In various exhibitions, teaching and cultural derivatives production process, we often need to use color printing copying paintings, murals and other art images. However, the color reproduction performance of the current color printer during operation is often difficult to directly achieve a better state, and often there will be a large color deviation. Even after the calibration using tools such as the Eyeone printer it's still difficult to achieve a good color reproduction result for particular image artifacts. Even the use of large-scale printing equipment, it is difficult to stably produce high color reproduction of color prints.

After analysing of the current poor performance of color print in color reproduction automatic correction, we think there are two factors. First, the digital image may be printed in color which has a certain deviation with the original, and sometimes the operator will correct the image data based on the color performance of the display image so as to the display color bias produced by the subjective feelings introduced into the original data. Second, a color printer is to take care of the entire color gamut for smooth color correction with the smoothing approximation during the whole color calibration process, the local deviations distributed to the whole range of color output to enhance overall performance. Such color correction mode in the face of a piece of a specific color image when printed would be difficult to have the best color performance.

In order to enhance the color reproduction of a specific art image in color printing replication, the authors developed a method of local adaptation accurate print color correction[4]. First, for a single image to be digitally printed, we extracted dozens of the most representative characteristic color by

clustering and make them into color chart images. Then after this color card printed we use a scanning device to read the RGB color value, calculate the correction parameter based on the deviation and transform the primary color card and then re-print and test. After several iterations of correction, we get the color correction parameters to best fit for this image characteristic color, and transform the primary color card applying the parameters to get the closest expectations of the copied result. If copying directly from the works on paper, you need to make some changes in the technical aspects, you can eliminate color correction bias of image capture devices. Currently the greatest difficulty of such correction methods is that it will amplify noise partial images in the color correction process, so that the results of the final copy printout rougher than some of the artwork. Meanwhile, after continuous output of multiple copies, the color printer may change the color output characteristics, the stability of correction result will be influenced to a certain degree.

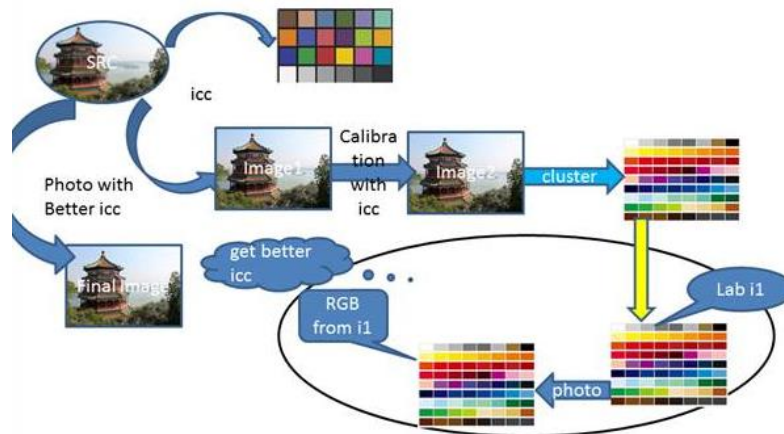


Figure 3. Workflow of color correction based on characteristic color

6. EXPECTATION

The requirement of color reproduction in the process of digital protection of cultural heritage is very high, but targeted research work is currently few. It has not yet formed a unified standard and the need to carry out related work is urgent. In the future China's economic development orientation and trends in the world economy, it will be based on splendid traditional culture and creative industries. It is urgent to clear related industry standards, and gradually build a comprehensive technical support system which will play an important role in the digital protection and inheritance of the culture.

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From Light to Color: the Path of Seeing the World

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ABSTRACT

Human vision is the resultant thing when the organism encounters light, the abundant physical stimulus in our world. However, vision is not the world. Human vision just represents the physical world in the brain reasonable for the organism, but not for the real world, as observed in the phenomena of visual illusions. Human vision, especially color perception in the present review article, can be thus understood from disciplines of physical sciences, psychophysics, physiology, and psychology, as different processes on the path of seeing the world. The physics of light is itself the origins of color studies, which is about the spectrum, radiometry and photometry, colorimetry, and metamerism. Among those physical phenomena of color, color mixtures are operated with physical stimuli, but seen with psychological principles, where color psychophysics was founded on. Color vision also plays an important adaptive role for organisms. Animals with color vision can easily identify ripe- fruits, tell who its mates are, and find enemies. In a modern human society, colors are used as codes for almost everything that needs to be separated and visually discriminated. However, we have to make it clear about what is color before we study color. Color is a pure visual phenomena, which does not exist in the physical world but only a product of vision, and color vision deficiencies are not rare. The application of color involves technology and aesthetics. Accurate measurements of color are essential before creative color design can be used on mass production. In the end, we point out that color is not merely like a red, green, yellow, or blue. All visual senses about surface, e.g., glossiness, transparency, hardness, wetness, etc., should be considered as colors in the visual world.

Keywords: Light, Color, Human Color Vision.

1. INTRODUCTION

How human beings see the world involves many academic disciplines. In the present study, we would discuss this issue through the basic question: What is seeing?

Seeing includes the processes and the resultant product of human vision, a sensation to light, the electromagnetic radiation that excites visual sensation. If defined by the wavelength range, the visible spectrum only occupies a very small portion in the whole electromagnetic radiation spectrum. However, the visible part of the spectrum, i.e., light, has the most abundant solar radiation energy reaching the surface of the earth¹. In studying human vision, we need to know about some basic properties of light, and the measurement of light. Light has a wave-particle duality in physics. It interacts with materials, and through the optics of human eyes, can form images that represent the world. Precise measurements of light are the first step to understand and study vision scientifically. Modern photometry is based on radiometry, transferred by international standard fundamentals into photometric units. However, a meaningful measurement of light has more aspects than merely photometry. The first level is about visual stimulus measurement, which is the description of radiation energy. The second level is photometry². Higher levels of light measurements are measurements of sensation and perception, which concerns psychology, and it is only in these levels that the measurements can reflect what light is for human beings, namely: VISION.

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Table 1. Flow chart of the processing of seeing.

2. COLOR

Visual sensation itself does not complete vision; the visual perception which is produced in the brain, and the following visual recognition are the final stage of human visual processing. However, we will focus on the most wonderful phenomenon of human vision, i.e., COLOR.

2.1. Color Attributes

Color is about the primary sensation to light stimuli. Whenever there is light, there will be color. The appearance of color can be stated by three properties: hue, brightness, and saturation. Hue is a sensational quality of light that can only be described with the words such as red, yellow, blue, and green. Brightness is the perceived amount of light flowing from a certain source. Saturation is about the strength or clearness regarding the quality of hue for a light ³.

2.2. Color Mixtures

Colors can be mixed to produce another color. The phenomenon is sensational rather than physical. Additive color mixtures happen when lights mix and there is an addition of energy from the lights. For additive color mixtures, the resultant colors are predictable from the amounts and chromaticities of the added lights. Similar compositions can also be found in optical and temporary successive mixing of colors, resulting in averaged energy rather than additional. In subtractive color mixtures, the light energy of resultant colors is reduced by absorption factors of the colorants ⁴. In contrast to additive color mixtures, the colors of subtractive color mixtures cannot be predicted unless the spectral properties of colorants are well known ².

2.3. Cesia

Color appearance is not limited to the three basic properties hue, brightness, and saturation. A whole “color appearance” for a surface should include all perceived surface properties. Recently, the uprising of “material perception” research has gradually filled up the insufficiency. In addition, a theoretical model “cesia” was suggested to categorize those surface appearance properties in a systematical way ⁵. Based on three elements of material properties: permeability, absorption, and diffusivity, a cesia system which is composed by P-D-L scales is going to be established and psychophysically tested by the authors for further applications.

3. VISION

Vision concerns visual sensation and visual perception. Human vision is not a reproduction of optical images, but rather a representation of the outside world. In the visual representation, the organism produces a reasonable world rich of generated information, such as form, depth, motion, object, and color. The visual world representation is meaningful and functional to the organism ⁶.

3.1. Color Vision

Perhaps color information is the most salient feature in the visual representation. It is a product of vision which does not really exist in the physical world. Color vision has its adaptive function. With color vision, an organism can easily spot certain objects, such as ripe fruits from surrounding foliage. Human color vision is trichromatic, which is owing to the three kinds of retinal cone photo receptors. People with this kind of color vision called trichromats.

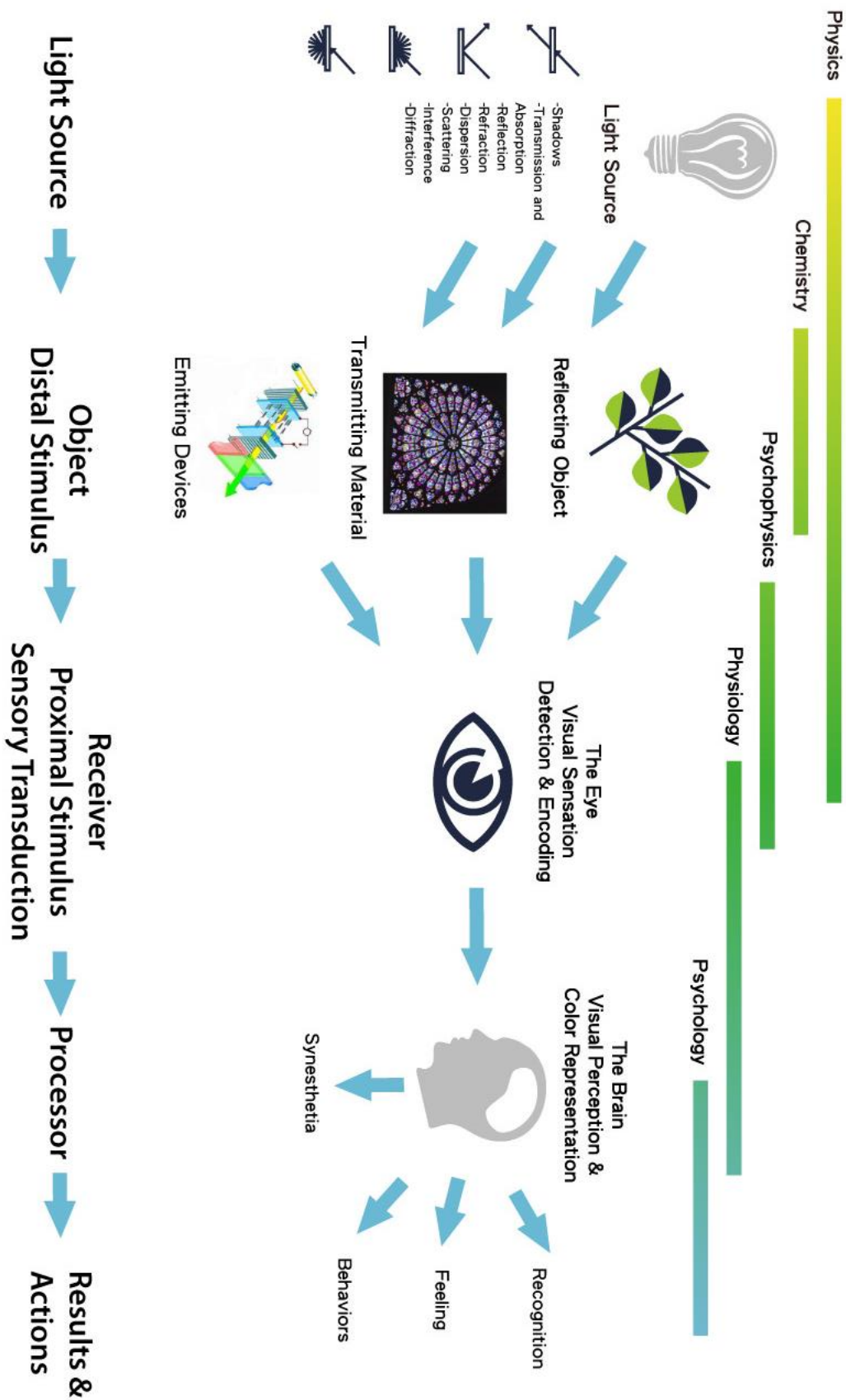


Figure 1. The human path of visual perception. Three major elements define the way we encounter and see color, perceive and experience it: a light source, an object, and a recipient.

3.1.1. Color Vision Deficiencies

Not everyone has normal color vision. People who have deficient color visions are not rare to find in modern human societies. Those who lack a certain kind of cone photo receptors are called dichromats. There are protanopes, deuteranopes, and tritanopes. Dichromats confuse certain colors that appear distinctively different from colors seen through a "normal" person's eyes. . However, dichromats can still see colors and are not color blind. In some rare cases, patients may lose two or even three kinds of cone cells in their retina. Those so-called monochromats are truly color blind ⁷.

4. RECOGNITION

The last step of seeing happens in the human brain, which involves the processing of cognition, emotion, and behaviors. Visual recognition includes the discrimination and identification of visual information. In this stage, meaningful figure-ground separation and objects are separated, they are identified, and their spatial locations are determined. Color information here is not merely about the appearance of light and surfaces. In the final stage of visual recognition, color belongs to objects, is a part of objects, surface properties, and invariant as objects in the world. Humans rely on visual perception to act successfully in the world, and to understand what events happen now and then. Color in the world serves as visual codes, as seen in a subway route map. Color has its symbolic meanings, like visual indexes and signs. Color shows the character of a city, reveals the values of a culture, and is related to climates and geology. Color exists in everything that can be seen. There is no color if there is no light, and so, fun is lost at all ⁸.

ACKNOWLEDGMENTS

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Many thanks to M. K. Lan for making the original figure[†].

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[†]Figure 1 was originally presented in the 2015 IYL Taipei lecture.

The Multiple Semantics of Color in Modern Design

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Abstract Color is the soul of design works, the characteristics of color in design, the fashionable change of color, and the scientific and artistic character of color. Based on these, this article elaborates the multiple semantics of color in modern design.

Key words: color, design, fashion, research

The academic study of color has the scientific and theoretical aspect. However, the application of color is reflected in design practices on a larger level. Though some thesis talked a lot from text to text, from concept to concept and from data to data, it is useless. So in design application color becomes the most important factor to directly influence the designers and customers. The design practice of color becomes the key factor in color study and the multiple semantics that color reflects in modern design are deserved to think for researchers.

Firstly, color is the soul of design works. Several years ago, the *Dragon TV* once interviewed a famous architecture expert in Shanghai. When talked about the architecture color design, the expert rebuked it as the insignificant skill. What he meant was that the function, pattern and color of architecture were triune and could not be separated. As an architect, he is responsible for all aspects of the architectural design. However, it is common in Chinese architectural design that many architects don't possess the comprehensive quality. The architects from the polytechnics lack the aesthetics quality about art and design. Though they will add architecture sketch, watercolor painting, artistic works appreciation, architecture history and some other courses in the later courses, for the overall aesthetics quality of the architecture students, it is not enough. Except few architecture students with high personal artistic quality, a lot of unqualified architects enter the society, which directly causes Chinese architects generally don't have high quality on color. *Architecture Color Design* emerges as the times requires. Song Jianming and some other color experts returning from abroad were conscious of the lacking of Chinese architecture color and then introduced some concepts and methods they had learned abroad to China, which promoted the progress of Chinese color study and application design. . There is no doubt that architecture color design is architect's responsibility. However, in the situation of generally ignoring the architecture color and the lacking of architects' color quality in Chinese architecture field, the architecture color planning and design in the future, as a relatively independent application design art, will exist for a long period of time and possess the rationality on scientific principle cognition.

This issue is discussed to explain the importance color plays in design. It is obvious to see the merits and shortcomings of current design education. What an excellent art and design institute reflects is such comprehensive art quality. I often took the works of graduates from Academy of Arts & Design, Tsinghua University and Central Academy of Fine Art for example in my class to explain the key role color plays in design. I did this not because I could not put forward the mature design works of other famous designers. What I want to express is that as a design student, due to the art background from Academy of Arts & Design, Tsinghua University and Central Academy of Fine Art, and the color

quality top design students owned contribute to a lot of successful graduation design works. This is a collection of fashion design works. Frankly, as for the design, this work has the critical defect and the craftsmanship is also not deserved to be boast. But from the upper garment, the dress even to the shoes, these small decorations formed a color relation and this relation was formed in the color contrast. This work has high gray scale color but hue is clear and the advanced gray expressed the unique color inclination, which formed the stylish color relationship in the color contrast. Coincidentally, in the spring of 2011, I was invited to assess the opening report of the important program of the Ministry of Education. When I visited a report exhibition about design foundation in the art gallery of Central Academy of Fine Art, I was attracted by the design of a set of comprehensive materials and glassware. It is also their color design that attracted me. The color including the advanced gray appears unified in contrast and the color brightness is relatively high, which is deserved to be regarded as the advanced design.

Color as the most striking elements in the design modes, its role is not only reflected in the designers and users' psychology, but also in its reveal of designers' color quality and aesthetic style.

Secondly, color has its characters in design. The characters of color not only reflect the designers' color quality, but also reflect the characters of the regions and nations. Professor Kenyohara from Musashino University in Japan had contacts with me for many times, and he even sent me the same book *Design of Design* of Japanese version twice. In the fall of 2010, he came to China for an important cultural architecture project for a Chinese city. We had a drink in the Li Gengtang Club in the Pingjiang Road of SuZhou. After the drink, we talked till midnight. He showed me his latest design work by notebook. As a designer of the broad sense, Kenyohara's work does not just lie in the graphic design. His design has become a kind of design concept and practices his design ideal in many fields, such as architecture, exhibition, automobile, landscape and other commercial space. At the beginning of this century, the *RE-DESIGN* curated by Kenyohara had a great influence on Japanese design. In fact he has become the leader of Japanese design innovation movement. Japanese famous brand MUJI, in which Kenyohara works as the design director, inherits the concise, bright and the high-classed design style of Kenyohara. Even sometimes MUJI is no design without color. Black, white and gray are such a kind of style, which highlights the brand's character and at the same time combines with the pureness of Japanese national color. From a small tag to the exhibition space of the mall, I could vaguely feel a kind of color implication.

The global design does not exist in Kenyohara's mind and it is also illogical. Kenyohara says *The Japanese design is always the Japanese design. Taking MUJI as the example, it will never become a global brand from a Japanese brand. As a country with a long history of design, we are not keen on becoming a part of the globalization and we must try to avoid the popularization of the excessive simplification.*

I respect the national expression of Japanese design. Also as the eastern nation, there is an intimate relation in culture, and even from the same source. Japanese early design was influenced by Chinese culture, from Kyoto, Nara-ken to Kagoshima in Kyushu, from architecture, vessel to apparel, from which you could feel the Chinese Tang and Song Dynasties' culture from Japanese ancient culture. In the summer of 2010, when I went into the Sengan in Kagoshima, this feeling was inspired again. It is a garden filled with ancient relic of Tang and Song Dynasty. Its quietness and pure, ancient wood bamboo and pavilions form a landscape painting of Song and Yuan Dynasty. It makes us seem to see the scene that ancients leaned on a balcony looking at the distance, which has the ancient spirit. Especially the bay in front of the garden is separated from the volcano that still spouts everyday, which

is a great scenery. When the Shimadzu family in Sengan defeated the Shogun and promoted the *Meiji Reformation*, Japan began to be on the way of modernization. It can also be said that it promoted the emergence and development of Japanese modern design indirectly. As the western country in the view of Geopolitical meaning, Japanese design fits the western design trend and complies with the simplicity of modern design thought. However, besides the fit with the fashion trend, no matter the clothes design, industrial product design or the graphic post design, it is Japanese design at the first if sight it. The Japanese national design is not just the explicit form in the basic meaning, but penetrates a kind of nation personality under the surface of the form and graph. Taking color for example, the Japanese design usually applies the gray collection like Matcha color and steel gray. Even the red color, it is expressed by a kind of cool color. It could be seen that these characteristic colors contain the spirit quality of quietness and the realization of truth.

Different regions and nations express their certain national characters by color. The graduation projects from the 2010 session students majoring in Dyeing and Weaving in the School of Arts, Soochow University were guided by Yong Zihong, Fan Weiyan and some other instructors. After returning from France, the understanding of fashion color was influenced by the lively color in southern France. It could be seen the influence of France design in the graduation projects and the mixture of Chinese cultural elements. The Germans usually use a kind of calx to express their nation's seriousness and rationality. The colors from Turkey focus on yellowish brown and also have a green component which Islam nations prefer to. The blue Americans prefer is the cool navy blue. While because of Chinese vast territory, the hue of the red is changed along with the regions. The contrast of red and green from the central plains is stronger and the red tends to be the warm red. And the red from the ethnic minorities in southwest of China is usually the pink and sometimes even the roseo.

With the progress of the times, the national colors that reflect the regions' characters actually are taking place in great changes. As the international metropolis, Shanghai is influenced by the western culture and the designers tend to find the colors in the warm gray collections. While Da Lian, Haerbin and other northern fashion cities prefer to use cold gray collections. Of course sometimes these changes are not absolute and sometimes will be affected by the epidemic factors.

Thirdly, color is usually changed along with the fashion. Thirty years ago when I first got in touch with fashion color, I began to attend the lecture of Mr. Cai Zuoyi, who is famous for fashion color study. Though at that time Chinese fashion color system was in the start-up stage and the information sources were just from few international textile expositions like Frankfurt, the concept of fashion color is enough for us to believe the authority from western design fashion. From the aspect of the fashion color system study, we should thank for the old chief editor of *Fashion Color* Mr. Zhoufeng, who has passed away. It is *Fashion Color* that brings us the earliest scientific principle analysis of fashion color. In the fashion color study field, we could not forget Mr. Yin Dingbang, Mr. Huang Guocun, Mr. Wei Guocun, Mr. Cao Yijun, Mr. Wang Yunqiang and other people's contributions. Until now, Mr. Yin Dingbang and Mr. Huang Guosong's chromatic books are still the irreplaceable excellent textbooks.

Fashion is the production of the social psychology. It is the psychological reflection that people produce common aesthetic perception to some certain elements in certain period of time. So-called fashion color, it is the color people commonly prefer to during a period of time. Therefore, *fashion color* could be regarded as a fashionable noun. Fashion color is the trend and tendency of color. It is a kind of color keeping pace with the times. Fast popularity and short circle are its characters.

However, in the global circumstance human beings' lifestyle and aesthetic consciousness are becoming more and more identical. Though the nation color element still plays an important part, the

color fashion under the dominance of the western fashion design is getting people's common acknowledge. People seek for fashion and pursue the new fashion along with the fashion change. Therefore, the study of design fashion could make scientific research on fashion color not only from the aspect of human cultural history and artistic transition history and the aspect of human behavior motivation, but also from the views of human cultural psychology and design ethic. But the academic field usually insulates the fashion color and design trend out of the academic study because of their prejudices on trend and fashion. These stereotypes exist in the respectable cultural experts' mind. Therefore, the design fashion study as the study could mostly solve the current application problems is usually insulated by the authorities in the academic field. For example, in the book *Master and Tradition*, written by cultural expert Mr. Liu Mengxi, "The masters should not have connections with trend and fashion."¹ I thought this sentence was relative to those academic masters who made the real achievements like Wang Guowei, Chen Yange and Fu Sinia, while from this it can be seen that the cultural experts like Liu Mengxi look down upon the application study. Of course, I don't mean that they don't care about the study of the realistic application problems. They are more likely to explain the already existed ancient classics and devote themselves to the past cultural glory. What I want to say is though the fashion color study could not create the world-famous academic masters like Chen Yange, trend and fashion should be a respectable study of science.

Fashion color is easily changeable. It concerns times, culture, nation and people's psychology. Many experts write books and comments on its scientific aspect. However, based on my knowledge on fashion color for several decades, in fact there are just three kinds of organizations publishing fashion color. The first one is independent scientific research organizations. They usually combine the main culture's taste from the aspect of color change history. They will analyses the fashion elements from current social development and cultural affairs and scientifically plan the fashion color in the future on the basis of people's psychological reflection. The second one is some enterprises groups for the aim of profit authorize some scientific research organization and social associations to make plan on the future fashion color, which could make their enterprises successful in the future business activities and be served for the enterprises' business success finally. The third one is some brands depend on some famous designers to promote their brands' fashion color plan and make success in business in order to make propaganda for their brands and grasp the discourse power in business promotion. I regard the last two fashion publishers as the *fashion conspiracy*, because they are not scientific. They mainly grasp a kind of group psychology and weave beautiful and fantastic stories by using money and famous people's propaganda to influence people's consumption needs, which contains the ulterior business conspiracy. On this topic, designer Mr. Wang Xinyuan and I have reached the consensus many years ago and talked about our thoughts in different occasions. Therefore, so-called *fashion color*, sometimes its semantics are complex.

Fourthly, color is not only scientific, but also artistic. In artists' eyes, color is non-text and illogical. To them, color is a feeling. If a painter applies scientists' preciseness and rationality and makes color through mixing this color with that color and then adds another color, it would be unimaginable to paint through these processes. The emotional meanings the color owned are all gone, of course except Mondrian's *cool abstraction*. *In the eyes of scientists, color not contains the red, orange, yellow, green, indigo, blue and purple, but also can be divided into physical indexes in detailed kinds of light environments.*

How to deal with the relationship between artists' intuitive sensibility and the scientists' objective rationality in the color study becomes the enclave of the color application study. The fashion color is

blurry in the sense of culturology. How to change the sensibility to the rationality of the color and construct relatively rigorous *mathematical mode* are the key points in the fashion color trend study. Though international color organizations will release the fashion color card with standardization and scientific meaning, some fields at the subject edge of the state are hard to be defined in the design trend study. For example, the division of the population suitable for fashion, not only has the historical, social, racial and psychological elements, but also affects the interrelationship in the international background. Therefore, it cannot make up ambiguously in a romantic prose writing style. Therefore, the description of the color trend is confused in some briefings and research reports. For example, what is *Widow Black* and what is *Lascivious Men From Turkey*. Some briefing topics are named *Midnight Stunning*, Peach Blossom River is Beauty Nest and so on. How to describe the designers' sensibility by using scientific rationality and at the same time to avoid the abstract romantic description and to be defined in easily understandable way, these questions require the color researchers to clear away the distractions of some organizations' utilitarianism and Pseudo science in scientific attitude, highlight the commonweal of the color science study and at the same time balance what the artists feel about color and the application expression of color in practice. Based on these, it could construct the scientific system of fashion color study.

Color is the direct design form element which is most accepted by people. Color contains multiple semantics in modern design, among which there exist the scientific ones and also have the cultural and artistic ones. In a word, color's multiple semantics in modern design are based on two points: one is from the aspect of macro methodology to know the significance of fashion color; the other is from the aspect of microcosmic application to set a reasonable study system. Color not only joins in the fashion game but also is applied for the enterprises, designers and customers.

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Oral Papers

Perception of Colour Identity: A Literature Review of Urban Environmental Colour

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ABSTRACT

Visual perception is the first and immediate reaction of people perceiving a coloured object in a given space. As Frank Mahrke (1996, p.11) proposes the basic level of colour experience is biological reaction to a colour stimulus. This paper thus only prioritises its focus on physical environment, which suggest a framework of the relation of physical colour stimulus and human perceived cognition of colour identity.

Identity in visual perception can be defined in terms of both difference and continuity in perceptual meaning (Floch, 2000, p.33). The literature centrals to the fundamental meanings in definition of identity: **sameness** and **difference** (Jenkins, 1996, p.3). It also intends to answer the research question of how to identify the colour identity in urban environment.

The question directs the research through a literature review of colour practice (the work of Jean-Philippe Lenclos and Luis Barragán), chromatic theories of colour harmony and colour contrast (Itten, 1962; Albers, 2013) and environmental scales in urban design field.

The findings could be summarised the perception of colour depends on the viewpoint, in which distance and scale perspectives determines the colour identity. The visual perception reflects a change in scale from the macro to the micro extent, which is important to identify a colour identity in urban environment.

KEY WORDS: Colour identity, Environmental colour, Colour harmony/contrast. Scale design

INTRODUCTION

This paper is extracted from the literature review of researcher's first year PhD study, entitled *Colour identity in urban environment*. The review of literature formed up with four main sections: colour as identity, perception of colour identity, colour identity as representation, and local colour identity. Subsequently, the research was conducted from ontology, psychology, semiology and sociocultural aspects to study the colour identity as a cultural phenomenon in urban environment. In this respect, the literature review approaches a qualitative method in both theoretical and methodological study. The thematic literature reviews the central concept of colour identity in relation to urban environment.

Visual perception is the first and immediate reaction of people perceiving a colour object in a given space. As Frank Mahrke (1996, p.11) proposes the basic level of colour experience is biological reaction to a colour stimulus. This paper thus only prioritises its focus on physical environment, which suggest a framework of the relation of physical colour stimulus and human perceived cognition of colour. Colour identity in visual perception can be defined in terms of both difference and continuity in perceptual meaning. The literature centrals to the fundamental meanings in definition of identity: **sameness** and **difference** (Jenkins, 1996, p.3). It also intends to answer the research question of how to identify the colour identity in urban environment.

BLEND IN / STAND OUT OF COLOUR ENVIRONMENT

In visual perception, *figure* and *background* are two of important visual components for recognition and identification of environmental colour. *Target-background* problem has been often studied in practical colour application, i.e. the degree of visual interaction between *figure* and *background* caused by varying relationships in the colours of physical forms and the natural colours of their setting (Ports, 1982, p.113). And also like Jack Nasar (1988) provides empirical information on the effect of artificial colour signs features on perceptual and cognitive visual judgement. The concept of *Target-background* helps to distinguish the colour of an object and its environmental setting.

Le Corbusier (cited in Ports, 1982, p.113-116) introduces two common function of environmental colour, one that is to help blend objects into their background, and other is to attract attention, the process of *colour attachment* through colour came to the fore in the development and application of *camouflage* effect; in opposite, *colour detachment* occurs when colour is used simply to use colour *sculpturally* to highlight forms against neutral background. The idea of blend in (*camouflage*) and stand out (*sculpturally*) developed as two schools of thoughts which implement to the urban design and architecture practice.

Neil Leach (2006, p.244) argues *camouflage* refers both revealing and concealing. The use of colour is both to blend into an environment, and to stand out on others. It processes a model of assimilation based on self-representation to homogenise the environment as the sense of place identity. In this respect, Jean-Philippe Lenclos (2004, p.19-21) has conducted a comprehensive analysis, which intend to reveal the specific colour character of each country or place (Figure 1). He devises his analysis into three phrases to classify the collection of colour samples and formed ‘colour maps’ and introduces a concept of ‘local colour’ to address the importance of geographical location and the characteristics of a site, which determine the chromatic qualities. In this respect, Lenclos’s method regards a whole homogenous visual experience as local colour identity.

Other practitioners like Luis Barrag  n use of fa ade colour to create strong visual differentiation in architecture (Figure 2). The high contrast colour stands out from its environment as *sculptural* colour. The colours have a sense of the extraordinary and to create a sense of place (Schindler, 2007). The high contrast of hue produces the attraction and heterogeneity from the background of a given environment. Recognising objects is made much easier when the colour of the object is set off from it background (Mahnke, 1996, p.99). And the colour as a strong visual element is for enhancing remembrance. Many landmarks implement this method to identify the sense of place.



Figure 1: Documents of site analysis (Source: Lenclos and Lenclos, 2004, p.19, 21)

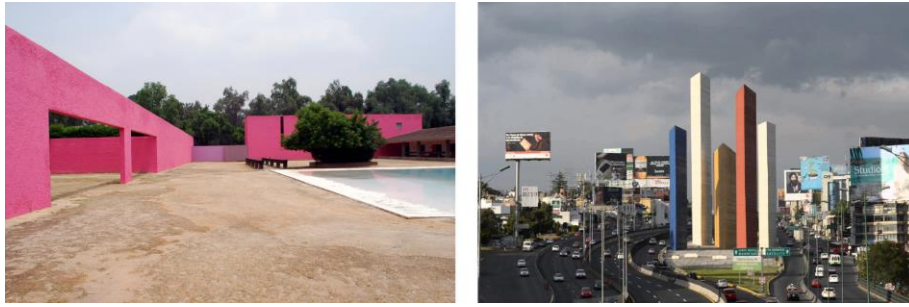


Figure 2: The works of Luis Barragán: San Cristóbal Estates, Mexico City, 1967 and Satellite Towers in Ciudad Satélite, Mexico, 1958. (Source: online)

The argument here is blend in and/or stand out to the urban environment: on the one hand, in order to attract attention and distinguished from others, using high saturation and contrasting colour for surface of architecture; on the other hand, considering the cultural reference and existing colour-scape, the colour implementation attempts to achieve the similar effect and harmonize the environment through colours. These two different ways of colour implementation imply the two-fold meaning of identity: distinctiveness and similarity. In the sense, the colour identity can be achieved in both ways. And similar and distinctiveness of colour directs the study to colour theories of colour harmony and colour contrast.

COLOUR HARMONIOUS /CONTRAST

Harmony of colour often refers to similar attributes of colour and unity of visual experience. Johannes Itten (1962, p.21) interprets analogous colour in the way called 'harmonious' which are composed of closely similar chromas, or else of different colour in the same shades. They are combinations of colours that meet without sharp contrast, which implies that harmonious colour has the opposite meaning of contrast. Josef Albers (2013, p.41) agrees and further commends that all harmony colours normally appear in the same quantity, value and size of shape. In other words, the colour harmony is not only sharing the equal hue, saturation, lightness, but also the shape and size of colours.

Harmonious colour schemes have been used in many traditional designs, such as architecture, urban design and so forth. For the consciousness of environment, the consistency and homogeneous visual experience serve the purpose of the word similarity or sameness in large scale. Group of reds can be recognised as colour identity of London. The same hues constantly enhance the visual experience and give the urban environment a unique character. The character of which is determined by the qualities of the colours used and their proportionate visual weight (Verlag and Leigpzig, 1981, cited in Düttmann et al.). It likely suggests that in order to determine the harmonious colour one should be considered the scales of observant environment.

With different hue, lightness and volume colour combinations, the contrast colour would result of distinguish visual effect. Colour contrast can be considered providing the clearest noticeable differences in terms of environmental perception (Rapoport, 1982). However, by contrasting two or more colours in same scale, the difference of colours does not identify a particular colour as focus in visual perception (Figure 3). Colours may be assembled in areas of any size. Thus, the proportion of colour combination plays a key role of producing colour identity.

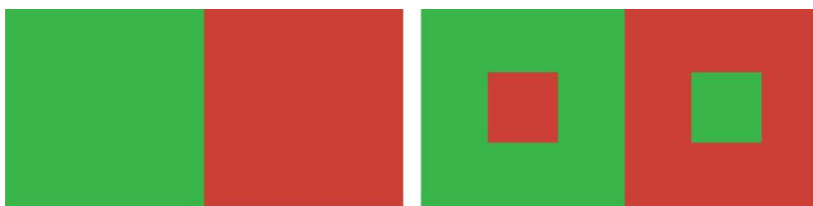


Figure 3: Contrast of different colours in same shape and size. (Source: Xu, 2016)

Johannes Itten (1962, p.35) points out only one type of contrast is closely related to the scale: contrast of extension- a contrast of proportion. It is the contrast between much and little, or great and small. One can inquire what quantitative proportion between two or more colours may suggest one of the colours used more prominently than another. Variations in the size of colours is an important design aspect for, up to a certain size, the larger the visual area of colour the more saturated it will appear (Porter, 1982, p.88). The prominent colour has attention value is based on not only the great contrast of colour but also the size of the colour. A comparison of two or more colours in their proportion can be distinguished colour identity from their background. That is to say, the perception of dimensions influences the recognition of colour identity.

ENVIRONMENTAL SCALES FOR COLOUR IDENTITY

The review of colour harmony and contrast theories already revealed that size and/or proportion is one of the main factors affects visual perception and identification of focused colour. It suggests any analysis of a given environment need a particular scale to work with. Urban design operates at and across a variety of spatial scales rather than at any particular one (Carmona et al., 2003, p.6). In geographical sense, colours of different structural components results different identities due to the different scale of built environment. These structural features create a difference between small-scale and large-scale environments as own identity. For example, the colour identity of individual building may have impact on a street, however it may not necessarily have impact on the whole district. Within a city, the visual environment is so complicated to identify the single colour as a representation of colour scape.

Christopher Alexander (1997, p.xiii) uses ‘pattern language’ to demonstrate the range of scales at which urban design operates, with the patterns being ordered in terms of scale, beginning with patterns for strategic (citywide) design. In particular, Kevin Lynch (1960, p.47) proposes a comprehensive scale of map: paths, edges, districts, nodes and landmarks. These elements were typically arranged in a series of levels, roughly by the scale of area involved, so that the observer moved as necessary from an image at street level to levels of a neighbourhood, a city, or a metropolitan region. The task of structural analysis concerns with the relations between the whole and the parts, between ‘micro’ and ‘macro’ levels (Lefebvre, 1991, p.158). In a chromatic sense, any urban environment is equivalent to a colour-scape by using different scales.

Cliff Moughtin et al. (1999, p.142) establish a more detailed colour map of the region or city and from that the palettes established as the basis for colour schemes (Figure 4). Dealing with a shifting urban environment, the workable image is only sufficient when a scale has been established. Within the particular frame, the special relevant colour element can be compared and measured. Barton et al. (2003, cited in Carmona et al.) consider more large scale in viewing the influential spheres of the scape relationship (Figure 5). And colour conversely has the potential to create a recognizable identity to the elements in different scale of urban environment.

Type of scale	Explanation
Scale of the city or of the district	
Scale of the street or square	where colour can create various characteristics or moods depending on adjacent buildings, and at street corners or on diametrically opposed façades;
Scale of the individual buildings	
Scale of details	windows, shutters, iron works, street furnishings

Figure 4: Four different scales on which colour in the city can be seen. (Resource: Moughtin et al., 1999, redrawn)

It is only possible to discuss colour identity in a specific colour-scape. For example, a prominent white façade of a house has the quality of high contrasting with its surrounding red bricks. In micro-colour-scape the white may be interpreted as a colour identity of the building. However in larger scale, for meso-colour-scape or macro-colour-scape, the red may not recognized as identity due to the

dimensions of the environment (Figure 6). In addition, harmonious colours often have great impact on the macro-colour-scape or meso-colour-scape. The red bricks of London are shaping the character of a city, and continuously emphasising on a sense of sameness, which can be recognised as the colour identity of urban environment.

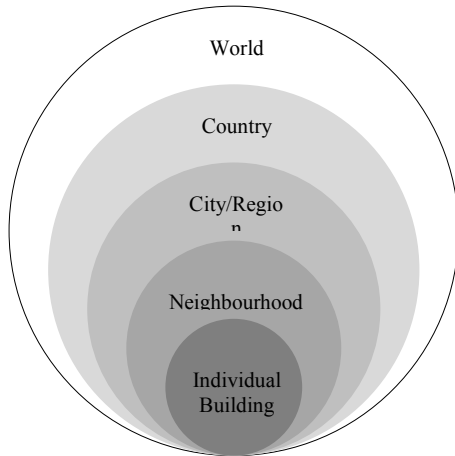


Figure 5: Nesting spheres of influence (Source: Barton et al., 2003, in Carmona et al. redrawn)

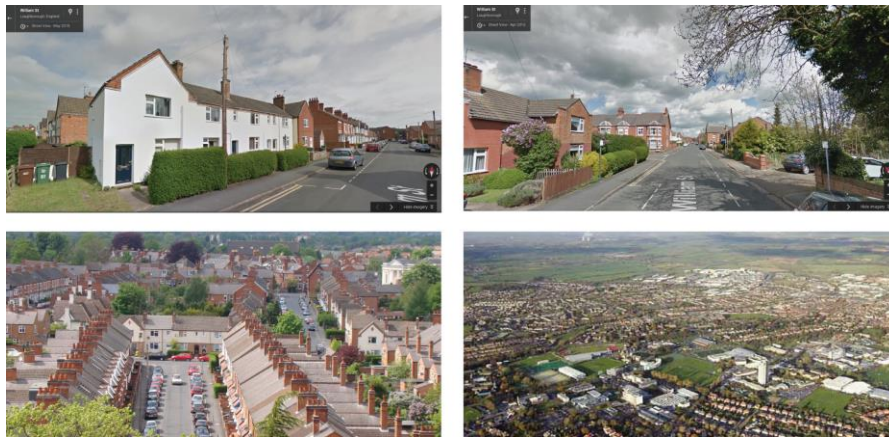


Figure 6: White façade house in different scales, William Street, Loughborough, UK. (Source: online)

CONCLUSION

The perception of colour depends on the viewpoint, in which distance and scale perspectives determines the colour identity. The visual perception reflects a change in scale from the macro to the micro extent, which is important to identify a colour identity in urban environment. Colour identity would be influenced by a set of scale relationships. In a complicated urban context, to identify colour identity must be understood where the observer in which dimension of scape.

Beatrix Bencseký (2008, in Thierstein & Förster, p.251) introduces a new design professional called ‘scale design’, and he explains a scale designer’s work involves contributing to identity formation in public space on different scales and for different areas of application. The scale design explicitly addresses the importance of scale related to identity. In order to identify colour identity, the scale should be considered as a key instrument to measure a given colour-scape in different urban environment setting.

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Color shifting of Great Wall gray from Beijing Olympic games 2008

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ABSTRACT

In the Beijing Olympic games 2008, a series of color names are identified in a visual design color system by the committee of Beijing Olympics, such as “Great Wall gray”, “China red” and so on. Where colors are not only for the design of Olympic venues, but also are widely used in graphic design and architectural color design, after the Games until now. For example, “Great Wall grey” is the main color of Beijing overpass, and the Great Wall grey is fixed to a pantone color chip. But, the maintain office of Beijing overpass found the “Great Wall grey” is much greener in 2014, quite different from 2008. At last, we’ve found out the reason the color shifting, fixed the “Great Wall gray” to CIE color space, and help the painting company found the original “Great Wall gray” back to Beijing.

Keywords: Great Wall gray, Color shifting, Beijing Olympic games, CIE Color space

1. INTRODUCTION

In the Beijing Olympic games 2008, a series of color names are identified in a visual design color system by the committee of Beijing Olympics, such as “Great Wall gray”, “China red” and so on. Where colors are not only for the design of Olympic venues, but also are widely used in graphic design and architectural color design, after the Games until now.

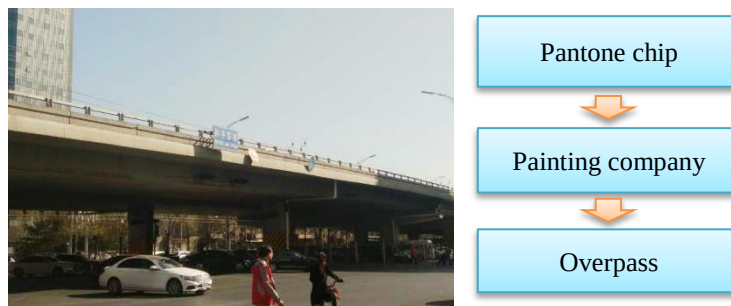


Figure 1 Beijing Overpass

“Great Wall grey” is the main color of Beijing overpass, and the color is fixed to a pantone color chip, and the painting company mixed and provided the paint according to the chip. But, the maintain office of Beijing overpass found the “Great Wall grey” is much greener in 2014, quite different from 2008.

2. ANALYSIS OF “GREAT WALL GRAY”

2.1. Original of “Great Wall gray”

"Color system for visual image of Beijing Olympic Games 2008 " (finalized in 2004) introduces the "Great Wall gray" as: "Great Wall gray is one of the important color of Beijing traditional architectural landscape, and it is a charming element of the color system for 2008 Olympic Games. It is the color of Great Wall winding down on the mountains, and the color of courtyard house nestled in the green trees"



Figure 2. Great Wall and courtyard house

The PANTONE Solid Coated chip: PANTONE 443 C was chosen as the color sample, and CMYK and RGB color values are designated as

- PANTONE: 443 C
- CMYK: C10, M0, Y5, K35
- RGB: R150, G160, B154

2 Color reproduction problem

2.1 Color space problem

There are two color spaces, which is fit for reproducing the color?

CMYK is an equipment related color space, and is related to the ink, paper and printing machine, so different hardware setup has the different CMYK value.

RGB color space is an additive color space based on the RGB color model, and sRGB is a standard RGB color space created cooperatively by HP and Microsoft in 1996 for use on monitors, printers and the Internet. Pantone is one of the RGB users, and the RGB can be transform to CIEXYZ and CIELAB, which is widely used in industry color management.

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} 0.4124 & 0.3576 & 0.1805 \\ 0.2126 & 0.7152 & 0.0722 \\ 0.0193 & 0.1192 & 0.9505 \end{bmatrix} \begin{bmatrix} R_{\text{linear}} \\ G_{\text{linear}} \\ B_{\text{linear}} \end{bmatrix}$$

Figure 3 Transform from RGB to CIEXYZ and CIELAB

So the RGB values are chosen as the data for color reproduction of “Great Wall gray”.

2.2 Data inconsistency problem

The RGB data of chip 443c is found out from the PANTONE database, and the value is different from the color system of Olympic 2008.

On the other hand, the PANTONE color are developing, the 443C chip have different RGB value in different Pantone version:

Table 1, RGB values of “Great wall gray”

	RGB values
color system of Olympic 2008	R150, G160, B154
PANTONE+ V2 database	R136, G150, B153
Old PANTONE database	R161, G163, B161

3. TRACING THE ORIGINAL COLOR OF “GREAT WALL GRAY”

The Pantone’s color is a color system for fashion and industry design, the color of the chips is changing when version of Pantone is upgrading. Therefore, it is necessary to represent the “Great Wall gray” by a stable color system, and finally the CIELAB are chosen.

The CIELAB is a color space for science and industry usage, includes all perceivable colors, and is not an equipment related color space, so it is quite stable. And it is also easy to be measured by commercial color instrument, well suited for project management and acceptance.

However, which RGB value should be chosen?

Time is the key. The color system of Olympic 2008 is developed in 2004, so the old Pantone version has been chosen as the original color.

So the original RGB coordinates is R161, G163, B161. And the $L^*a^*b^*$ data is conversed from the RGB data in sRGB color space: $L^* = 66.8$, $a^* = -1.1$, $b^* = 0.8$.

Color system of Olympic 2008	PANTONE+ V2 database	Old PANTONE database
R150, G160, B154 $L^*58.3$, $a^*-8.3$, $b^* 5.6$	R136, G150, B153 $L^*61.1$, $a^*-7.8$, $b^*0.4$	R161, G163, B161 $L^*66.8$, $a^*-1.1$, $b^*0.8$

Figure 4. Schematic diagram of color cards

All the colors in table 1 are printed in color card for verification. The visual evaluation result is: the color from the old Pantone database is the best match of “Great Wall gray”.

5. CONCLUSION

The fashion color system, such as Pantone, is very easy to use for designer, and convenient for industry design and printing media. However, the CIE color system should be used, if a long term color consistence is needed. Because, CIE color system is very stable, and easy to be measured for project implementation and management.

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Urban Color expressing the Spirit of the City

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ABSTRACT

From Chinese philosophy point of view, Urban Color is the generalized color which value is beyond the outer beauty. As the generalized color, Urban Color is from heaven and earth, take care of the heart. In the macro level of urban color, my paper advanced the concept of Urban Color Type by researching the color of Chinese sky, soil and vegetation and analyzing the samples of urban color within and out of China. At the same time, concluded some color rules of different urban color type.

In the median level of urban color, my paper analyzed the color of the central axis of the Forbidden City in Beijing. Then, advanced the concept of Color Force which is the force on human from the color in the space. In city, different area, road, boundary, node and landmark has different Color Force, and giving people different feeling, expressing different spirit of the city.

Keywords: urban color, generalized color , city, spirit, color force

Urban color is a kind of generalized color. Usually, we see the bright color when they think of color, this is the narrow sense of color. "Generalized color including the narrow sense of color, contains the sense of distance, light and shadow, texture, dry and wet etc., such like sense of perception and experience." Generalized color integrated visual and tactile, auditory, olfactory, gustatory perception, including not only what we see, but also what we feel. Therefore, based on the Chinese philosophy, the value of generalized color is beyond the outer beauty. Because it comes from heaven and earth, take care of the heart, it can express the spirit of the city.

In the macro level, the city grows on the earth, which can be understand from the following four dimensions.

The first dimension is the sky light. According to the ideal color of the sky map, we divided the city into the bright city, the medium bright city and the shadow city. Some bright city can use the high purity color boldly, such as Lhasa. The medium bright city is good at expressing texture, such as Rome; the shadow city, one solution is drawing the outline to increase the clarity, such as Amsterdam.

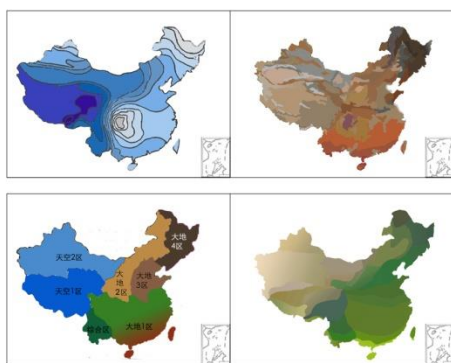
The number of the medium city is the most, such as Beijing, they need to do color design. Analyzing by the tool from the western color theory, colors of the medium bright city covers almost the entire color triangle. Usually, the main color will appear in the middle region of the color triangle. The secondary color located in relatively high and low lightness area. So, there appears black and white, grey level. In order to increase the sense of color, we can add a bit of high purity things. Of course, if not, at least there is a frame of brightness. As for hue, starting from the visual balance of psychological needs, a huge volume of city needs all of the hue in the color ring. Of course, in a city, there is always some color to appear with high frequency, or in large area, it has a relationship with the city spirit. Now, for a large number of medium bright city, most of the time we ignore the urban color planning and the architecture color design. It is a pity. We see that this kind of city have wide range of color. After color

planning and design, there will have an extremely diverse effect. This is a very broad world.

The second dimension is the soil. The last century 50's, the government organized the survey of the national geological soil and the soil samples were collected around. We drew the color of real samples in the distribution range of real soil located, then get a national soil color distribution map. We pleasantly surprised to find that it coincides with the Chinese Five Color Soil law. We see that in the middle of map is yellow, the South is red, the east is blue green. Why the soil is blue green tone? Because there is a long history of farming in this area and there are a lot of paddy soil. The paddy soil is the blue green tone. The west part of the soil color map is white, the north is black. This map leading us to analyzing the city from the angle of warm and cold hue because cities grow on the earth. Most of building materials come from the soil, and vegetation too.

The third dimension is vegetation. The southern vegetation is broadleaf, so it looks fresh, juicy, the purity and brightness of color are high. From Beijing to Chengde, we can find obviously that more coniferous vegetation appears, the color brightness reduced, and the purity lower. Put these things on the Chinese map we will find a clear rule, from south to North and northeast, the purity and brightness of color reduced very much.

So, we can study city from the angle of color purity. There are many different purity of cities. The cities have a low purity such as cities in Japan, Zhangjiakou in China. There is a great relationship between purity and dry and wet. For instant, Zhangjiakou's low purity because of dry. We can also study the city from the perspective of the purity relationship between the contrast. For example, Beijing is the city have purity strong contrast. The Forbidden City in Beijing during the Ming and Qing Dynasties is brilliant which has golden tile and red wall surrounding by grey quadrangles. At that time, the Beijing city belongs to the bright city. The nature has the law of purity strong contrast. When artificially constructed city in line with this law, it will become the earth art. Another example, Hunan in China has the red soil which color purity is high relatively. There is abundant rainfall in Hunan. After rains, all colors are bright, and the purity is elevated. So, from the relationship of contrast, cities in Hunan have purity weak contrast.

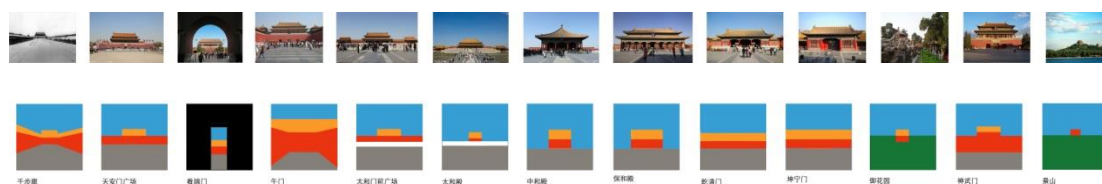


The fourth dimension and the most important dimension is humanity. The generalized color is composed of natural color and humanity color. Because the generalized color comes from heaven and earth, humanity color has a great relationship with the region. One of the words made up of 'humanity' in Chinese means "pattern", that is, 'humanity' means the diversity of people in different region have different ways of life. food, clothing, housing and transportation is the best way to reflect life. Housing in 'food, clothing, housing and transportation ' is architecture which decide the largest area of color saw by human eyes. So, housing plays the most important role in humanity color.

There are many kinds of folk housing in China such as Courtyard Dwellings in Beijing, the Huizhou-style folk dwelling houses, old villages in Guangdong, Guizhou and Yunnan, Tibet carved room, Kazakh yurt, Mongolia Mongolian yurt, Loess Plateau cave, etc. We put the ' food, clothing, housing and transportation' on the map, found that there is great regularity. The nature of nomadic region is vast, so the humanity color imitated nature. In the farming area, North and South have a clear demarcation, because of different language family. After we put the small areas of the color extracted from ' clothing, food and transportation ' on the 'housing' color background we can make the classification of the city from the angle of humanism color. Of course, there is a premise. We found a section to study. That is, our study is under the premise of the Ming and Qing Dynasties. Although the mode of production and the volume of the city today changed a lot, this study still has its value. It can help us to find the source of culture.

In the median level, people are immersed in the generalized color perceiving the city mainly through the five elements which are area, road, boundary, node and landmark. These elements affect people by means of generalized color, we call it 'color force'. Different color force give people different experience. These different color force formed the rhythm and intertwined, expressing different city spirit.

For the ideal road which give people good experience is very difficult to find, we try to let the central axis of the Forbidden City in Beijing as an example, studying the color force variation law of the road.



As shown in the figure, traveling along the central axis, we divides 13 nodes, and each node into color map. We can get from the color map that the area of artificial color is more than half of all, that is, all of the nodes have big color force. As a result, the space sequence of central axis has a great effect on people.

In the sequence, there are three levels of colors which are from building, sky and ground in each color map. The building color is the main melody, the sky and the ground colors are the bass accompaniment. Three levels of color woven together. Although the lightness, hue, purity of the main melody of building color do not change, but while people march forward in space, the three levels colors' area relationship, position relations are constantly changing, they cooperate with each other to form a sequence of rhythm and rhyme.

Node 1 is the 'thousand steps corridor', the color area relationship in the view is the main-auxiliary relations. The position relation is 'half contains', three edges contrast. They all belong to the medium contrast giving people the emotional experience of overture.

Node 2 is Tiananmen square, the color area of the sky, ground, building in the view are divided into three parts approximately. So, the color area relationship is the weak contrast. The position relation is the weak contrast, too. Because it is adjacent to each other, one edge contrast.

Node 3 is gone into the Tiananmen gate which is dark without light making people see the very small area of the building, the sky and the ground. The color area relationship is master-slave strong contrast. The position relation is four edges contrast, is strong contrast, too. There are another strong contrast exist at the same time, such as light and shade, vivid and grey contrast. From now on, the effect of

color within the space sequence becomes strong.

Node 4 is Wu gate. The large area of building color oncoming determines the color area relationship in view is master-slave strong contrast. The position relation is medium contrast because of perspective deformation. The internal color force of space sequence continued to increase.

Node 5 is in the front court of Taihe gate. The color force reduced because the colors in view are almost equally divided the whole area and the position relation is one edge contrast. As a result, the color area relationship and position relation are weak contrast.

Node 6 is the hall of Taihe. It is the climax of this central axis space sequence. But we do not see a large area of the building color. On the contrary, the building color area is very small, the sky and the ground area is great. The hall was in the strong contrast between the sky and ground (The color area relationship is master-slave strong contrast. The position relation is strong contrast, too.) while it integrated with nature. These contrast implied the meaning of 'majestic and grand' which is beyond any artificial large scale building. The suggestibility of Chinese philosophy was expressed thoroughly in these contrast relationship. It is the color relationship in the space sequence embodies the spirit of philosophy Chinese rather than the buildings with different hue in the Forbidden City on behalf of the Chinese universe. If this methods is used in the design of contemporary architecture, it should be able to open up a new path of inheritance and innovation.

All kinds of color contrast relationship from node 7 to 10 is weakened gradually.

Node 11 is Imperial Garden. The natural color area increases and the building color area decreases. The color area relationship and the position relation turn into strong contrast again.

Finally, through node 12 Shenwu gate, we enter the node 13, Jingshan Hill which is the end of central axis space sequence. The natural color influence reached the climax, the building color area is reduced to a minimum, showing a strong contrast. The position relation is strong contrast, too. The space sequence of the Forbidden City's central axis is full stopped here.

The color force variation of whole sequence is from weak artificial color to the strong climax, then weakened gradually, and changes smoothly to natural color, ultimately end with strong natural color force. No matter how wonderful the man-made environment, the human home is still in nature. Chinese ancient emperors built such brilliant place for themselves, their last wish are still go back to nature. Here, the spirit of 'harmony between man and nature' in Chinese philosophy is expressed very clearly by color relationship in material carrier.

In summary, urban color as a kind of generalized color, it comes from heaven and earth, taking care of the heart, so as to express the spirit of the city.

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Spectral images browsing using PCA and JPEG2000

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Spectral imaging technology, which make it possible to accurately reproduce the color of an original object under various viewing illuminants, have been used mostly in remote sensing, but have recently been extended to new area requiring high fidelity color reproductions like telemedicine, e-commerce, etc. These spectral imaging systems are important because they offer improved color reproduction quality not only for a standard observer under a particular illumination, but for any other individual exhibiting normal color vision capability under another illumination. A possibility for browsing of the archives is needed.

In this paper, the authors present a new spectral image browsing architecture. The architecture for browsing is expressed as follow:

- (1) The spectral domain of the spectral image is reduced with the PCA transform. As a result of the PCA transform the eigenvectors and the eigenimages are obtained.
- (2) We quantize the eigenimages with the original bit depth of spectral image (e.g. if spectral image is originally 8bit, then quantize eigenimage to 8bit), and use 32bit floating numbers for the eigenvectors.
- (3) The eigenimages were lossy compressed by JPEG2000 algorithm.

For experimental evaluation, the following measures were used. We used PSNR as the measurement for spectral accuracy. And for the evaluation of color reproducibility, ΔE and ΔE_{CIELAB} were used. here standard D65 was used as a light source.

To test the proposed method, we used FOREST and CORAL spectral image databases contain 12 and 10 spectral images, respectively. The images were acquired in the range of 403-696nm. The size of the images were 128*128, the number of bands was 40 and the resolution was 8 bits per sample.

Our experiments show the proposed compression method is suitable for browsing, i.e., for visual purpose.

RECENT PROGRESS IN REPAIRING CIECAM02

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ABSTRACT

While CIECAM02 enjoys its popularity in widely used in theoretical research and industrial applications, some problems are also identified. Unexpected computational failure is one of the important problems concerned by the cross-media colour reproduction industry. In this paper progress towards repairing the CIECAM02 is reviewed, which includes the several proposals for replacing the CAT02 matrices under the same structure as the original CIECAM02 in the past and the newest development in changing the structure of the CIECAM02. It was found that all the extension proposals under the same structure of the original CIECAM02 have one thing in common, that is at the expense of losing predicting accuracy compared with the original. However, the latest development in changing the structure of the CIECAM02 results in a very promising proposal. In the latest proposal, the adaptations of the colour and luminance of the illuminant are made in one space rather than in the two different spaces in the original CIECAM02. The new proposed version not only solves all the problems concerned related to the CIECAM02, but also performs equally well or better than the original in predicting the visual corresponding colour datasets and the colour appearance datasets. Furthermore, it is simpler than the original.

Keywords: CIECAM02, CAT02, HPE Matrix, Yellow-Blue and Purple Problems

1. INTRODUCTION

Since the recommendation of the CIECAM02^{1,3} by CIE TC8-01 (Colour appearance modelling for colour management systems), the model has been used to predict colour appearance under a wide range of viewing conditions, to specify colour appearance in terms of perceptual attributes, to quantify colour differences, to provide a uniform colour space and to provide a profile connection space for colour management. However, many problems have been identified and various approaches have been proposed to repair the model to enable it to be used in practical applications. In this paper we will review what the problems are, and what the proposals are for solving the problems.

2. THE PROBLEM OF NEGATIVE TRISTIMULUS VALUES (TSVS) PREDICTED BY CAT02

In 2007-2008 Verdú et al.⁴ computed the gamut boundary of the optimum colours under various illuminants and CIE 1931 standard colorimetric observer. In order to compare the gamut boundaries under different illuminants, CAT02 was used to transform all the boundaries to a single reference illuminant. It was found that for many colours close to the boundaries, CAT02 predicted their corresponding colours with negative TSVs (i.e., negative X, Y, and/or Z values). The problem of negative TSVs is a detriment to many applications such as to evaluate image reproduction devices⁵ using the real surface colour since many transforms such as CIELAB and CIECAM02 does not allow negative TSVs as input. Li et al.⁶ modelled the CAT matrix as variables/parameters in a constrained optimization problem for the assurance of the non-negative TSVs by the CAT prediction, and derived, by numerical solution, a new CAT matrix named as M_{CAT} . It was found that the CAT02 with this new matrix gives non-negative TSVs under D65 for any colours in the domain (denoted by Ω_{CIE}) enclosed by the spectral locus and purple line under 81 test illuminants. However, if the original CAT02 matrix was replaced by the new matrix M_{CAT} in the CIECAM02, the modified CIECAM02 still had problems in computing lightness J under certain illuminants⁷. Hence Li et al.⁷ further considered the CAT matrix Mat as parameters/variables, modeled the unexpected computational failure for the CIECAM02 as a constrained optimization problem satisfying:

$$\begin{pmatrix} R' \\ G' \\ B' \end{pmatrix} = M_{HPE} \text{Mat}^{-1} \Lambda(D) \text{Mat} \begin{pmatrix} X \\ Y \\ Z \end{pmatrix} \geq 0 \quad (1)$$

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and fitting visual corresponding datasets⁸⁻¹⁴ and the colour appearance datasets¹⁵⁻²⁰ as best as possible, and finally, by numerical solution, gave another matrix named M_{CAM} given by

$$M_{CAM} = \begin{pmatrix} 0.211720 & 0.837987 & -0.049707 \\ -0.65974 & 1.542704 & 0.117036 \\ 0 & 0 & 1 \end{pmatrix} \quad (2)$$

Note that the symbols used in this paper have the same meaning as those in the original CIE document¹ and the diagonal matrix $\Lambda(D)$ is defined by

$$\Lambda(D) = \text{diag}(D \frac{Y_w}{R_w} + 1 - D, D \frac{Y_w}{G_w} + 1 - D, D \frac{Y_w}{B_w} + 1 - D)$$

Thus, the new matrix M_{CAM} defined by eq. (2) can replace the original CAT02 matrix, resulting in a new version of the CAT02, named as CATv1. The CATv1 can replace the CAT02 in the original CIECAM02, results in a new version of the CIECAM02, named as CAMv1. It was found that the CAMv1 can avoid computational failure problem. The performances of the CATv1 and CAMv1 are listed in Tables 1 and 2 respectively. Table 1 shows the weighted and overall means in terms of CIELAB colour differences when the original CAT02 and CATv1 (and other CATs as well which will be discussed later) are used for predicting the 21 corresponding colour datasets. When predicting a particular dataset, the mean CIELAB colour difference is used for evaluated the performance of a particular chromatic adaptation transform (CAT). The overall mean is the average of the 21 mean colour differences. Since, each dataset has different number of pairs, the overall mean may not well represent the performance. Hence, weighted mean is also used, which averages the 21 mean CIELAB colour differences using different weights. The more pairs the dataset has the larger weight it has. However, the sum of the weights equal to 1. Thus, the smaller the weighted and overall means are, the better the model is. From Table 1 it can be seen that the CATv1 does not performs well compared with the original CAT02.

Table 2 lists the performances of the CIECAM02 and CAMv1 for predicting the colour appearance datasets in terms of CV values¹⁵. The smaller the CV value is, the better the colour appearance model (CAM) performs. There are eight groups of colour appearance datasets and in each group there are different phases as well. A CV value can be computed from each phase. Thus, mean CV value can be obtained from each group. The overall mean CV is the average of the eight mean CV values. It can be seen from Table 2 that CIECAM02 and CAMv1 perform the same for the colorfulness. For the lightness attribute, the CIECAM02 is better than the CAMv1, while the opposite is true for the hue attribute. In general, they perform similar.

Table 1. Weighted and overall mean CIELAB colour differences for CATs: CAT02, CATv1, CATv2, CATv3 and CAT16 when used for predicting the 21 corresponding colour datasets

	CAT02	CATv1	CATv2	CATv3	CAT16
Overall Mean	6.3	7.4	7.5	7.3	6.3
Weighted Mean	5.5	6.7	6.8	6.5	5.6

Table 2. Overall mean CV values in Lightness, Colourfulness and Hue for the CAMs: CIECAM02, CAMv1, CAMv2, CAMv3 and CAM16 respectively

Model	CIECAM02	CAMv1	CAMv2	CAMv3	CAM16
Lightness	14.0	14.2	14.2	14.2	14.0
Colourfulness	18.6	18.6	18.9	18.7	18.2
Hue	6.9	6.8	7.0	6.9	6.6

Furthermore, Li et al²¹ noticed that the constrained defined by eq. (2) is satisfied if the matrix Mat equals to the HPE matrix M_{HPE} ¹. They proposed that the CAT02 matrix is replaced by the HPE matrix, resulting in new CAT, named as the CATv2, and they also proposed that the CATv2 can replace the CAT02 in the CIECAM02, resulting in a new CAM, named as CAMv2 here. It was shown that the CAMv2 can overcome the problems concerned with the CIECAM02 and is simpler than original CIECAM02. Unfortunately, the performances of the CATv2 and CAMv2 become worse compared with original CAT02 and CIECAM02 respectively as shown in Tables 1 and 2 above.

3. THE “YELLOW-BLUE” AND “PURPLE” PROBLEMS

Brill and Süssstrunk^{22,23} pointed out that one of the problems comes from the CAT02 which is embedded in the CIECAM02. They observed that part of the CAT02 triangle falls slightly outside the HPE triangle. Because of this, the adaptation to a bluish illuminant will shift to a yellowish colour from inside to outside the HPE triangle, resulting in a negative achromatic response. They called this phenomenon the “Yellow-

Blue” problem. They also observed that the CAT02 triangle lies partially inside the domain Ω_{CIE} enclosed by CIE spectrum locus. Because of this, adaptation to a purple illuminant will make a purple colour outside the CAT02 triangle but inside the CIE chromaticity locus ‘more purple’ and can even locate it outside the HPE triangle, resulting in a negative achromatic response. They called this phenomenon the “Purple” problem. They pointed out that only when the yellow-blue and purple problems are solved simultaneously, CIECAM02 problems can be overcome. However, they gave only partial solution and pointed out it is hard to solve the purple problem. Recently, Li et al ²⁴ found that there are many ways to solve the yellow-blue and purple problems simultaneously, and Jiang et al ²⁵ gave an optimum solution to the yellow-blue and purple problems in the senses: a) the yellow-blue and purple problems are solved simultaneously; b) the models fit the visual datasets as best as possible, resulting in a new matrix:

$$M_{OPT} = \begin{pmatrix} 0.556150 & 0.556150 & -0.112300 \\ -0.507327 & 1.404878 & 0.102449 \\ 0 & 0 & 1 \end{pmatrix}. \quad (3)$$

The above matrix defined by eq.(3) replace the original CAT02 matrix ends up with a new CAT named as CATv3, and the CATv3 replaces the CAT02 in the CIECAM02, resulting in a new CAM named as CAMv3. The performances of the CATv3 and CAMv3 are listed in Tables 1 and 2 as well. It can seen from Table 1 that the CATv3 is better than CATv1 and CATv2. But it does not perform well as the original CAT02. Table 2 also shows the CAMv3 is not as good as the original CIECAM02.

The three proposals: CAMv1, CAMv2, CAMv3 have one thing in common, that is they have the same structure as the original CIECAM02 and the results in Tables 1 and 2 tell us that they solve the CIECAM02 problem as the expense of losing the accuracy in predicting the visual results.

4. COLOUR AND LUMINATION ADAPTATIONS IN DIFFERENT SPACES

Recently, Li et al ²⁶ and Wang et al ²⁷ consider the source of the CIECAM02 problem comes from the colour and luminance adaptations of the illuminant are completed in two different spaces. The colour adaptation is completed in the CAT02 sharper sensor space and the luminance adaptation is completed in the HPE cone space. They merged the two adaptations in the same but a new space. The new space is defined by the matrix:

$$M_{16} = \begin{pmatrix} 0.401288 & 0.650173 & -0.051461 \\ -0.250268 & 1.204414 & 0.045854 \\ -0.002079 & 0.048952 & 0.953127 \end{pmatrix} \quad (4)$$

They proposed that the CAT02 matrix is replaced by the above matrix defined by eq.(4), resulting in a new CAT named as CAT16. At the same time, a new CAM named as CAM16 is formed by the new structure and the new space. The new model CAM16/CAT16 satisfies the nesting rule, hence it solves the yellow-blue and purple problems simultaneously and overcomes all the problem concerned with the original CIECAM02. The performances of the CAT16 and CAM16 for predicting the visual data are listed in Tables 1 and 2. It can seen that CAT16 is better than CATv1, CATv2 and CATv3, and competitive with the original CAT02. While, for CAM16, it is better than any of the CAMv1, CAMv2, and CAMv3, and the original CIECAM02. Furthermore, CAM16 is simpler than the original CIECAM02.

5. CONCLUSIONS

This paper has reviewed some of the problems with the CIECAM02 colour appearance model and reported progress towards repairing or extending the model. Up to now, four colour appearance models: CAMv1, CAMv2, CAMv3 and CAM16 are proposed. The associated chromatic adaptation transforms are: CATv1, CATv2, CATv3 and CAT16. First three CAMs have the same structure as the original CIECAM02 and the CAM16 structure is different from the original CIECAM02. The performance tests show that the CAM16 is better than all other models including the original CIECAM02. Furthermore, it is simpler than the original as well. Thus, it is expected that the CAM16 will be recommended by CIE for replacing the current CIECAM02.

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Investigation study on the printing and color development of Chinese newspapers

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ABSTRACT

Along with the progress of science and technology as well as human development, Chinese newspapers have witnessed several evolutions since early time with great changes taken place in formation, color and format design. From primitive handwritten era to network communication era, newspapers have always been an important carrier to disseminate information. Nowadays, reading public has developed prominent requirement on the visual aesthetics of no matter the traditional newspapers or the digital media ones. The quality of printing impacts directly the quality of newspapers and color is one important visual element in its format design. This thesis carries out analysis on the printing and color evolutions of newspapers during its different development stages, and on how transformations of paper, ink performance and printing technology impact printing and color presentation during the evolution of newspapers. This thesis also emphatically discussed how development of printing technology impelled color transformation from black & white features to monochromatic one and then to chromatic one. The formation and color uniqueness of Chinese newspapers and its historical evolution process will also be familiarized in this thesis as enlightenment in establishing characteristic native inherent newspaper culture to the modern newspaper design in China.

Key Words: Newspapers, color, printing, ink

1. INTRODUCTION

Under the vigorous boost of modern information technology and on the basis of traditional newspaper media, new digital newspapers come into being and renovate with each passing day. Likewise, the public has developed higher and higher visual requirements, the eye-catching format design and color part of newspapers when reading. In recent decades, newspaper business has made rapid progress. However, the design of Chinese newspapers has always been so heavily influenced by the Western ones, especially in color and printing design and in mainly the form of plagiarism, that it displays rarely any dissimilarity from Western newspapers and lacks individuality. This study believes that in the search of China's preference for color and printing features, combining the evolution process of ink, paper and printing technology, we're able to discover the important basis to establish our own culture individuality.

Regarding preliminary stage sampling objects, this study takes mainly contents from published works as investigation references for ancient printed newspapers, as well as Shun Pao and Liberation Daily from Shanghai Library, Liberty Times and Chinese Christian Tribune from Taiwan University Library and so on as references for modern and contemporary newspapers. The specific sampling standard is to choose those typical works with distinct printing and color variation features from representative newspapers and existing original material of different times. By using content analysis method and historical document analysis method, this study looks into the printing and color evolution of Chinese newspapers, as well as the relevance between newspaper printing & color and China's territory and ethnic culture.

2. LITERATURE REVIEW

2.1. Newspaper Printing

Beru Grignard of West Germany mentioned in book *Color Printing* the function of “printing” in physics, namely applying pressures on an object while printing. Generally speaking, this function involves an assembly of printing, the printing ink and the printing stock. In a real printing process, color tinted

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printing plate comes into contact with printing stock via the pressure of machinery and thus printed products come into being. In newly-developed methods, “printing inks” are also transferred onto printing stocks as colourant through electrical, chemical or other ways.

2.2. Color Printing of Newspapers

Color printing refers to the printing method of duplicating image or texts in a chromatic way. There are normally two ways to print colors with inks: 1. four-color inks printed with a combination of halftone dot and overprint methods; 2. Combined printing methods using specially prepared spot color ink, that is also called spot color printing, a method in which colors are presented by means of solid color or halftone.

3. APPLICATION OF NEWSPAPER PRINTING AND COLOR IN DIFFERENT STAGES OF CHINA

3.1. Forms of Ancient Newspaper Printing and Color

Newspapers in the early days were duplicated by means of manual transcribing. During Han and Wei Dynasties, Cai Lun improved papermaking technology, which facilitated the wide application of paper. Later on, printing technology was invented and high quality ink was created.

Block printing technology was invented in Sui and Tang Dynasties, and popularized in the period from Tang Dynasty to the Five Dynasties. In his book *Images of Ancient Printing in China*, Xu Yinong mentioned that in the Year One of Tang Dynasty, there was a newspaper *Kaiyuan Gazette* produced in woodblock printing method. *Kaiyuan Gazette* was in a vertical format with borders but no gutter, and bound in butterfly format. There were also some manually transcribed newspapers in this period, such as *Jinzou Report*, which was in scroll binding format with no borders.

By the time of Song Dynasty, Bi Sheng invented the kind of typography, of which the movable types were made of puddle clay. With skills type making, bush printing and so on, printing technology at that time had reached a quite integrated level. Later typography was further developed to types made of clay, wood, tin, copper and lead. Newspaper *Jixuan Bulletin* from Ming Dynasty Emperor Wanli Period was still printed using totally woodblock printing technology. Typography was only popularized during Qing Dynasty due to imperial court bulletin and folk tabloid. Capital Bulletin produced by means of wooden typography in Qing Dynasty Emperor Tongzhi Period, was a newspaper with thin yellow cover, and red characters “capital bulletin” stamped by wooden chop on it, (Shi Meicen, 1988).

During this period, printing was still at the stage of black and white, in which black color were prepared from coarse pine soot, and paper made from raw materials such as marijuana, bamboo, grain plant and so on.

3.2. Application of Modern Newspaper Printing and Color

Along with the introduction and development of modern western printing technologies, western style lead typesetting and printing technology was put into use in China during Emperor Jiaqing 20th Year of Qing Dynasty to Emperor Daoguang Period. Moreover, the left to right horizontal kind of typesetting was adopted for Chinese text. In the 1870s, newspapers were printed with wood carved letters, lead typesetting and platform letterpress. During Emperor Guangxu Period of Qing Dynasty, technicians from Japan and the United States were employed to pass on the intaglio printing technology. Newspapers of late Qing Dynasty were mainly black and white. When looking up Shun Pao in Shanghai Library, this study discovered that newspaper of this period presented features such as light yellow square Maotai paper printed on one side by rotary newspaper press with technology of clay type and lead cast type.

In the early period of the Republic of China, technicians from the United States and Germany were employed to develop intaglio printing and gravure printing. In 1921, the new technology of three-color planography was learnt from the United States, and in 1924 apprentices were sent to the Netherlands to study color gravure and color register. Along with those progresses, color inks were invented and Chinese typewriter as well as manual phototypesetter was created later successively.

As a matter of fact, color register technology has been invented long time ago in Yuan and Ming Dynasty. Technologies such red and black color register, three-color register and so on already existed but were only used on the printing of color books in an extremely tedious color register operating process. Moreover, colors in this time period were refined from natural raw materials, for example red were obtained from cinnabar and cochineal and black from smoke ink. Due to its expensive cost and complicated process, this technology was seldom used in newspaper printing.

The root of colored newspaper printing was in Great Britain. In 1853, synthetic chemical dyestuff came into being. Later in 1909, Britain invented three-color gravure technology which set the foundation for

colored newspaper printing. The United States first adopted color register rotary gravure press to the mass production of *Tribune* (Shi Meicen, 1988). While in China, as mentioned in Xu Yongping's book *Study on Colored Planography of Newspaper Printing*, two-tone rotary press was firstly used on June 21st 1932 to print *Shanghai Times*, the newspaper held as the earliest colored newspaper in Asia. However in this period, newspaper printing remained in the stage of black and white. Seldom do colored one came out.

3.2. Contemporary Revolution in Newspaper Printing and Color

Following the development of technology, planographic printing, gravure printing and other special printing presses were invented in the 1960s; we were able to manufacture polychromatic gravure printing press and multitubular color press and successfully clone gravure color presses in 1964. In the 1980s, laser typesetting system for Chinese characters was invented. Newspapers were typeset on computer-laser screen and output in a full-page format. Printing technology had reached full automation level.

Study shows that on 1965's *Shanghai Daily*, headlines were generally printed in vermilion and black by color register technique, mainly for advertising space on front page, or major events and headlines (Figure 1). The fonts printed are distinct, but in uneven shades of vermilion, and there are obvious sign of color bleed (Figure 2) in almost every page. On *Chinese Christian Tribune*, red register technique were only brought into use on the front page headlines in the 1970s, but contents printed in red register had obviously increased (Figure 3). Monochromatic printing of Prussian blue, brown (Figure 4) and ultramarine blue appeared respectively in August and September of 1973.

It is discovered that on October 31st 1975, *Chinese Christian Tribune* printed the first time two sheets of the fourth page with high definition pictures and characters in different colors, which is quite close to the pattern of current newspapers (Figure 5). However, there were only two of those color sheets in that year, which gives a fair reflection of how expensive the cost of colored newspaper printing was. In the next five years, black and white printing was still the main tone. Red register prevailed and occasionally there were colored pages. It is quite evident that Chinese people have always had a preference for red, the symbolic color of auspicious and festival in traditional culture (Figure 6-7). In December 1992, colored pages became more frequently. Each edition of newspaper in the 1993 (issued every 4-5 days) was designed as four colored one out of totally eight pages, colors appearing on the first and the eighth page. From 1995 to 1999, each edition was designed as six out of twelve pages, colors appearing on the first, the fifth, the eighth and the twelfth pages, all printed on newsprint paper. From year 2000 to the end of 2005, the number of pages and quantity of colored ones were no longer limited. Each edition varied but the increasing tendency is evident. Till 2003, full color printing was adopted for all pages, and that is the beginning of an era in which color newspapers become commonplace (Figure 8).

It is discovered on *Liberty Times* that color pages increased from one out of four in 1983 to one out of two in 1988. Full color stage was realized in 2003, leaving only "job opportunities, categorized advertisements" column in black and white. Since 2009, there is no page in black and white only anymore (Figure 9-10). The epaper of *Liberation Daily* since 2009 to up till now has been designed in full color, with blue and red as main tones and very little major changes. The newspaper is bright in color, even in shade and the rich colors are entertaining and pleasant (Figure 10-11). (Figure Data Source: Taiwan University Library and Liberation Daily website)



Figure 1



Figure 2



Figure 3



Figure 4



Figure 5



Figure 6



Figure 7



Figure 8



Figure 9



Figure 10



Figure 11



Figure 12

Figure 1. Shanghai Daily 19650604. **Figure 2.** Partial of Shanghai Daily 19650604. **Figure 3.** Chinese Christian Tribune 19661030 **Figure 4.** Chinese Christian Tribune 19730903. **Figure 5.** Chinese Christian Tribune 19751031. **Figure 6.** Chinese Christian Tribune 19821031. **Figure 7.** Chinese Christian Tribune 19910922. **Figure 8.** Chinese Christian Tribune 20050503. **Figure 9.** Liberty Times 19830101. **Figure 10.** Liberty Times 20140101. **Figure 11.** Liberation Daily 20091001. **Figure 12.** Liberation Daily 2160322.

4.CONCLUSION

This study analyzed newspapers from different periods in ancient, modern and contemporary times, from the point of view of newspaper printing technologies including manual transcribing, woodblock printing and wooden type printing in ancient time, lead type printing in modern time, as well as planographic, gravure and special printing presses, computer-laser screen typesetting and full-page output technology in contemporary time; the evolution of printing technology from manual transcription in book form and woodblock printing to single page square shaped single side print and later rectangle shaped perfect printing is discussed. From the point of view of color, the development from black and white printing in ancient time to monochrome and full color printing in modern and contemporary time is long process. It is discovered during the investigation of newspaper printing and color formation that in every time period, along with the issuing of each edition of newspaper, its printing and color presents subtle changes correspondingly, with ethnic cultural individuality in it; and along with the transformation of printing equipment and machinery as well as printing paper and ink, the reader group of newspapers spreads from the ruling class only to ordinary folks. Meanwhile the progress of newspaper color from dull black and white, monotone color register to bright and pleasant full colors is a gradual evolution from low quality to high level and precision presented before our eyes in real. The improvement of newspaper colors, on no matter epaper or traditional paper in the future, will bring to the readers a bright and vivid visual fiesta. With the development of time and progress of future printing business, newspapers with more exquisite printing and brighter color will come into being.

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Methods for assessing memory colors on a display

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ABSTRACT

The memory colors have been continuously aroused great interests from researchers but previous studies mainly focused on the reflected samples in real scenes. In this work, we evaluated the effect of different experimental settings in the memory color matching method on a display by investigating ten familiar objects among Chinese people, especially the traditional Chinese colors. Different aspects in the color matching methods have been explored, including the influence of context-based grey image and colorimetric values of the starting colors. The memory color centers were quantified in terms of CIELAB L^* , a^* and b^* , and the inter- and intra- observer variations were estimated by MCDM values. A statistical analysis showed significant differences between experiments with different starting color values but non-significance between experiments with and without grey image.

Keywords: Color matching method, Memory color, MCDM, Ellipse fitting

1. INTRODUCTION

Memory colors have long been of interest to many different areas of color research. Bartleson investigated the memory colors of skin, blue sky and grass colors using Munsell color chips, and also studied the difference between memory colour, preferred colour and natural colour ^[1, 2]. Overall, there is a trend that memory colours are more saturated than natural colours with great hue constancy. This has been confirmed by many other researchers ^[3-7].

Tarczali et al. compared the method of memory colors from choice colors, reproducing a color name and reproducing appropriate color in a grayscale photo ^[8]. They found no significant difference in these three different types of experiments. Bodrogi and Tarczali studied the memory color shifts in the presence and in the absence of the image context and found systematic shift within a given category of the image context ^[9]. Newhall et al. did the comparison of successive with simultaneous color matching and the former yielded higher variability, shorter matching time, and higher purities and luminance ^[10].

In the present article, we investigated the memory colors of Chinese observers based on homogeneous color patches on a self-luminance display. The aim is to assess the magnitude of matching bias of different experimental settings in the color matching methods. Three psychophysical experiments were conducted to determine memory colors and observer variation of a panel of ten cultural-based familiar objects through complete color matching method.

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2. METHOD

2.1. Display Characterization

The experiment was carried out on a calibrated LED-back lighting self-luminous EIZO CG277 display, with 110 cd/m² luminous level and 6500K white point settings. The GOG model was implemented as display colorimetric characterization, which maps device-dependent RGB digital values into device-independent XYZ tristimulus values ^[11]. Then XYZ values were transformed into uniform CIELAB L^* , a^* and b^* values by using the peak white of the monitor as reference white. The accuracy of GOG model was less than 0.60 ΔE^*_{ab} unit averaging from 72 testing patches (0:15:255, R, G, B and grey-scale channels). The display stability was around 0.52 ΔE^*_{ab} unit during the six-month period.

2.2. Psychophysical Experiment

The current study contains three psychophysical experiments by differing experimental settings. In the first experiment, the matching was based on the object name description. The starting RGB values of the homogeneous color patches were close to the memory colors. In order to assess the effect of object-based context, a grey image of the corresponding object was introduced on the interface. The grey image served as a clue and could probably remind observers of any previous experience in color impression. The third experiment was set in condition with grey image but with grey starting color values so as to look into the chromatic influence.

The color-matching experiment was conducted in a completely dark room where the monitor was the only light source. The viewing distance was 50 cm. The memory color matching was operated on the monitor by a feasible Matlab GUI interface. The size of changeable patch for displaying respective object color was 2.5 cm×2.5cm within the 2 degree viewing angle. There were three manipulatable slide bars of CIELAB L^* , C^*_{ab} and h_{ab} attributes to make a desirable color. Participants were asked to do complete color match, that is, in brightness, hue and saturation, on the basis of their color memory ^[12].

Ten objects were selected to investigate the long-term memory color of Chinese observers, including skin (Caucasian, Oriental and African), blue sky, green grass, blue jean, tradition Chinese colors (Chinese red, Dragon robe, Sausage and Blue-and-White porcelain). There were 25 observers attending in the first experiment and 31 in the second and the third.

3. RESULTS AND DISCUSSION

The long-term memory colors of Chinese observers were quantified as L^* , a^* and b^* values in the CIELAB uniform color space. Ellipses were fitted to measure the statistical boundary based on the distribution of group data with a confidence level (see Figure 1). The representative memory color center results of ten investigated objects were averaged from the group data and were visualized in the a^*b^* diagram represented by the crosses. The two figures not only show the memory color centers and range, but the difference among three experiments. The mean color center difference between the first two experiments was 4.9 ΔE^*_{ab} , whereas it reached 11.6 ΔE^*_{ab} between the last two experiments.

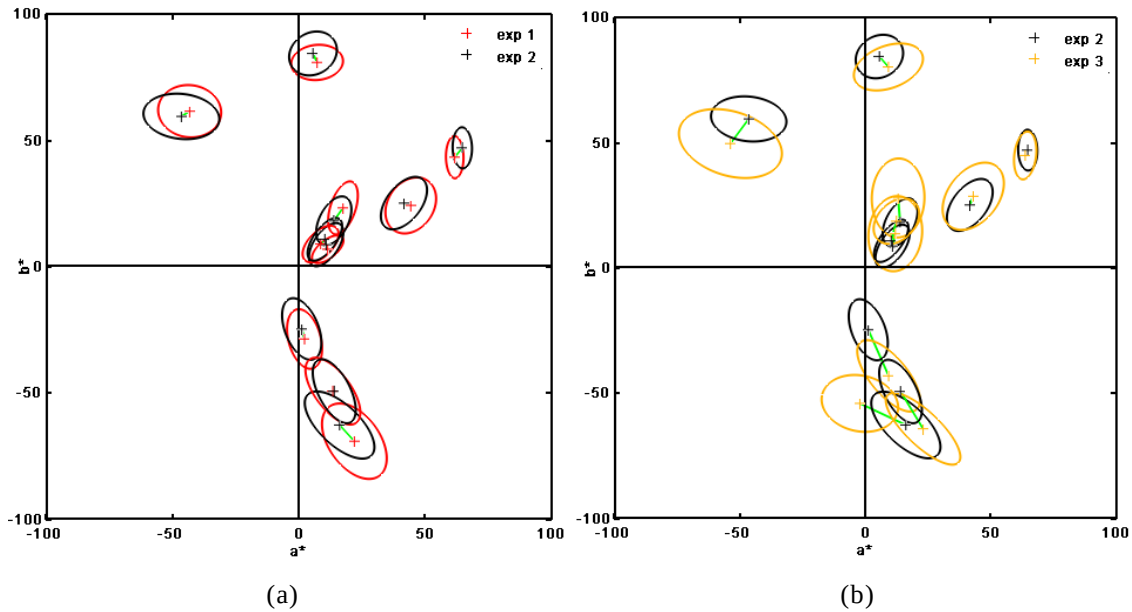


Figure 1. Ellipses and color centers drawn in the a^*b^* diagram with 50% confidence level. a): comparing experiment 1 and experiment 2; b) comparing experiment 2 and experiment 3. Crosses represent color centers, ellipses fit the group data and green line links the color centers between two experiments. Red represents the first experiment results with colorful starting values but without grey image; black represents the second experiment results with colorful starting values and grey image; yellow represents the third experiment with grey starting values and grey image.

The measure of mean of colour difference from the mean (MCDM) was used to indicate the inter-observer variation and intra-observer variation. For inter-observer variation, it is the overall individual difference comparing to the group mean value. The intra-observer variation concerns the variation between several results of the same observer. For a perfect agreement, MCDM will be zero. As shown in Table 1, the mean inter-observer MCDM values for Chinese subjects are 13.8, 14.9, and 18.3 respectively (Object names are shortened in acronym). Likewise, the overall intra-observer MCDM values for Chinese subjects are 11.1, 11.6, and 15.8 respectively. From the two tables, it can be seen that the inter-observer variation is larger than intra-observer variation. MCDM values of the third experiment increases largely both in inter- and intra- observer variation. Though ANOVA factor analysis, the type of experimental setting influences the memory colors results significantly (at $P = 0.05$ level).

Table 1. Inter-and intra- observer variations of all memory colors in three experiments.

Object name	GG	BJ	BS	CS	Asian Skin	African Skin	CR	IR	S	BP	Mean
Inter-observer											
Exp 1	14.6	14.2	18.9	10.3	14.0	10.0	13.4	11.9	14.7	15.6	13.8
Exp 2	18.9	14.3	19.5	14.0	13.7	13.3	11.8	14.3	14.1	15.5	14.9
Exp 3	25.2	17.1	22.1	17.1	18.6	14.7	14.7	17.9	15.4	20.5	18.3
Intra-observer											
Exp 1	12.5	9.9	12.5	8.3	10.3	7.8	19.3	9.0	11.5	10.1	11.1
Exp 2	17.0	10.8	19.5	12.6	8.7	8.7	8.7	9.6	8.8	11.2	11.6
Exp 3	21.1	21.2	20.8	15.5	15.9	11.1	10.1	12.9	12.8	16.5	15.8

Both the large color center difference and the increased inter-and intra- observer variation address the significant impact of the chromatic value of the starting point, which is much greater than the grey image as context clue in colour matching methods.

4. CONCLUSION

The effect of three different experimental settings in assessing memory colors of ten familiar objects was investigated on a LED backlighting display. For each object, the mean observer value was quantified in CIELAB L^* , a^* and b^* . The inter- and intra- observer variation reveal larger MCDM values in the third experiment comparing to the first two experiments. The statistical factor analysis confirms significant difference between the third and the first two experiments. This goes to show, in the current work, the results demonstrate that chromaticity of starting colors elicits great difference, while object-oriented grey image gains non-significant impact.

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Effect of color working memory under Stroop color matching on prefrontal brain activity during Zen-meditation

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ABSTRACT

Using an fMRI, we obtained brain activation maps while participants were engaged in the color Stroop task. Brain activity was measured using fMRI for the expert Zen-meditators and age-matched control participants under the congruent- and incongruent-conditions. We found the left dorsolateral prefrontal cortex (DLPFC), the right PPC (posterior parietal cortex), and the ACC (anterior cingulate cortex) with reduced interference on the Stroop task in Zen-meditators, in contrast with a lack of effect in the control participants. This suggests that Zen-meditation produces brain's long-term increases in the efficiency of the executive attentional network of color working memory based on the ACC.

Key words: Color Stroop test, working memory, prefrontal cortex, Zen-meditation

1. INTRODUCTION

When the name of a color (e.g., "green," or "red") is printed in a color not denoted by the name, for example, the word "red" printed in green ink instead of red ink (incongruent condition), naming the color of the word takes longer than when the color of the ink matches the name of the color (congruent condition). This interference effect between color name and perceptual color is called the Stroop effect (1). Major theories explaining the interference between perceptual color and its verbal code suggest a race model in which both relevant and irrelevant color information are processed in parallel, but race to enter the single executive attentional processor during response selection (2).

2. METHODS

Participants

Nineteen Zen monks ($M = 39.26$, $SD = 5.91$) and eighteen age- and education-matched healthy male volunteers ($M = 38.83$, $SD = 6.35$) were participated in the present study. All the monks finished Zen training in the professional school which had lasted for at least four years, and mean training year was 7.53 ($SD = 2.50$). Participants in the matched group had not experienced meditation training. All participants reported normal or corrected to normal vision. The study protocol was approved by the Ethical Committee of Advanced Telecommunications Research Institute International prior to the experiment

Stimulus

Four color words (red, yellow, green, and blue) and four non-color words (stone, door, ship, and car) were used. They were all Kanji character, and each word was printed in one of four color inks (red, yellow, green, or blue). Color words printed in the same color were used in the congruent condition, and those printed in the different color were used in the incongruent condition. Non-color words were used in the neutral condition.

Procedure

A standard color Stroop task was given in the MR scanner. The task consisted of three types of block: congruent block, incongruent block and neutral block. In the congruent block, color name of target words was always congruent with color ink. In the incongruent block, on the other hand, color name of targets was always incongruent with color ink. In the neutral condition, non-color words were presented. Participants were instructed to press one of four buttons; each button corresponded to one of four colors to be reported (red, yellow, green, or blue). In each block, four color inks was presented six times and same color ink was not repeated more than three times in a row. A tone signal was given at the beginning of each block to notify the start of the task. A target

stimulus was presented for 1000 ms and inter-stimulus-interval was 1000 ms. Each block consisted of 24 trials and each condition (congruent, incongruent or neutral) was repeated four times. An order of the conditions was pseudo-randomized. Blocks were separated by a rest period which had lasted for 48 seconds.

fMRI data acquisition

Functional images were obtained using a 3.0-T MRI scanner (MAGNETOM Verio (3T), Siemens, Munich, Germany). Head motions were minimized by use of a forehead strap and comfortable padding around the participant's head. Functional images sensitive to blood oxygen level-dependent (BOLD) contrasts were acquired by a single-shot echo-planar imaging sequence (TR = 2000 ms, TE = 30 ms, flip angle = 80°, 64 × 64 at 3 mm in-plane resolution, 4-mm thickness with 1 mm gap, 30 contiguous oblique axial slices parallel to the AC-PC line). Following to the acquisition of the functional images, anatomical images were collected for all participants (TR = 2250 ms, TE = 3 ms, flip angle = 9°, voxel size = 1 × 1 × 1 mm).

3. RESULTS & DISCUSSION

Brain activity was measured using fMRI for the expert Zen-meditators and age-matched control participants under the congruent- and incongruent-conditions. Accuracy and reaction time showed a significant interaction between the factors of the group and condition. The interaction appears to be due to poorer performance in the incongruent condition than the other conditions in the control group while expert Zen-meditators showed equivalent accuracy across conditions. We found the left dorsolateral prefrontal cortex (DLPFC), the right PPC (posterior parietal cortex), and the ACC (anterior cingulate cortex) with reduced interference on the Stroop task, in contrast with a lack of effect in the control participants. According to brain image analysis, control subjects showed greater activation in the prefrontal regions in the incongruent condition than the neutral condition. Those regions include also the left DLPFC, the right ventrolateral prefrontal cortex (BA47), and the medial prefrontal cortex (BA9). Interestingly, expert meditators showed equivalent activation across conditions in those prefrontal regions. This suggests that Zen-meditation produces brain's long-term increases in the efficiency of the executive attentional network of color working memory based on the ACC.

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Color rendering ability of light sources evaluated based on metameric reflectances

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ABSTRACT

The chromatic adaptation transform models have been widely used in the color rendering index (CRI) and color constancy calculations. However, there are transformation errors in the chromatic adaptation transform models themselves, which would further affect the accuracy of the CRI and color constancy models. The CIE Cat02 chromatic adaptation transform model was quantitatively evaluated based on different sets of reflectance samples under various kinds of illuminants. The results indicated that the transformation accuracy of the Cat02 model was illuminant dependent and the accuracy was low for the human-made light sources. A new method based on the volume of metameric reflectances was proposed to evaluate the color rendering ability of light sources. The new method doesn't require the chromatic adaptation transformation step and the experiment results indicated that the proposed method performed better than CIE CRIs.

Keywords: Light sources, Color rendering index, Color constancy, Metamerism

1. INTRODUCTION

The color rendering index (CRI)¹ is understood to be a metric to evaluate the color rendering ability of the light sources. The Commission on Illumination (CIE) R_a ² is such an index and has been widely used in the lighting industry since it was proposed in 1965. While, there are lots of criticisms¹ to CIE R_a when it is used to evaluate the quality of the light sources with spiky or band spectral radiance, so various other CRIs have been proposed to make up for the drawbacks of the CIE R_a . However, the newly developed indices are not remarkably different from the old ones based on the evaluation results of twenty-two CRIs³. In the color imaging application field, human have the color constancy ability. However, cameras do not intrinsically have this ability and the color of the captured image would change with the lighting environment. The computational color constancy algorithm⁴ was widely used in the cameras to correct the color cast images under the capture lighting environment to standard color images under the canonical illuminant. The chromatic adaptation transformation is one key step for most of the CRIs and the computational color constancy calculation. In the CRI calculation, the chromatic adaptation transformation is used to transform the colors of the samples under the test light source to the corresponding colors under the reference light source². For the computational color constancy, the chromatic adaptation transformation is used to correct the colors of the images under the estimated light source to that under the canonical illuminant⁴. However, there are transformation errors in the chromatic adaptation transformation itself. In this study, the chromatic adaptation transformation model was evaluated based on different sets of reflectance samples under various kinds of illuminants and light sources. A new method which doesn't require the chromatic adaptation transformation step was proposed to evaluate the color rendering ability of light sources.

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2. EVALUATION OF CHROMATIC ADAPTATION TRANSFORMATION

In order to evaluate the chromatic adaptation transformation accuracy, different reflectance spectrums and illuminant spectrums were collected. All the spectrums were sampled from 400nm to 700nm at a 10nm-sampling interval in this study. The reflectance spectrum include the 1600 reflectances of the Munsell glossy edition papers⁵, the 1950 reflectances of the Natural Color System samples⁶, along with 218 reflectances from the “Natural Colors” database⁷. Eleven illuminants, namely, the CIE standard illuminants A, D50 (5000 K), D65 (6504 K), D100 (10000 K), D150 (15000 K), D200 (20000 K), F4, F8 and F11, along with two cell phone LEDs are used in evaluating the chromatic adaptation transformation.

CIECAT02⁸ is the newest chromatic adaptation transformation model and has been adopted in the CIECAT02 color appearance model⁹. The CIECAT02 was evaluated in this study. Firstly, the CIE1931XYZ tristimulus values of the three testing reflectance sample sets were calculated under all the eleven illuminants and light sources. The CIE1931XYZ tristimulus values under D65 were selected as the reference tristimulus values as which were considered as the canonical colors in the computational color constancy study. Secondly, the XYZ tristimulus values under A, D50, D100, D150, D200, F4, F8, F11 and the two LEDs were rendered to that under D65 by the CIECAT02 model. Finally, the CIEDE2000 color differences¹⁰ between the reference and predicted tristimulus values were calculated for all the ten illuminant changing cases respectively. The results indicates that the prediction accuracies of daylight to D65 (D50 to D65, D100 to D65, D150 to D65 and D200 to D65) are much higher than that of other man-made illuminant to D65 (F4 to D65, F8 to D65, F11 to D65, LED1 to D65 and LED2 to D65). The main reason is that the chromaticity differences between the daylight to D65 are much smaller than that between the man-made lights to D65, which indicated that the more similar color of the testing and the reference light, the higher of the prediction accuracy. While, for the cases of D100 to D65 and LED2 to D65, the chromaticity distance between D100 and D65 and that between LED2 to D65 are the same, while the prediction accuracy of LED2 to D65 is much lower than that from D100 to D65. The main reason is that there are spiky radiances in the SPD of LED2, which indicates that the prediction accuracy is also affected by the SPD shape of the testing light, the spikier of the SPD, the lower of the prediction accuracy. As a whole, the prediction accuracy of the chromatic adaptation transformation model is illuminant dependent, and both the chromaticity and SPD differences between the testing and reference light would affect the prediction accuracy.

3. COLOR RENDERING EVALUATION METHOD BASED ON METAMERIC REFLECTANCES

The prediction accuracy of the chromatic adaptation transformation model is strongly depended on the light, so it is not a good choice to include the chromatic adaptation transformation step in the CRI definition. In this study, the matrix R method¹¹ was employed to generate the metamers and a method based on the metamer mismatching volume of practical reflectances was used to evaluate the color rendering ability of lights. This method doesn't require the chromatic adaptation transformation step and could be used to evaluate the color rendering ability of any light.

The metamer **B** is generated by Eq. (1),

$$\mathbf{B} = \mathbf{N} - \mathbf{A}(\mathbf{A}'\mathbf{A})^{-1}\mathbf{A}'\mathbf{N}, \quad (1)$$

where **N** is a n -by-1 vector and denotes the original spectral reflectance, n is the number of wavelength intervals and equal to 31 in this study, **A** is n -by-3 matrix and the three columns are the dot production of

the reference illuminant and observers, the CIE1931XYZ observers are adopted in this study, ‘ $'$ and ‘ -1 ’ denote the transpose and inverse of the matrix.

The generated $\mathbf{B}$ actually is the metameric black spectrum, which indicates that the tristimulus values under the reference illuminant equal to $[0, 0, 0]$. So if the testing light has the same color rendering ability as the reference illuminant, the tristimulus values of metameric black under the testing light should also equal to zeros. If not, which indicates that the color rendering ability of the testing light is different from that of the reference illuminant, and the bigger of the XYZ values under the testing light, the bigger difference of the color rendering ability between the reference illuminant and testing light. So the XYZ values of the metameric black under the testing light are a good indicator of the color rendering ability of the testing light. In this study, the volume of the XYZ values of the metameric black spectrums under the testing light was used to define the color rendering index. The calculation method is shown in Eq. (2),

$$CRI_{vol} = 100 - k * V^{(1/3)}, \quad (2)$$

where V denotes the XYZ value volume of the metameric black spectrums under the testing light, k is the coefficient and determined by the CIE illuminant F4 to make CRI_{vol} equal to 51 as which of CIE R_a .

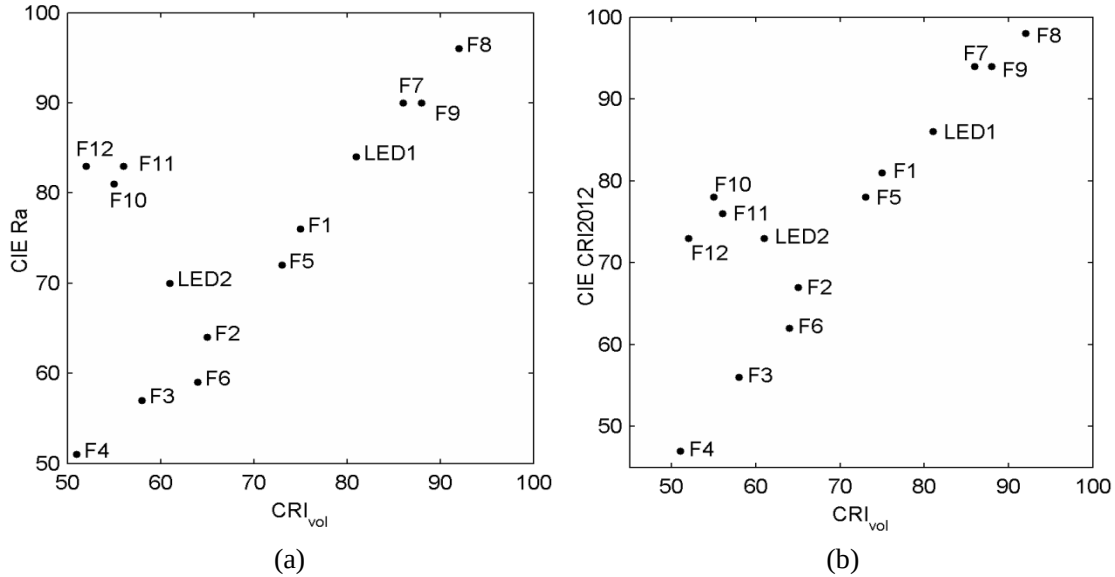


Figure 1. Comparisons between the CIE CRIs and the CRI_{vol} , (a) CRI_{vol} versus CIE R_a , (b) CRI_{vol} versus CIE CRI2012.

4. EXPERIMENT AND RESULTS

In this study, the Munsell color atlas was used to generate the metameric black spectrums and CIE D65 was selected as the reference illuminant. The coefficient k was firstly determined by make the CRI_{vol} of F4 equal to 51. After that the CRI_{vol} of the CIE fluorescent illuminants F1, F2, ..., F12 and the two LEDs were calculated. To compare the proposed CRI_{vol} and the CIE color rendering index, both the CIE R_a and CIE CRI2012¹² were calculated for the fourteen testing lights. The results are shown in figure 1. For the comparison between CRI_{vol} and CIE R_a in figure 1(a), it clearly indicates that there are strongly linear relationships between the CRI_{vol} and CIE R_a for most of the lights, except the illuminants F10, F11, F12. The CIE R_a of illuminants F10, F11, F12 is much higher than that of the CRI_{vol} . The SPDs of illuminants F10, F11, F12 all contain lots of spiky radiance, it seems unlikely that their color rendering abilities are very good, and this is confirmed by the CRI_{vol} . The comparison case between CIE CRI2012 and CRI_{vol} in figure 1(b) is very similar as that between CIE R_a and CRI_{vol} , the CIE CRI2012 of illuminants F10, F11

F12 are out of the line and higher than that of CRI_{vol} , which indicates that the CIE CRI2012 is not a good color rendering index. However, the CIE CRI2012 of illuminants F10, F11 F12 is lower than that of CIE R_a , which indicates that CIE CRI2012 performed better than that of CIE R_a .

5. CONCLUSIONS

The chromatic adaptation transformation is one key step for most of the CRI and color constancy calculations. The CIE Cat02 chromatic adaptation model was evaluated by transforming the CIEXYZ tristimulus values under different lights to that under CIE D65. The color difference between the predicted colors and the measured colors under D65 were calculated. The results indicate that the prediction accuracies of Cat02 model are strongly illuminant dependent. The prediction accuracy is low for the man-made light sources, which would affect the CRI accuracy if the chromatic adaptation transformation is included in the CRI calculation. The CRI_{vol} method based on the metamer mismatch volume of the metameric black spectrums was proposed in this study to evaluate the color rendering ability of the light sources. The CRI_{vol} method doesn't require the chromatic adaptation transformation step. An experiment was implemented to compare the new proposed method with the CIE R_a and CIE CRI2012. The results indicate that the new method performed better than that of the CIE methods.

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Chromatic Adaptation and Simultaneous Colour Contrast Effect under both Neutral and Colour Backgrounds

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ABSTRACT

To study the performance of existing CATs and the degree of adaptation under both neutral and colour backgrounds, corresponding colour data was obtained in achromatic-matching experiments using real 3D objects for 12 background pairs. Two trends for the degree of adaption for different background chromaticities were found. Based on the results suggestions for possible revision of existing CATs were made.

Keywords: Chromatic Adaptation, Simultaneous Colour Contrast, Unique Colour

1. INTRODUCTION

A Chromatic Adaptation Transform (CAT) is an important component of any Colour Appearance Model (CAM)^{1, 2} as it predicts corresponding colours under different adaptive conditions. Over the years, many CATs³⁻⁵ have been developed, including the widely used CAT02^{2, 5} embedded in CIECAM02. CAT02 is a chromatic adaptation transform of the von Kries type applied in a sharpened sensor space instead of a regular cone space. The transform was derived using corresponding colour datasets with adaptive field chromaticities along the blackbody locus (e.g. A, D50 and D65). Incomplete adaptation is taken in to account using the incomplete adaptation factor (D)^{2, 5} which ranges from 0 to 1 for no to full adaptation respectively. In the CAT02 model adopted by CIECAM02, D is defined by Equation (1):

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

where F is a factor dependent on the surround condition and L_A is the luminance (cdm-2) of the adapting field. Possible surround conditions include dark, dim and average, such as cinema, projected images in a classroom, and office conditions respectively. Note that according to the equation (1) D is independent of the background chromaticity. However, according to daily life experience, one does not fully adapt to a very high chroma environment, no matter how long the adaption time and how bright the environment is. A CAT (and/or simultaneous contrast⁶ model) that is also able to account for coloured, high chroma, adaptive fields or backgrounds is missing in most existing CAMs.

To study the performance of existing CATs and the degree of adaptation under both neutral and colour backgrounds⁷, and with the aim of developing more generally valid models, corresponding colour data was obtained in achromatic-matching experiments using real 3D objects for 12 background pairs (with illuminant E as reference). Based on the results suggestions for possible revision of existing CATs were made.

2. METHODS

The experimental setup consisted of a 3D background scene, composed of various white, grey and black objects and a large white panel in the back, illuminated by a calibrated data projector. A grey 3D cube in the center of the scene served as test stimulus. A projector was used as light source to enable separate colour control of the background and test stimulus. Figure 1 shows the experimental situation from observers' view.

In the experiments, the background was set at approximately 800 cd/m² to 13 different chromaticities corresponding to: Planckian radiators of 2300K (P2k), 4000K (P4k), 12000K (P12k) and infinite K (Pinf); illuminants A, E and D65; *neutral white* obtained by Smet et al.⁸ (N); and several high chroma sources (Red, Yellow, Green, Blue, and Purple). Figure 2 shows the chromaticities of the testing

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backgrounds in the $u'v'$ diagram. For each randomly presented background colour observers were asked, after an adaptation time of 30s, to adjust the test cube colour until it appeared achromatic (neutral) by navigating in $u'v'$ space using a keyboard. Observers made appearance matches, not surface matches⁹. Starting bias was minimized by using 4 initial cube chromaticities distributed evenly in hue. Each achromatic setting was spectrally recorded using an OceanOptics QE65Pro tele-spectroradiometer (TSR). Ten observers with normal colour vision took part in the experiment. The results were used to investigate existing CATs and the colour contrast effect.

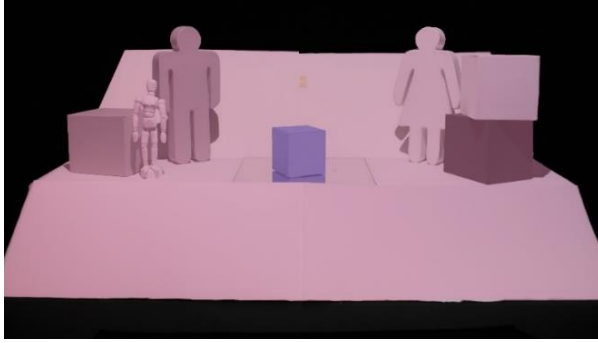


Figure 1. The experimental situation from the observers' view.

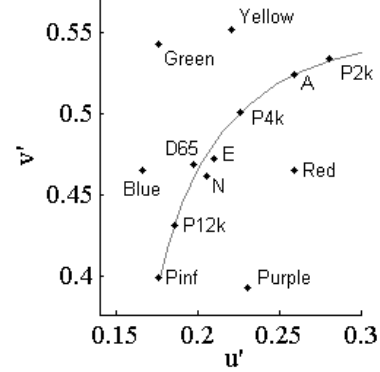


Figure 2. The chromaticities of the testing backgrounds in $u'v'$ diagram

3. RESULTS

Mean Colour Difference from the Mean (MCDM) were calculated to represent the observer variation of the result. The CIEDE2000 with zero luminance difference (DE2000c) was used in the colour difference calculations. The intra observer variation describes the repeatability of the single observer's matching performance while the inter observer variation describe the consistency between all observers of the visual neutral grey. Figure 3 shows observer variations under each background. The overall MCDM values are 5.0 and 5.9 for the intra- and inter- observer variations respectively.

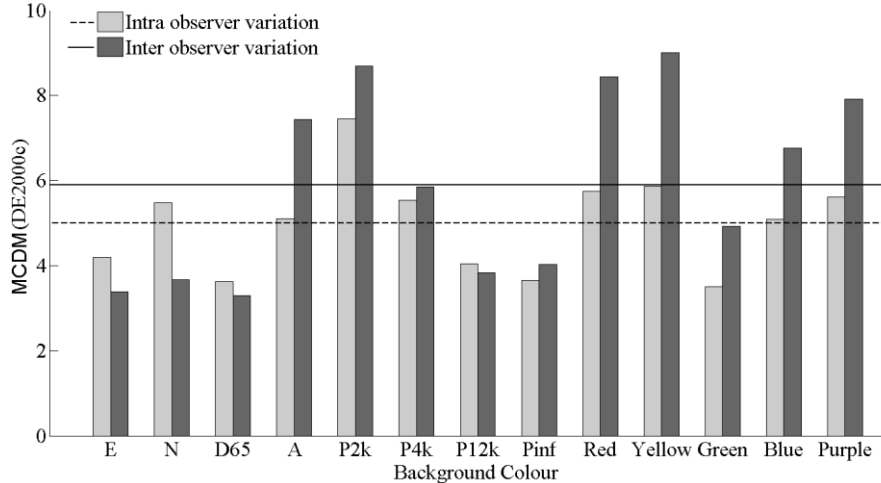


Figure 3. The intra- and inter- observer variations under each background with lines as mean values.

The observer-averaged achromatic settings for the 13 background chromaticities were arranged in 12 pairs of corresponding colours by selecting the data for illuminant E as reference. The CAT02^{2,5} was tested by calculating the colour difference between experimentally determined corresponding colours and those predicted by the models. DE2000c are illustrated in Figure 4. Colour differences were minimized by adjusting the degree of adaptation (factor D in CAT02)^{2,5} for each of the background colours. **Figure 5** shows the optimized D values. For most of the neutral, and some high-chroma, backgrounds (Red, Blue, Yellow, A, P4k, N and D65) CAT02 performed well ($DE2000c < 2.5$), while some higher-chroma backgrounds (Purple, Green, P2k, P12k, Pinf) could not be accurately predicted. Note that the observer inter variability was found to be around 5-6 DE2000c units.

In the present experiment, the luminance, 800cd/m², is at a very high level with the aim of inducing full observer adaptation. However, the optimized D values show that the degree of adaptation is only around 50% for the neutral backgrounds. This value challenges the D factor formula in CAT02 as

equation (1). In **Figure 5**, two trends of the optimized D can be observed. The first is that the further away the background colour is from the reference illuminance E , the lower the optimized D . This implies that a higher chroma background (adapted field) reduces the extent of the adaptation. The second trend is that observers appear to adapt more fully to a bluish background than to a yellowish one: D values are obviously lower for backgrounds with correlated color temperatures (CCT) below 4000 K (P2K and A) than for ones with CCTs higher than 4000 K (N, D65, P12k and Pinf).

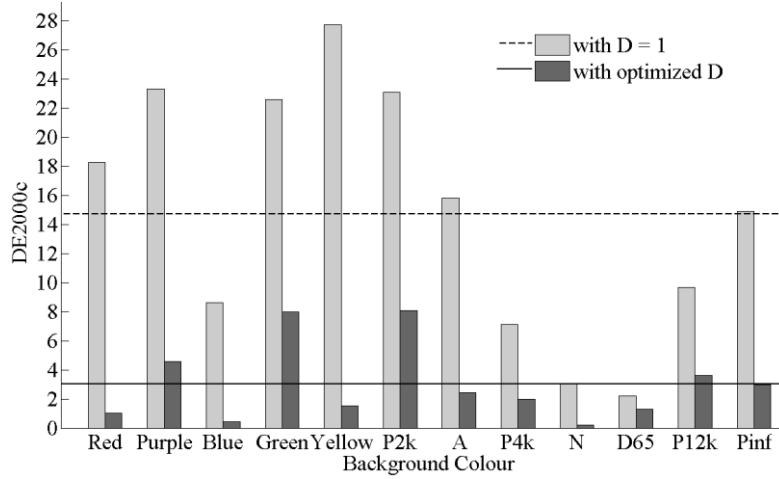


Figure 4. The colour differences between the experimentally determined corresponding colours and the ones predicted by the CAT02 model.

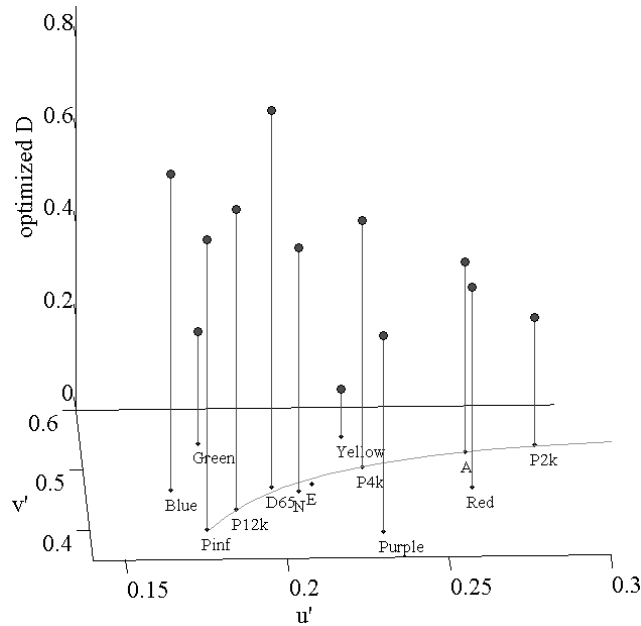


Figure 5. The optimized D for each background colour

Based on the trends found above, possible improvements of the CAT02 model would be to include a CCT or, more generally, a chromaticity dependence in the degree of adaptation formula given by Equation (1). A background chromaticity dependence would especially be useful when trying to account for color contrast. There were two main findings in previous investigations on colour contrast¹⁰. Firstly, the contrast effect works the same as the mechanism of chromatic adaptation with a relocation of the target colour in a certain colour space based only on the background chromaticity, which means target independent. The colour contrast effect would be included in the modelling of the factor D according to this assumption. The second is that the colour contrast effect is target dependent. The larger the colour difference between the target and the background colour, the less the effect of appearance change will be. For the modelling of the D factor and colour contrast effects, more experimental data is need. Therefore, future experiments will collect data for

- 1) More target objects with different colours: in addition to an achromatic settings of a grey cube, memory color matches of familiar objects, such as fruit, will be made.

- 2) More luminance levels ($< 800\text{cd/m}^2$).
- 3) Both real scenes and the pictures on the monitors.

With sufficient data of corresponding colours, the model of new factor D based on background chromaticity can be built, and the necessity of a target dependent correction for colour contrast effect could be discussed.

4. CONCLUSION

Corresponding colour data was obtained in achromatic-matching experiments using real 3D objects for 12 background pairs. The trends of degrees of adaption were found that higher chroma or yellower background chromaticities reduce the extent of chromatic adaptation. Based on the results suggestions for possible revision of existing CATs were made.

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The Study on Comparative Analysis of Color Application Characteristics of Architecture facade and Sign on Modern Commercial Street between Korea and China

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ABSTRACT

This study is a part of the color analysis on the commercial street in Korea and China. The basic of research is divided into two parts. The first part is aimed at doing comparative analysis of architecture facade color and sign facade color for traditional commercial street in Korea and China. The second part is aimed at doing comparative analysis of architecture facade color and sign facade color for modern commercial street between Korea and China. This study is aimed at the relationship of architecture facade color and sign facade color in modern commercial streets between Korea and China by ΔE^*_{ab} . The results are following. Firstly, following international influence, color using of architecture facade and sign facade have become more unified between Korea and China. It have not bigger difference in the direction of architecture facade color and sign facade color than traditional commercial street between Korea and China. Secondly, the result of ΔE^*_{ab} analysis, the color of using in the respect of stability and unify is not very well. The color of architecture facade and sign facade in modern commercial streets between Korea and China are confusion and dissonance.

Keywords: Korea, China, Modern Commercial Street, Architecture facade, Sign facade, color, ΔE^*_{ab}

1. INTRODUCTION

The importance of commercial buildings has not been properly noticed, although they hold a large majority of commercial buildings, which have caused some problem such as the relationship between color of sign and architecture facade and disharmonious architectural structures owing to poor investment. This study is aimed at the relationship of architecture facade color and sign facade color in modern commercial streets between Korea and China by ΔE^*_{ab} . In this paper, we adopt NCS color system and ΔE^*_{ab} to research the relationship between architecture facade color and sign facade color. I do this study for two reasons. The first reason is compared with other method such as photo analysis method in past research, this method that raises precision and reduces error keep below 0.1. The second reason is fewer research results in this direction between Korea and China. So I decide to do this study for researching the relationship of architecture facade color and sign facade color by ΔE^*_{ab} between Korea and China. For this study set doing comparative analysis of color on the basis of the modern commercial street. The relationship between architecture facade color and sign facade color of the two areas, whose environment differs from each other, as a primary research purpose, it is thought that this research will be used as important data for the commercial streets of Korea and China in the future.

2. METHOD

2.1. Sample Preparation

In this paper, four modern commercial street between Korea and China are selected and founded in the Beijing and Seoul which are Wufujing, Xidan, Cheongdamdong Street of Luxury Goods, Garosu-gil. This study is aimed at the relationship of architecture facade color and sign facade color in modern commercial streets between Korea and China (Figure 1).

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Figure 1: Wufujing, Xidan, Cheongdamdong Street of Luxury Goods, Garosu-gil

2.2. Experimental Procedure

In this study, I measure architecture façade color and sign façade color. The current study uses NCS color Scan 2.0 and NCS Index original-1950 color atlas to measure physiological signals. To avoid the inaccuracies in this study, I must wipe the surface of architecture façade and sign façade by lens paper before color measuring and measure the surface of architectural façade and sign façade for many times. Compared with other method, such as photographical analysis method analysis, this method that raise precision and reduce error is kept below 0.1. Due to weather and building high, I also use NCS Index original-1950 color to measure the color of architecture façade and sign façade.

The measurement method uses as follows. Firstly the subject is seated comfortably in the outside when the day have no strongly sunlight. I use lens paper to wipe the surface of architecture façade and sign facade. Secondly, NCS color Scan 2.0 is taken for 10 seconds in the surface of architecture façade and sign facade. In order to reduce the error of result of measurement, I measure different positions in the surface of architecture façade and sign façade. The other way to reduce the error of result of measurement, I use NCS color Scan 2.0 to measure for many times to find the average value. The research method is as follows(Figure 2).

Element	Summary	
Time	2015.7.26-2015.8.22 sunny	
Hour	9am-5pm	
Tool	NCS color Scan 2.0, NCS Index original-1950 color atlas	
	 NCS color Scan 2.0	 NCS Index original-1950 color atlas

Figure 2: Research Summary

2.3. ΔE^*_{ab} (color difference)

The International Commission on Illumination(CIE) called their distance metric ΔE^*_{ab} where delta is a Greek letter often used to denote difference, and E stands for Empfindung. German for "sensation". Use of this term can be traced back to the influential Hermann von Helmholtz and Ewald Hering.

CIE76

The 1976 formula is the first color-difference formula that related a measured to a known set of CIELAB coordinates. This formula has been succeeded by the 1994 and 2000 formulas because the CIELAB space

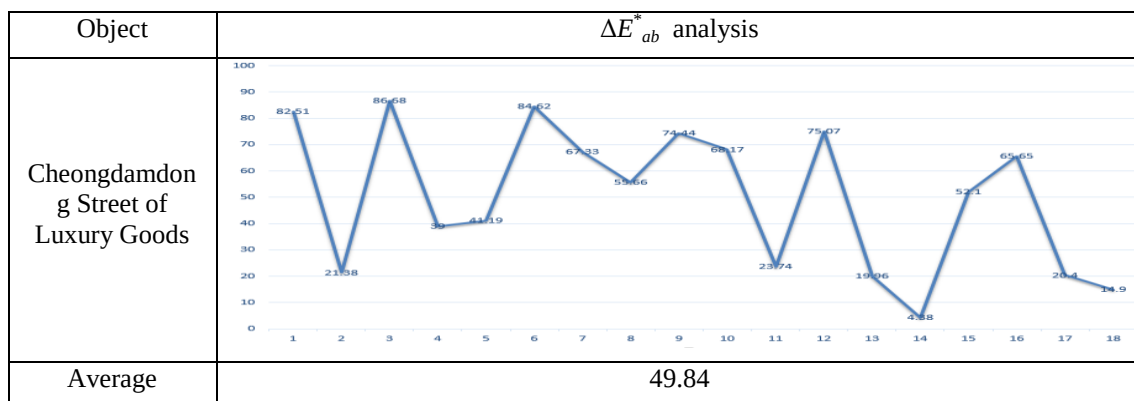
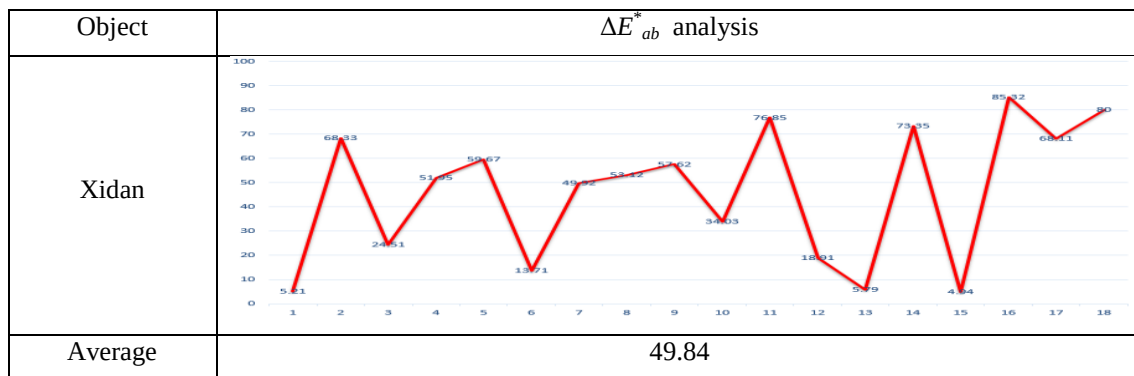
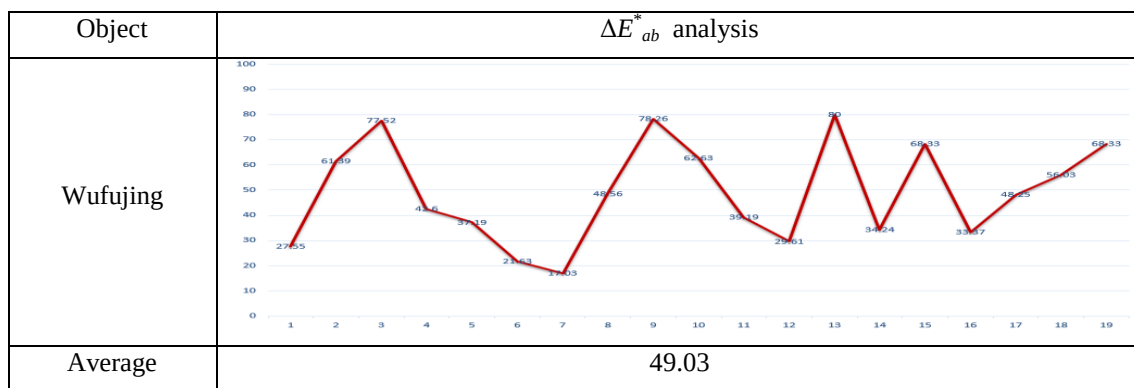
turned out to be not as perceptually uniform as intended, especially in the saturated regions. This means that this formula rates these colors too highly as opposed to other colors.

Using $(L_1^*a_1^*b_1^*)$ and $(L_2^*a_2^*b_2^*)$. Two colors in $L^*a^*b^*$.

$$\Delta E_{ab}^* = [(L_2^* - L_1^*)^2 + (a_2^* - a_1^*)^2 + (b_2^* - b_1^*)^2]^{1/2}$$

3. RESULTS AND DISCUSSION

This study use NCS Color system and ΔE_{ab}^* to analysis the relationship of color using between architecture façade and sign façade. In order to compare and analysis the color of selected architecture façade and sign façade, the colors are classified into the following: dominant color; assort color; accent color. ΔE_{ab}^* that used dominant color is extracted, analyzed and compared(Figure 3).



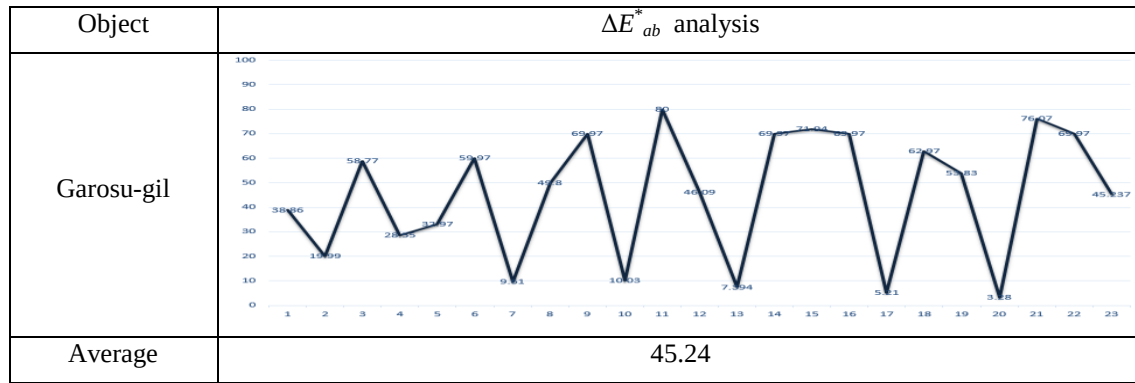


Figure 3 Architecture façade and Sign façade (dominant color) ΔE^*_{ab} analysis

The result of ΔE^*_{ab} analysis is showed as Figure 3. From the figure 3, it have not bigger difference in the direction of architecture facade color and sign facade color than traditional commercial street between Korea and China. The result of ΔE^*_{ab} analysis are above 45 in four objects. According to the book of A technique of urban design in Japan, when ΔE^*_{ab} analysis is below 20, the aspect of color using is stability and unify. But from the result of this study, the color of using in the respect of stability and unify is not very well. The relationship of color using between architecture façade and sign façade is confusion and dissonance in modern commercial streets between Korea and China.

4. CONCLUSIONS

The purpose of the current study is to analyze the relationship between architecture façade color and sign façade color China and Korea by ΔE^*_{ab} . Based on the result, it have not bigger difference in the direction of architecture facade color and sign facade color than traditional commercial street between Korea and China. From the result of this study, the relationship of color using between architecture façade and sign façade is confusion and dissonance in Korea and China modern commercial streets.

Following the result, it is judged that there should be the need to consider the harmony in color between architecture façade and sign, and the effective color range about the colors in architecture façade on the street, and sign in order to create the visually stable modern commercial streets.

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Natural screen printing ink comprises natural rubber latex and soil colorants

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ABSTRACT

Screen printing ink is comprised of three main components: binder, colorant and additive. A newly developed screen printing ink needs to be more environmental friendly or non-toxic. This research aimed to produce water-based screen printing ink by using natural materials. Natural rubber latex was selected for substitute chemical binder. Three Types of soil were used as colorant: black, red and yellow. Cassava starch was used as dispersing agent to help disperse colorant and binder. Ink formulas of natural rubber latex, cassava starch and soil colorants were studied by printing on cotton fabric with screen block number 48. The density and CIE L * a * b * of the printed on cotton fabric were measured, the best formula was selected for further test for the qualities of printed on cotton fabric. The results showed that natural screen printing inks that had ratio in weight of soil colorant: cassava starch: natural rubber latex at 8:10:20 is the best formula, the printed on cotton fabric showed the best qualities. The CIE L*a*b* values of printed cotton fabric from screen printing ink with black soil colorant were L*=49.70, a*= 7.37 and b*17.95; red soil colorant were L*=62.58, a*25.08, b*24.56; yellow soil colorant were L*=76.90, a*=8.54, b*=31.51. Natural screen printing ink from soil colorant and natural rubber latex that printed on cotton fabric showed that font TH SarabunPSK could be seen clearly at 18 point up of positive image and negative images at 20 point up. However, yellow soil could not give details of the image on cotton fabric, positive image was clearly at 0.25 point up and negative image was clearly at 2 point up. Natural screen printing ink was tested for adhesion on cotton fabric by washing the printed with detergent in washing machine. The results showed that the printed density before washing of black, red and yellow soil colorant were 1.18, 0.98, 0.80 and after washing were 1.15, 0.96, 0.77, respectively.

Keywords: Natural screen printing ink, Natural Rubber latex, Soil colorants

1. INTRODUCTION

Screen printing ink comprise of three main components: binder, colorant and additive. Almost screen printing inks comprise of harmful chemical from both solvent and colorant. Newly developed screen printing ink needs to be more environmental friendly or non-toxic. This research aimed to produce water-based screen printing ink by using natural materials. Natural rubber latex was selected for substitute chemical binder and soil as colorant. Soil is the important natural resources and differences of soil when we looking are colors. In agriculture soil color means the fertile of the soil but for painter or artist soil colors were used as colorants. Thailand has varieties of soil series and colors (Boonsompopphan et al, 2008). The different of soil color because of the component of mineral from the original and weather and environment. Trirat et al (2014) and Chotaku et al (2014) reported used soil dyes for colored handmade paper and printing ink, respectively. Jenkunawat et al (2015) reported the use of soil colorants substitute chemical colorant in silkscreen printing ink for cotton fabric by mixed soil colorant with water-based chemical resin of silkscreen medium. Presently, almost of screen ink is used chemical resin and some of the ingredients used are hazardous. In this research, authors aim to reduce the use of harmful chemicals by replacing with a friendly natural material that can be easily obtained such as soil to replace chemical colorants and natural rubber latex to replace synthesized resin. The screen printing ink is applied by conventional screen printing procedure and printed cotton fabrics are air dried.

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2. MATERIALS AND METHODS

2.1. Preparation of soil colorants

Three types of soil color were collected from the areas of Pathumthani province: red, yellow and black soil. Soil colorants were prepared by drying and grinding soil into fine powder. To make soil colorant, 100g of soil powder was added into 500 ml of clean water and mixed well by the blender. The mixture was filtered through muslin sheet to remove debris, and the mixture was left overnight for sedimentation. The supernatant liquid was discarded and the sediment was collected as soil colorant.

2.2. Preparation of screen printing ink

Many formulas were pre tested for printing qualities onto cotton fabrics, the best formula was selected for further test for the qualities of printed on cotton fabric. The best formula had ratio in weight of soil colorant: cassava starch: natural rubber latex at 8:10:20, respectively. The mixture was mixed well by hand.

2.3 Screen printing on cotton fabric

Prepare screen frame by using T48 screen. Natural screen printing inks from soil colorants were printed onto cotton fabric with the resolution of image printed at 30 LPI by using square-shaped rubber with the off contract of 3.0 mm.

2.4 Wash resistant

Printed cotton fabric was test for wash resistant by washing machine with 5 g of detergent in 48 liter of water and were washing for 15 minutes and rinsing with water for another 5 minutes, after that they were dried by sun light and density was measured after ironing.

2.5 Data collection

Printed cotton fabrics were measured for density, CIE-L*a*b* values were measured by using TECHKON SpectroDens. The qualities of printed cotton fabric were measured.

3. RESULTS AND DISCUSSION

The results showed that natural screen printing inks that had ratio in weight of soil colorant: cassava starch: natural rubber latex at 8:10:20 is the best formulas, the printed on cotton fabric showed the best qualities. The CIE L*a*b* values of printed cotton fabric from screen printing ink with black soil colorant were L*=49.70, a*= 7.37 and b*17.95; red soil colorant were L*=62.58, a*25.08, b*24.56; yellow soil colorant were L*=76.90, a*=8.54, b*=31.51 (Table 1). Natural screen printing ink from soil colorant and natural rubber latex that printed on cotton fabric showed that font TH SarabunPSK could be seen clearly at 18 point up of positive image and negative images at 20 point up. However, yellow soil could not give details of the image on cotton fabric, positive image was clearly at 0.25 point up and negative image was clearly at 2 point up (Figure 1-3).

Table 1. The CIE L*a*b* values of printed cotton fabric from screen printing ink with soil colorant

Screen printing ink	CIE		
	L*	a*	b*
Black soil	49.70	7.37	17.95
Red soil	62.58	25.08	24.56
Yellow soil	76.90	8.54	31.51



Figure 1. Printed fabric of natural screen printing ink with colorant from red soil.



Figure 2. Printed fabric of natural screen printing ink with colorant from yellow soil.



Figure 3. Printed fabric of natural screen printing ink with colorant from black soil.

Printed cotton fabrics were measured for density and then were washed for wash resistant. It was found that density was slightly decreased from before washed. Densities of printed cotton fabrics before washing were 1.18, 0.98 and 0.80, for black,-red- and yellow soil, respectively. After washing printed cotton fabrics for three times the results showed that densities were changed to 1.15, 0.96 and, 0.77 respectively (Table 2). The result showed that wash resistant of natural screen printing ink comprises soil colorants, rubber latex and cassava starch was better than screen printing ink comprises of commercial water-based resin and soil colorants (Jenkunawat et al, 2015).

Table 2. Densities of printed cotton fabrics before washing and after washing.

Screen printing ink	Before washing	After washing
Black soil	1.18	1.15
Red soil	0.98	0.96
Yellow soil	0.80	0.77

4. CONCLUSIONS

Natural screen printing ink from soil colorant and natural rubber latex that printed on cotton fabric showed that font TH SarabunPSK could be seen clearly at 18 point up of positive image and negative images at 20 point up. However, yellow soil could not give details of the image on cotton fabric, positive image was clearly at 0.25 point up and negative image was clearly at 2 point up. Natural screen printing ink was tested for adhesion on cotton fabric by washing the printed with detergent in washing machine, the density of printed fabric after washed was slightly decreased from before washed of all soil colorants.

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COLOR DIFFERENCES OF OKRA BLENDED WITH GREEN TEA POWDER ON CONSUMER ACCEPTABILITIES

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ABSTRACT

The effect of different temperatures and ratios of okra and green tea on sensory and color properties were studied in this research. Firstly, to study 3 of optimum temperature, i.e. 50,60 and 70°C of okra drying by using tray drier and jasmine as flavoring agent. The results found that temperature of 50°C gave the best overall quality of product. After that, blending of mixture ratios of 4 treatments (green tea:jasmine 4:1, green tea:okra:jasmine 3:1:1, green tea: okra:jasmine 2:1:1, green tea:okra:jasmine 1:3:1), respectively were performed on color measurement and sensory evaluation. The results showed that temperature differences did not affect on color values. Finally, Sensory evaluation test was performed by using ranking test showed that treatment 4 was the most acceptable from panelists in color value. From the information above can be used in developing color of products in form of health drinks, covers the essential nutrients and essential antioxidants needed in the future to meet the demands of consumers, which has increased steadily and expanded, in the large future level in beverage industry.

Keywords: green tea, okra, color, consumer, acceptabilities

1. INTRODUCTION

The aspect and color of the food surface is the first quality parameter evaluated by consumers and is critical in the acceptance of the product. The color of this surface is the first sensation that the consumer perceives and uses as a tool to accept or reject food. The determination of color can be carried out by visual (human) inspection or by using a color measuring instrument. In order to carry out a more objective color analysis, color standards are often used as reference material. Unfortunately, their use implies a slower inspection and requires more specialized training of the observers. For this reason it is recommendable to determine color through the use of color measuring instrumentation. At present, color spaces and numerical values are used to create, represent and visualize colors in two and three dimensional space “as shown in Ref. 1.” Okra is a popular health food due to its high fiber, vitamin C, and folate content. Okra is also known for being high in antioxidants. Okra is also a good source of calcium and potassium and the mucilage contains soluble fiber. Some people prefer to minimize the sliminess; keeping the pods intact, and brief cooking, for example stir-frying, help to achieve this. Cooking with acidic ingredients such as a few drops of lemon juice “as shown in Ref. 2.” Green tea contains phytochemicals, such as polyphenols and caffeine. Polyphenols found in green tea include

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Epigallocatechin gallate (EGCG), epicatechin gallate, epicatechins and flavanols. The advantages of green tea for the health benefits of green tea, human clinical research has not provided conclusive evidence of any effects. Although the mean content of flavonoids and catechins in a cup of green tea is higher than that in the same volume of other food and drink items that are traditionally considered to promote health, flavonoids and catechins have no proven biological effect in humans “as shown in Ref. 3.”

The objective of this research was to study temperature and ratios of okra and green tea differences affected on color measurement and consumption acceptabilities.

2. METHOD

2.1. Okra and Green Tea Preparation

Washing of okra and slice into small pieces and soaking in sodium hydroxide solution for 15 minutes. Drying of okra by using tray drier at 4 temperature. (50,60 and 70°C) and choose an optimum temperature for performing okra and green tea ratios as follow as:

Treatment 1: green tea: jasmine 4:1 (control)

Treatment 2: green tea: okra: jasmine 3:1:1

Treatment 3: green tea: okra: jasmine 2:1:1

Treatment 4: green tea: okra: jasmine 1:3:1

After that, blending of powders were performed continuously until homogeneous by using an electric blender and packed of products in aluminium foil bag “as shown in Ref. 4.”

2.1.1. Color Measurement

The sample of mixed okra and green tea from each treatment were prepared for color measurement using a Spectro Dens A407077 Premium (D-61462, Germany). Color was recorded and shown using brightness (L*), greenness (-a*) and yellowness (b*) “as shown in Ref. 5,6.”

2.1.2. Sensory Evaluation

The sensory evaluation was carried out 30 of panelists in Rajamangala University of Technology Thanyaburi, (RMUTT) Thailand. Sensory evaluation was done by 30 of panelists. Panelists was asked to analyze the level of preferences on each treatment by using ranking scale based on attributes of color adapted from “as shown in Ref. 4.5 and 6”.

3. RESULTS AND DISCUSSION

3.1. Color Measurement

Table 1. Color value of okra blended with green tea and jasmine

Treatment	L*	Color value	
		-a*	b*
green tea: jasmine 4:1	36.23	-3.57	8.63
green tea: okra: jasmine 3:1:1	36.60	-1.77	8.43
green tea: okra: jasmine 2:1:1	36.63	-4.20	8.83
green tea: okra: jasmine 1:3:1	36.80	-2.63	8.20

From the above results, the values of L*, a* and b* and physical appearance depending on different ratios of okra and green tea. The results from statistics (p=0.05)) showed that all values had not

differences. The possibilities of reason might be similar ratio among green tea, jasmine and okra “as shown in Ref. 4.”

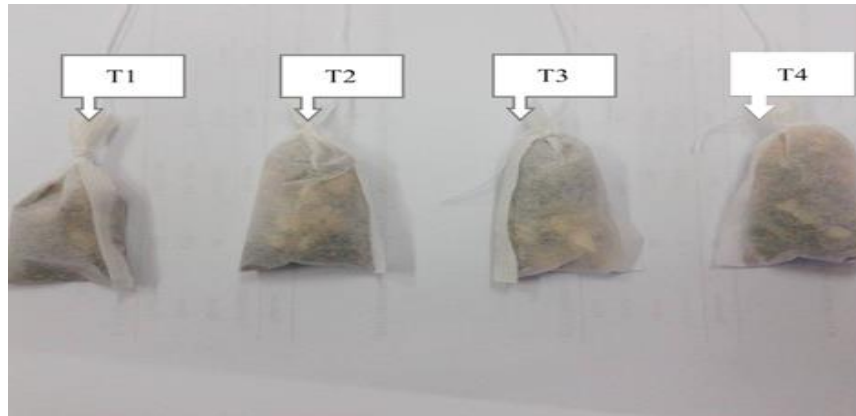


Figure 1. Product of different ratios of green tea, okra and jasmine

N.B. T 1: green tea: jasmine 4:1 (control)
 T 2: green tea: okra: jasmine 3:1:1
 T 3: green tea: okra: jasmine 2:1:1
 T 4: green tea: okra: jasmine 1:3:1

From the Figure1, the images could be seen that the color is slightly different in each treatment. Color measurable impacted on the quality of the sensory packaging and storage products “ as shown in Ref. 4.”

3.2. Sensory Evaluation

In sensory evaluation, the highest average of the mean of attributes color were treatment 4. The using of higher levels of okra indicated on quality color panelist acceptabilites “as shown in Ref. 4.”

4. CONCLUSIONS

The uses of different ratios of raw material preparation has not effects on color of mixed okra and green tea. Treatment 4 revealed that gave the first color ranking value from panelists.

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Testing performance of IES color fidelity index in optimizing spectra of light sources based on multi-color LEDs

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ABSTRACT

The method of producing white light by mixing multi-color LEDs has much greater flexibility to achieve optimal light quality, such as excellent color rendition capacity or high luminous efficiency, than the phosphor-converted (PC) approach. The newly proposed two-measure system for evaluating color rendition of light sources by the Illuminating Engineering Society of North America (IES) is targeted for improving the deficiencies of the Commission Internationale de l'Eclairage (CIE) color rendering index, which is currently the most widely accepted metric. In this study, IES color fidelity index (R_f) and CIE general color rendering index (R_a) were employed to optimize the color quality of white light composed of three- or four-color LEDs via a differential evolution algorithm, which is applicable for solving global optimization problems. The results indicate that, in a wide range of correlated color temperature from 2800K to 6500K, for the mixed light sources through three-color LEDs the optimal peak wavelength of individual LED generally shifts to short wavelength when optimizing R_f , as opposed to the situation occurring when optimizing R_a . However, the sources with four-color LEDs nearly do the opposite. In addition, the light sources with optimal R_f always possess pretty good R_a , and vice versa, whereas they render saturated red color relatively poorly in comparison with those having optimal R_a .

Keywords: Light source, multi-color LEDs, color rendition, IES color fidelity index, spectral optimization

1. INTRODUCTION

Typically, two methods are used for creating white light with LEDs. One is phosphor-converted white LED utilizing the blue LED to irradiate a yellow-emitting phosphor. The other is through mixing multiple color LEDs with different peak wavelengths and spectral widths, usually red, green, and blue in multi-chip packages or LED clusters. The former is of low efficiency owing to Stokes shift, and relatively poor color rendering capacity rooted in the absence of long-wavelength energy. However, the latter has much great flexibility to produce the desired color. Importantly, more than three-color LEDs offer tremendous opportunities to tailor synthetic spectrum to optimize different lighting quality, such as Commission Internationale de l'Eclairage (CIE) color rendering index (CRI)¹ and luminous efficacy, which are the most concerned characteristics of light sources for general lighting. The CRI for assessing color fidelity of sources, suffers from some well-known limitations and deficiencies, especially for highly-structured spectra, such as those produced by LEDs,² although it is currently also the most widely used metric in the lighting industry. Over the past few years, numerous efforts have been devoted to develop color metrics for supplementing or replacing the CRI,³ like CQS, FCI, GAI, RCRI, MCRI, CRI2012, etc., but unfortunately, a widely accepted measure has not yet been available. Recently, the Illuminating Engineering Society of North America (IES) published a two-measure system, including a color fidelity index (R_f) and a relative color gamut index (R_g),^{4,5} to overcome the limitations of the CRI. It is inspiring that the system has won the support from the related interest groups.⁶ To this end, it is essential to explore its evaluation performance.

In particularly, IES R_f and CIE general color rendering index (R_a) were employed in this study to optimize the color fidelity of a given white light, corresponding to the chromaticity of the Planckian radiator, produced by three- or four-color LEDs via a differential evolution (DE) algorithm, since over four LED channels have been demonstrated to yield negligible benefit in improving color rendition of mixed sources, along with increased cost and low-efficiency color management.⁷

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2. METHODS

2.1. IES method for evaluating color fidelity of light sources

In spite of varied measures, there has been no consensus on color rendition metric of light sources so far. Fortunately, the two-measure system (R_f and R_g) published by the IES seems to make significant progress towards the direction. The method is targeted for the limitations of the CRI and gives corresponding improvements, which includes 99 real color evaluation samples (CES) with color space uniformity and spectral uniformity, and a calculation engine based on the latest uniform color space CAM02-UCS.^{4,5} R_f is basically a more accurate version of the R_a , though its performance needs further verification. R_g , a relative color gamut index to supplement the R_f , can estimate the average extent to which a test source increases or decreases the saturation of CES compared to its reference illuminant. The procedure for achieving R_f of a test source is, firstly, to compute the color differences $\Delta E_{Jab,i}$ (in CAM02-UCS) of 99 CES illuminated under the test source and its reference illuminant. Note that if the correlated color temperature (CCT) of the test source is between 4500K and 5500K, IES adopts a linear combination of the Planckian radiator and CIE illuminant D as its reference illuminant to eliminate the discontinuity at 5000K. Then, the R_f of the test source is calculated as

$$R_f = 10 \ln \left(e^{R'_f/10} + 1 \right), \quad (1)$$

where

$$R'_f = 100 - 7.51 \left(\frac{1}{99} \sum_{i=1}^{99} \Delta E_{Jab,i} \right). \quad (2)$$

2.2. Optimization method

The CIE 1931 chromaticity coordinates (x, y) of mixed light by multi-color LEDs can be specified by

$$x = \frac{\sum_{i=1}^n c_i X_{i,m}}{\sum_{i=1}^n c_i (X_{i,m} + Y_{i,m} + Z_{i,m})}, \quad y = \frac{\sum_{i=1}^n c_i Y_{i,m}}{\sum_{i=1}^n c_i (X_{i,m} + Y_{i,m} + Z_{i,m})}, \quad (3)$$

where $X_{i,m}$, $Y_{i,m}$, and $Z_{i,m}$ indicate the CIE 1931 XYZ tristimulus values of the i th LED at its maximum output, and can be obtained from the spectral power distribution (SPD) of the LED, n is the number of single-color LED for mixture, c_i is the mixing coefficient of the i th LED. As a matter of convenience, the model proposed by Ohno² was adopted to characterize the SPD of a single-color LED, as given by

$$S(\lambda, \lambda_0, \Delta\lambda_{0.5}) = \frac{g(\lambda, \lambda_0, \Delta\lambda_{0.5}) + 2g^5(\lambda, \lambda_0, \Delta\lambda_{0.5})}{3}, \quad (4)$$

and

$$g(\lambda, \lambda_0, \Delta\lambda_{0.5}) = e^{-\frac{(\lambda - \lambda_0)^2}{\Delta\lambda_{0.5}}}, \quad (5)$$

where λ denotes the visible wavelength ranged from 380 nm to 780 nm, λ_0 and $\Delta\lambda_{0.5}$ are the peak wavelength and the full width at half maximum (FWHM) of the single-color LED, respectively.

In view of the universality of CIE R_a nowadays, IES R_f and CIE R_a were exploited respectively to optimize the color fidelity of light sources composed of three- and four-color LEDs through adjusting peak wavelength and mixing coefficient of each LED, while FWHMs held constant, i.e., 30 nm. Hence, the optimization problem can be defined as

$$\begin{cases} \text{Max } f(\lambda_{0,1}, \lambda_{0,2}, \lambda_{0,3}, c_1, c_2, c_3) & (\text{three-color LEDs}) \\ \text{Max } f(\lambda_{0,1}, \lambda_{0,2}, \lambda_{0,3}, \lambda_{0,4}, c_1, c_2, c_3, c_4) & (\text{four-color LEDs}) \end{cases} \quad (6)$$

where f is the objective function, representing R_a or R_f , $\lambda_{0,i}$ denotes the peak wavelength of the i th LED, and c_i , being any value between 0 and 1, is the mixing coefficient of the i th LED. In particular, for three-color LEDs, c_i can be uniquely determined by Eq. (3) to match a given color. However, with four-color LEDs, the c_i coefficients are no longer unique, one of which needs to be adjusted and the other three coefficients can be easily determined by Eq. (3). The target colors selected in this study were a

range of the chromaticity coordinates of the Planckian radiator at different color temperatures, including 2800K and those from 3500K to 6500K with 500K intervals, which can basically cover the usual CCT range for general lighting.

Given the above non-derivative object function, the differential evolution (DE) was utilized to search its global solution. The DE, which has been demonstrated to effectively solve the global optimization,⁸ is a population-based evolutionary algorithm. Recently, Soltic *et al.* utilized DE to optimize various lighting quality of LED light sources,⁹ but they failed to provide optimal color rendition of the light source corresponding to a given chromaticity.

3. RESULTS AND DISCUSSION

3.1. Case of three-color LEDs

The results for maximizing R_f or R_a of the light sources mixed by three-color LEDs are summarized in Table 1, in which the special CRI R_9 of the ninth red sample, always used to supplement R_a , is also listed. It is clear from Table 1 that the set of optimal peak wavelengths for different CCTs are similar to each other when optimizing the same index. The results can provide guidance for developing and selecting LEDs. Furthermore, the optimal peak wavelength of individual LED generally shifts to short wavelength when optimizing R_f , as opposed to the situation occurring when optimizing R_a . As an illustration, Fig. 1 (a) shows the optimal spectra corresponding to the chromaticity of the Planckian radiator at 3500K for both indexes. Generally, no matter which of R_f and R_a is optimized, the other index also has a pretty good score. Importantly, R_f does have negative effects on achieving a higher score, as a result of well spectral uniformity of its CES. It is interesting that, as seen from the R_9 values, the light sources with optimal R_f render saturated red color relatively poorly compared to those having optimal R_a , which may be due to its shorter optimal peak wavelengths especially for the peak wavelength of red LED, while the spectral reflectance of the red sample concentrates mainly on long wavelengths. On the other hand, as a measure for judging the average degree of change in saturation of CES, the R_9 values all approach 100, since the purpose of the present optimization is to maximize the color fidelity of light sources so that the saturation of CES under the test sources generally keep pace with that under their reference illuminants.

Table 1. Results for optimizing R_f or R_a of light sources mixed by three-color LEDs.

CCT/K	Maximizing R_f					Maximizing R_a				
	Peak wavelength/nm	R_a	R_9	R_f	R_g	Peak wavelength/nm	R_a	R_9	R_f	R_g
2800	464/543/616	88	61	84	104	479/555/621	92	86	76	90
3500	459/535/610	85	24	84	104	469/548/617	91	76	79	96
4000	458/534/609	85	25	84	104	466/544/615	91	76	80	98
4500	458/533/607	86	11	84	102	464/544/615	91	80	79	98
5000	458/532/606	86	7	84	102	464/544/614	91	72	79	97
5500	457/531/605	86	5	84	103	464/543/614	91	83	80	98
6000	456/531/605	87	11	84	104	463/542/612	91	68	80	98
6500	457/529/605	85	25	84	104	462/541/611	91	63	80	98

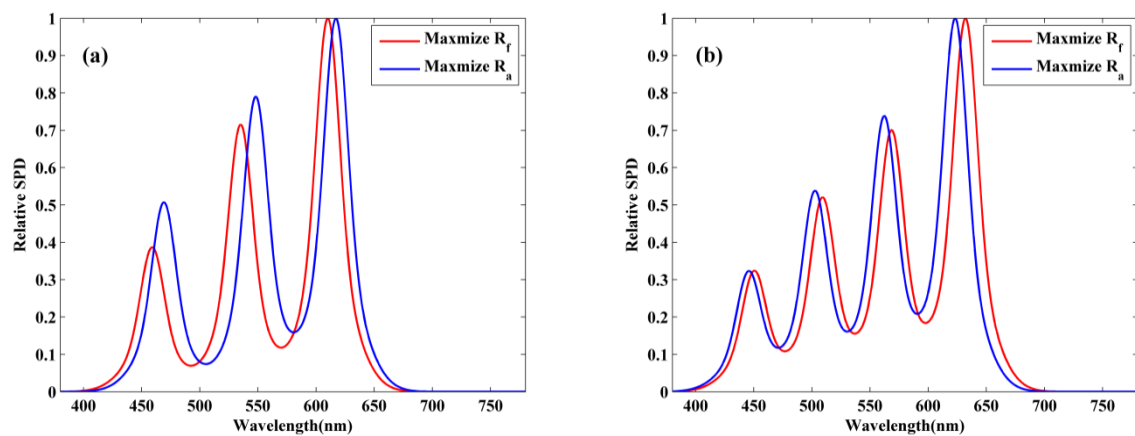


Figure 1. Optimal relative SPDs at 3500K. (a) Three-color LEDs, (b) four-color LEDs.

3.2. Case of four-color LEDs

Likewise, the results for maximizing R_f or R_a of sources composed of four-color LEDs are given in Table 2, which indicates that the set of optimal peak wavelengths for different CCT are also resemble with each

other whether maximizing R_f or R_a . However, the change in optimal peak wavelength of individual LED between the two indexes nearly does the opposite to the case of three-color LEDs, and Fig. 1 (b) illustrates an example of the fact. The scores of R_f and R_a , especially the latter, present significant improvement resulted from the addition of one more LED, compared to three-color LEDs. Indeed, the performance of color rendition produced by four-color LEDs with proper peak wavelengths seems to be enough for general lighting. What's more, the light sources with optimal R_f always have a high score of R_a , and vice versa. Although R_f has a difficulty in obtaining as excellent a score as R_a due to its huge number of CES with color space uniformity and spectral uniformity, this feature of R_f is conducive to avoiding the optimization of unrealistic color rendition for light sources, which is the very deficiency of R_a . The R_9 scores of the light sources with optimal R_f are also inferior to those having optimal R_a , but outperform their counterparts in the case of three-color LEDs owing to the introduction of the fourth LED. Finally, these mixed light sources can undoubtedly maintain the saturation of test samples.

Table 2. Results for optimizing R_f or R_a of light sources mixed by four-color LEDs.

CCT/K	Maximizing R_f					Maximizing R_a				
	Peak wavelength/nm	R_a	R_9	R_f	R_g	Peak wavelength/nm	R_a	R_9	R_f	R_g
2800	456/522/579/639	95	62	93	105	447/504/563/624	99	96	92	100
3500	450/509/568/632	95	52	94	103	446/503/562/623	99	96	93	100
4000	448/509/568/628	96	77	94	102	446/502/560/621	99	96	93	100
4500	447/506/567/629	95	66	94	102	447/503/561/621	99	95	93	101
5000	450/506/565/628	95	56	94	103	450/507/562/622	98	95	93	101
5500	448/504/565/627	96	66	94	102	451/504/560/620	98	95	93	101
6000	449/506/564/627	96	61	94	103	449/503/561/621	98	92	93	101
6500	446/505/564/624	96	76	94	103	453/507/561/619	98	94	91	100

4. CONCLUSIONS

Color fidelity, as an important aspect of color rendition of light sources, can be specified by the CIE CRI. However, CRI has many well-known limitations, especially for LED sources. Recently, a two-measure system was proposed by the IES, and its performance was investigated in this study through optimizing IES R_f and CIE R_a , respectively, of the light sources composed of three- and four-color LEDs with a DE method. It is found that in a wide range of CCTs from 2800 to 6500K, the set of optimal peak wavelengths in the case of three- or four-color LEDs are similar to each other when maximizing R_f or R_a . Further, the light sources with optimal R_f always possess pretty good R_a , and vice versa, whereas render saturated red color relatively poorly compared to those having optimal R_a . It is worth noting that the color space uniformity and spectral uniformity of IES test samples makes it hard to win significantly high scores. Additionally, considering the increasing importance of energy saving, further work will be expected to take fully into account both luminous efficiency and fidelity index R_f of light sources.

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Spectral reflectance estimation based on adaptive selection of training samples from multichannel responses

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ABSTRACT

Utilizing multispectral imaging, the surface spectral reflectance of non-fluorescent object can be estimated from the corresponding multichannel responses. The estimation accuracy is significantly impacted by the training samples used to calculate the transform matrix from multichannel responses to reflectance. In this study, the training samples were adaptively selected according to the correlation of the response vectors between test sample and training samples. The adaptive spectral estimation results were compared to those of the conventional approach by different channel numbers. It is verified that the adaptive spectral estimation outperforms the conventional one in both spectral and colorimetric accuracy especially when fewer channels are adopted.

Keywords: multispectral imaging, spectral reflectance estimation, correlation of response vectors, adaptive training samples

1. INTRODUCTION

Estimating spectral reflectance from multichannel responses of multispectral imaging has been widely studied recently. Using more than three channels adopted in a common commercial camera, the reflectance at each wavelength can be recovered more accurately from the correlated camera responses. Related researches show that using training samples close to the test sample, better reflectance estimation accuracy can be obtained. With respect to spectral characterization for scanner, an adaptive method¹ was proposed to search the neighboring samples for a candidate sample in terms of Euclidean distance in the reflectance space after estimating the primary reflectance of the candidate sample based on all the training samples. For the spectral estimation based on multispectral imaging, a metric of spectral similarity² was developed to select the neighboring sample for a candidate sample. As a result, the shapes of the neighboring training samples were found to be similar to that of the candidate sample. Zhang *et al.*³ proposed to reconstruct reflectance from CIE XYZ tristimulus values by dividing spectral space and extending the principal components via principal component analysis. The spectral space was divided into 11 subspaces according to different hues. The shapes of the reflectances in the same subspace were also very similar. Since the reflectance shapes of adaptive training samples are similar with that of the test sample, the correlation coefficient, as a similarity metric, was adopted in this study to select the adaptive samples according to the multichannel responses.

2. METHODS

2.1. Spectral estimation algorithm

Two spectral estimation algorithms were adopted to test the proposed adaptive spectral estimation method. One is the commonly used pseudo inverse algorithm⁴, and another is the Wiener algorithm⁵.

Let $\mathbf{p}_i$ be a sensor response vector that is obtained by the image acquisition of a known spectral reflectance $\mathbf{r}_i$ of the i th sample, where i represents the sample number. Let $\mathbf{P}$ be an $M \times k$ matrix that contains the sensor responses $\mathbf{p}_1, \mathbf{p}_2, \dots, \mathbf{p}_k$, and let $\mathbf{R}$ be an $N \times k$ matrix that contains the corresponding spectral reflectances $\mathbf{r}_1, \mathbf{r}_2, \dots, \mathbf{r}_k$, where k is the number of training samples. The pseudo inverse model is to find an $N \times M$ matrix $\mathbf{W}$ that minimizes $\|\mathbf{R} - \mathbf{W}\mathbf{P}\|^2$, where the notation $\|\cdot\|$ represents the Frobenius norm. The matrix $\mathbf{W}$ is given by

$$\mathbf{W} = \mathbf{R}\mathbf{P}^+, \quad (1)$$

where $\mathbf{P}^+$ represents the pseudo inverse matrix of the matrix $\mathbf{P}$. By applying a matrix $\mathbf{W}$ to a sensor response vector, i.e., $\hat{\mathbf{r}} = \mathbf{W}\mathbf{p}$, a spectral reflectance $\hat{\mathbf{r}}$ is estimated. This spectral estimation algorithm is denoted as PI (pseudo inverse) algorithm below for brevity.

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If the spectral characteristics of a set of sensors $\mathbf{S}$, an illumination $\mathbf{L}$, and the reflectances of samples are known, the matrix $\mathbf{W}$ that minimizes the mean square error $E\{\|\mathbf{R}-\mathbf{W}\mathbf{P}\|^2\}$ is derived as

$$\mathbf{W} = \mathbf{R}_{ss} \mathbf{S}_L^T (\mathbf{S}_L \mathbf{R}_{ss} \mathbf{S}_L^T + \sigma_e^2 \mathbf{I})^{-1}, \quad (2)$$

where $E\{\cdot\}$ and T represent the expectation and the transpose of a matrix, respectively, $\mathbf{R}_{ss}$ is an autocorrelation matrix of the spectral reflectances of training samples, $\mathbf{S}_L$ represents $\mathbf{S} \mathbf{L}$, σ_e^2 is a noise variance used for the estimation, and $\mathbf{I}$ is the identity matrix. The noises are assumed to be uncorrelated random variables and zero mean. This kind of spectral estimation algorithm is referred to as the Wiener algorithm.

2.2. Adaptive spectral estimation

The straightforward way for estimation of the matrix $\mathbf{W}$ is to use the statistics of a large number of training samples. However, the statistics is inconsistent for individual training sample. In order to calculate the transform matrix $\mathbf{W}$ that is close to the statistics of the test sample, the neighboring training samples for the test sample are adaptively selected as follows.

1) For a test sample with known response $\mathbf{p}_i$, calculate the correlation coefficient with each training sample in the response vector space according to

$$c_{ij} = \frac{(\mathbf{p}_i - \bar{\mathbf{p}}_i)^T (\mathbf{p}_j - \bar{\mathbf{p}}_j)}{\|\mathbf{p}_i - \bar{\mathbf{p}}_i\| \cdot \|\mathbf{p}_j - \bar{\mathbf{p}}_j\|}, \quad (3)$$

where $\mathbf{p}_j$ is the j th sample within the training samples, $\bar{\mathbf{p}}_i$ and $\bar{\mathbf{p}}_j$ are the mean values of the response vectors $\mathbf{p}_i$ and $\mathbf{p}_j$, respectively, and c_{ij} is the correlation coefficient between the i th test sample and the j th training sample.

2) Search L training samples that have largest correlation coefficients with the test sample. Then estimate the adaptive transform matrix $\mathbf{W}_i$ using these selected L neighboring training samples and calculate the final reflectance $\hat{\mathbf{r}}_i$ from the test sample $\mathbf{p}_i$.

3. EXPERIMENTS AND RESULTS

A typical multispectral imaging system was employed, equipped with a set of filters mounted in a filter wheel between a lens and a monochromatic CCD sensor. Sixteen interference filters with nominal 20 nm full-width at half-maximum (FWHM) at the peak transmittance wavelengths from 400 nm to 700 nm individually were adopted. A total of 168 color patches in the GretagMacbeth ColorChecker DC chart were used to test the proposed method, excluding the duplicated black, gray and white ones at the edge and centre and 8 glossy ones. The odd patches were selected as the training samples, while the even ones were chosen as the test samples. Thus, the amounts of training and test samples are both 84. In order to investigate the impact of different numbers of adaptive training samples upon the spectral estimation accuracy, 10 to 80 adaptive training samples were individually selected with an interval of 10 for each test sample. In addition, the adaptive spectral estimation was tested with 3 to 16 filters, respectively. Each group of filters was selected as evenly as possible across the visible spectrum.

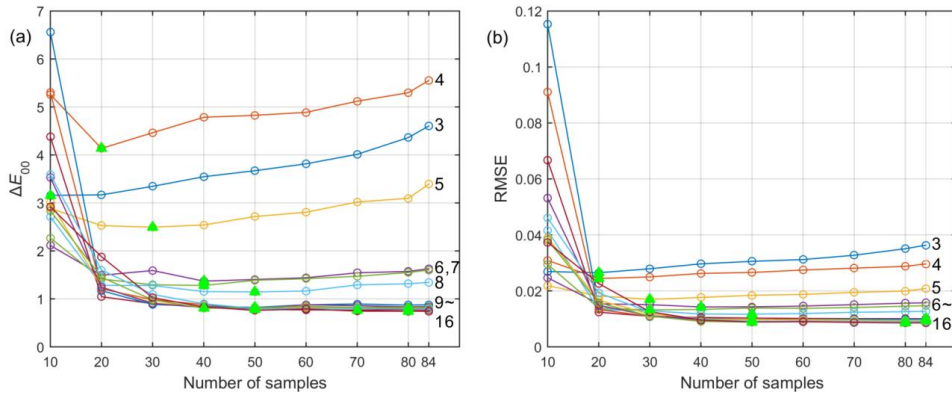


Figure 1. Colorimetric errors (a) and spectral errors (b) of PI algorithm versus different numbers of adaptive training samples.

Figure 1 illustrates the spectral estimation errors of PI algorithm in terms of mean ΔE_{00} and RMSE^6 , respectively, of all the test samples. The colorimetric errors ΔE_{00} were computed using CIE 1931

colorimetric observer and CIE standard illuminant D65. In Figure 1, each folding line represents the estimation errors for one group of filters as marked by the number at the right end of the line. The green triangle in each folding line denotes the optimal number of training samples for reaching the best estimation accuracy under that group of filters. As can be seen, the estimation accuracy is improved when the adaptive training samples are used especially for small number of filters (usually less than 6). However, the optimal numbers of training samples for different groups of filters are not the same. Fewer filters usually need fewer optimal numbers of training samples, and vice versa. In addition, the optimal numbers of training samples in terms of ΔE_{00} and RMSE for the same number of filters are also discrepant.

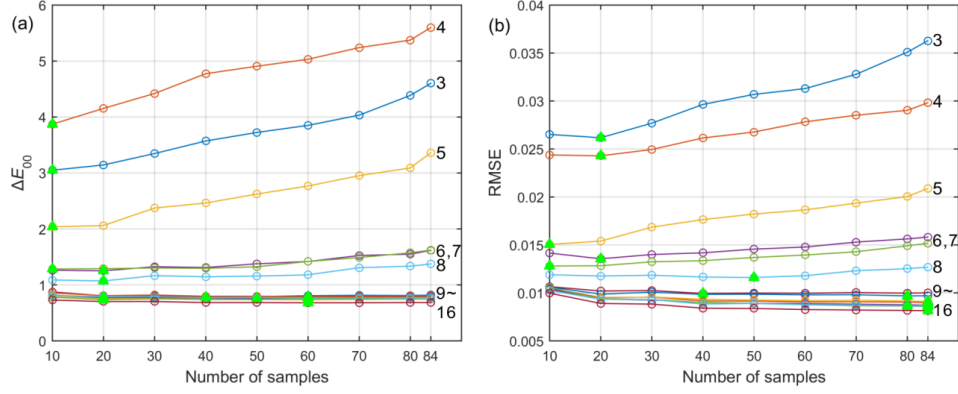


Figure 2. Colorimetric errors (a) and spectral errors (b) of Wiener algorithm versus different numbers of adaptive training samples.

The similar behavior for Wiener algorithm can be found from Figure 2. Nevertheless, the optimal numbers of training samples are not all the same with PI algorithm for each group of filters. Table 1 lists the minimum estimation errors and the corresponding optimal numbers of training samples for the two spectral estimation algorithms. In Table 1, ‘A’ represents the best accuracy obtained with the optimal number of training samples, while ‘I’ denotes the magnitude of accuracy improvement from the accuracy using all the training samples to that utilizing optimal number of training samples. It can be seen that the adaptive spectral estimation is more effective when fewer filters are adopted. However, the adaptive effect is not obvious when more than 8 filters are used. With respect to different numbers of filters, the Wiener algorithm almost always has better estimation accuracy than PI algorithm due to its consideration of the noise presented in the imaging system. Moreover, fewer than 50 adaptive training samples seem to be sufficient for both algorithms when not more than 8 filters are used. For Wiener algorithm, 10 adaptive training samples may be reasonable for the colorimetric estimation of reflectance when less than 8 filters are adopted.

Table 1. The best spectral estimation accuracy and the corresponding number of adaptive training samples with respect to different numbers of filters.

NOF ^a	Pseudo inverse algorithm						Wiener algorithm					
	ΔE_{00}		NOS ^b	RMSE		NOS	ΔE_{00}		NOS	RMSE		NOS
	A ^c	I ^d		A	I		A	I		A	I	
3	3.16	1.45	10	0.0265	0.0099	20	3.05	1.55	10	0.0262	0.0101	20
4	4.14	1.42	20	0.0244	0.0052	20	3.87	1.73	10	0.0243	0.0055	20
5	2.49	0.90	30	0.0170	0.0039	30	2.04	1.33	10	0.0151	0.0058	10
6	1.37	0.26	40	0.0143	0.0015	40	1.25	0.36	20	0.0136	0.0023	20
7	1.28	0.32	40	0.0132	0.0015	30	1.28	0.34	10	0.0128	0.0024	10
8	1.15	0.20	50	0.0117	0.0010	50	1.07	0.30	20	0.0116	0.0011	50
9	0.77	0.00	70	0.0101	0.0000	84	0.78	0.01	40	0.0099	0.0001	40
10	0.82	0.05	50	0.0097	0.0002	50	0.78	0.04	20	0.0097	0.0000	80
11	0.80	0.00	80	0.0089	0.0000	80	0.79	0.01	60	0.0090	0.0000	84
12	0.77	0.01	50	0.0093	0.0000	84	0.73	0.01	60	0.0091	0.0000	84
13	0.80	0.04	50	0.0086	0.0000	80	0.76	0.02	50	0.0087	0.0000	84
14	0.80	0.02	40	0.0089	0.0001	50	0.74	0.01	20	0.0086	0.0000	84
15	0.79	0.00	80	0.0090	0.0000	80	0.77	0.00	60	0.0086	0.0000	80
16	0.74	0.00	80	0.0086	0.0000	80	0.68	0.01	60	0.0082	0.0000	84

Note: ^a number of filters, ^b number of training samples, ^c adaptive accuracy, ^d accuracy improvement.

4. CONCLUSIONS

The spectral estimation based on adaptive training samples was proposed in this study. The adaptive training samples were selected by calculating the correlation coefficient between the multichannel response vectors of test sample and each training sample. The results indicate that the spectral estimation based on adaptive training samples is more effective when fewer filters are used. The optimal numbers of adaptive training samples are not the same with respect to different numbers of filters. Aiming for color difference or RMSE of the spectral reflectance, the optimal numbers of adaptive training samples are also different even if the same number of filters is used. In addition, the spectral estimation algorithm has influence on the optimal number of adaptive training samples. For Wiener algorithm 10 adaptive training samples may be reasonable for colorimetric estimation of reflectance when fewer than 8 filters are adopted, while 50 adaptive training samples at most seem to be sufficient for both algorithms when not more than 8 filters are used.

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The characteristics of connection between memory colors and reproduced colors of women's preferred products in their 20s

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ABSTRACT

The purpose of this study is to understand the characteristics of connection between preferred products' memory colors and reproduced colors for investigation how preference product's color is recognized. The two trials of experiments were conducted. For both experiments, the subjects comprised 30 twenties female students majoring in design. In order to analyze the characteristics of how they recognize Preference product's color. The results of this study are as follows: First, 46.7% of twenties women chose red(R) as preferred products' colors, 26.7% to blue(B), 20% to yellow(Y), and 6.7% to green(G). Second, the memory colors were remembered more closely with 4 basic colors of NCS than reproduced colors by 14 women(46.7%; 16.7% to red, 16.7% to yellow, 10% to blue, 3.3% to green). 10 women(30.3%) remembered the same color as memory color and reproduced color. Third, we compared the color and nuance of red and blue that subjects preferred. The difference of nuance for red and blue was larger than color difference. Furthermore, we measured color error(ΔE) between memory colors and reproduced colors for all subjects. The whole average of color error was 18.38, in contrast with red(16.79) and blue(7.78), signifying that twenties women tend to more clearly perceive memory color and reproduced color for red and blue.

Keywords: Color Error, Memory Color, Preferred Color, Reproduced Color

1. INTRODUCTION

Advances in production technologies and materials have enabled the expression of sundry colors, which in turn has made colors a critical aspect in design planning. Individual colors, as a visual sense encompassing physical perceptual activity and psychological response, impart different feelings; in fact, colors determine product sales, personality, and taste of food (Faber Birren, 1950). For the production of products desired by consumers and efficient marketing, it is essential to identify colors that are favored by many people. To this end, we must understand the process of how people remember colors.

Researchers have proposed differing ideas with regard to the factors that affect color preference. The study by Albert Wesley Frey & Faber Birren is one of the most popular in the field; this study divided the factors that affect color preference into demographic aspect (gender, age), psychological aspect, lifestyle aspect (refinement or sophistication), and environmental aspects (region, culture). However, color preference is determined by a complex interaction among several factors, not by the sole effect of one factors such as environment or personal experience. Recently, societal changes, such as advances in scientific technology, expansion of civilization, and collapse of gender-specific traits, have further diversified the factors that play a role in color preference.

Individual color preference is easily changed, and the factors that affect such change have been diversified. Frequent intercontinental and international movements have undermined the cultural effects on color preference. In addition, factors such as fashion in trend and hipster products also affect an individual's color preference.

Memory color is a psychology-based perception and is intimately related to other phenomena in color psychology. Psychologist Richard L. Gregory explained that memory of a color is a subjective perceptual effect and is a process of active—as opposed to passive—reception of a simple sensory stimulus with the

combination of external and internal content. Therefore, memory color, which refers to the color that comes to mind in connection with an object, occurs as a result of color association and symbolization, and is manifested in vastly different ways in accordance with region, age, social status, and preference. “Memory” occurs simultaneously with the construct of “preference,” thus must always be considered in combination. Hence, it is important to understand preferred colors and the properties of memory of preferred colors in order to efficiently utilize colors during designing and undertake effective marketing.

For these reasons, the objective of the present study is to analyze the color error—the difference between color reproduced on memory (memory color) and that reproduced while looking at the physical object (reproduced color)—and to identify the connection between memory color and reproduced color.

2. Research Method

We conducted two trials of experiments to identify the connection between memory color and reproduced color. The experiments were conducted on 30 female students in their twenties majoring in design in Korea from November to December in 2015. In the first experiment, we instructed the subjects to select their preferred daily product and to express the color using water colors to examine how they perceive their preferred color. The subjects were instructed to reproduce the color only relying on their memory, without physically looking at the object. The second experiment was conducted one week later at the same time and place, but the subjects were instructed to bring the object and reproduce the color while looking at the object.

The results were analyzed using the Natural Color System (NCS), and the preferred colors were categorized into YRGB, the basic colors of NCS. We measured the NCS color and Lab color space of the color samples (experimental outcome) using the NCS color scan 2.0 and confirmed the color errors.

3. Results

When the preferred colors of the 30 subjects were categorized into YRGB, 14 selected red (R) (46.7%), followed by 8 blue (B) (26.7%), 6 yellow (Y) (20%), and 2 green (G) (6.7%). Table 1 shows the memory colors and reproduced colors of the subjects’ preferred objects.

Table 1. Memory colors and Reproduced color’s NCS code and Color sample

No.	Memory Colors		Reproduced Colors		No	Memory colors		Reproduced Colors	
1	1060-Y10R		1080-Y20R		16	0540-R30B		0530-R30B	
2	7010-G70Y		8005-G80Y		17	1070-Y90R		1070-Y90R	
3	1070 Y		0580 Y		18	1070 R		1060 R	
4	2040-Y20R		2030-Y30R		19	3050-R10B		3050-R10B	
5	2070 Y		2060-Y10R		20	2055-B10G		4040-R90B	
6	0530-G80Y		0515-G40Y		21	6030 B30G		5540 B30G	
7	2070 R		2070-R		22	5040-R80B		5030-R70B	
8	7005-Y80R		7010-Y90R		23	0540 B		0540 B	
9	4050-Y80R		5030-180R		24	1050-R90B		0540-R90B	
10	8005-Y50R		5030-Y60R		25	2055-B10G		3040-R90B	
11	3050-Y80R		1080-Y90R		26	1555-B10G		2055-B10G	
12	3560-Y90R		1080 R		27	8005-R50B		8005-R80B	
13	1050-R20B		0540-R20B		28	4050-R80B		5040-R80B	
14	1050-R30B		1050-R40B		29	1060-G10Y		0550-G80Y	
15	3050 R		5030-Y90R		30	0590-B90G		1040-B90G	

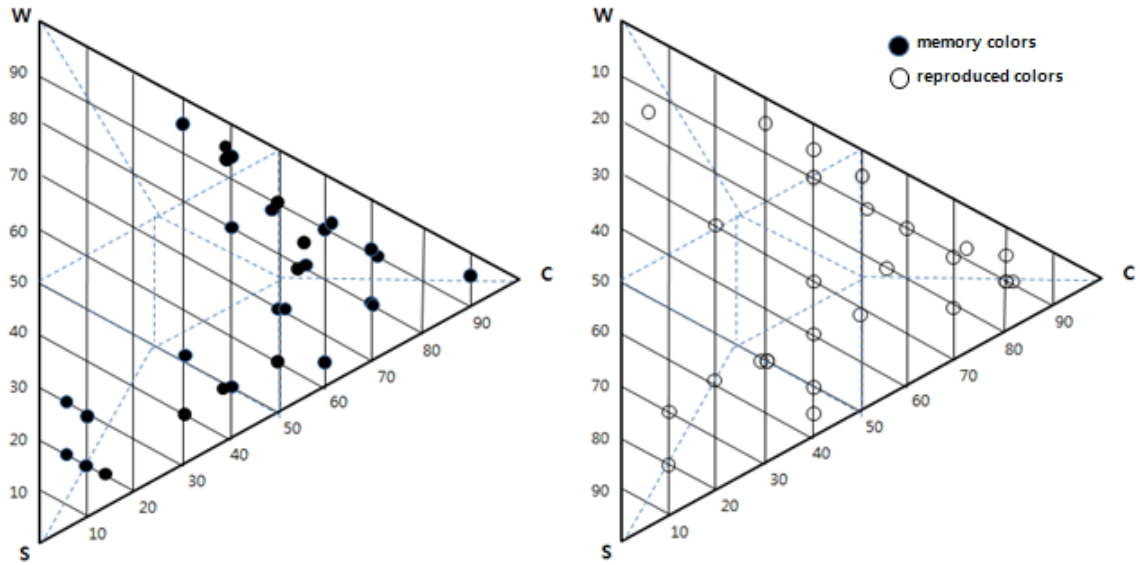


Figure 1. Memory colors and reproduced colors' distribution of nuance

The nuance analysis of the color sample is shown in Figure 1. For memory colors, the most preferred nuance was Brilliant (10, 33.3%), followed by 6 Deep chromatic (20%), and 4 Light Clear (13.3%); for reproduced colors, there were 7 Brilliant (23.3%), followed by 4 Deep (13.3%), and 4 Deep chromatic (13.3%). In other words, when the experimental subjects remember their preferred colors, they remembered a brighter and clearer nuance of the color than when they actually perceived the color physically.

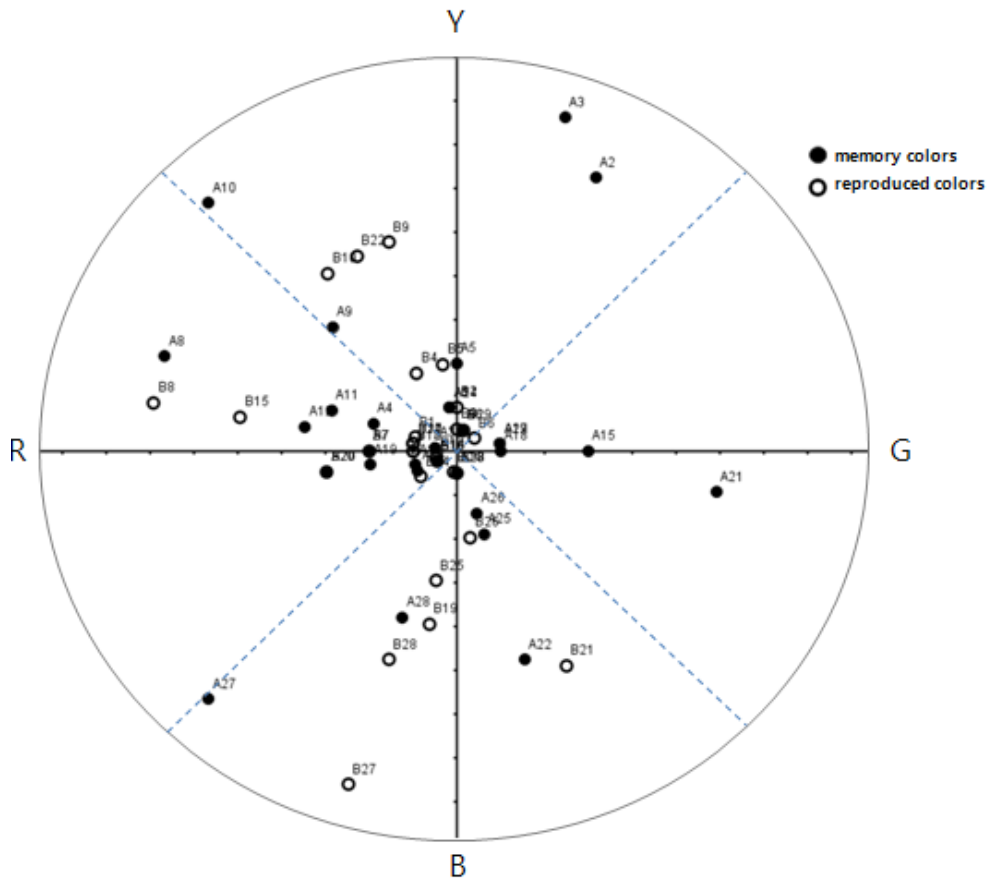


Figure 2. Memory colors and reproduced colors' distribution of color and blackness

Furthermore, 14 subjects (46.7%) remembered their colors in shades closer to the YRGB primary colors, and 10 subjects (20%) remembered different nuances of the same color; in addition, 6 subjects (20%) remembered colors that are more distant from the four primary colors. Figure 2 shows the reproduced and actual colors and distribution of blackness.

When we compared the colors and tones of the memory and reproduced colors based on the above results, there was a greater difference of nuance than that of the color. This is presumed to be due to the fact that people are able to perceive their preferred colors more detailedly, just as the ability to distinguish preferred colors and range of distinguishable colors are varied depending on the perceiver's country background and natural environment. The color errors between memory color and reproduced color was 17.51 for yellow, 31.45 for green, 16.79 for red, and 7.78 for blue with an overall average of 18.38. As shown in the errors, red and blue, which were more frequently preferred, had lower errors, meaning that the participants were able to accurately remember the colors. In particular, the color most accurately remembered was blue.

4. Conclusion

The present study conducted two experiments on Korean female design major students in their twenties to identify the connection between memory color and reproduced color. To this end, we identified the colors of objects that the subjects and compared and analyzed the colors in their memory and the colors perceived when physically looking at the object.

The following is a summary of the experimental results. First, red (R) was the most preferred color among the subjects (46.7%), followed by blue (B) (6.7%), yellow (Y) (20%), and green (G) (6.7%). Second, the 14 of the 30 (46.7%) subjects remembered their colors as more similar to the primary colors of red, blue, yellow, and green: 5 subjects from red, 5 subjects from yellow, 3 subjects from blue, and 1 subject from green. In ten subjects (30.3%), the memory color and reproduced color were identical, and in 6 subjects (20%), the reproduced color was closer to the primary colors than the memory color was. Third, the nuance analysis of the color samples showed that Brilliant was the highest in memory colors (10, 33.3%) while 7 of the reproduced colors were in the Brilliant nuance (23.3%), signifying that the subjects remembered their colors in a brighter and clearer nuance. Furthermore, we compared the colors and tones of the memory and reproduced colors and found that there was a greater difference in nuance than in colors. This is presumed to be due to the fact that people are able to perceive their preferred colors in more detail. Finally, the average color error (ΔE) was 18.38, with highly preferred red and blue having errors below the average (7.78 and 16.79, respectively); in particular, blue was relatively accurately remembered. These results of this study will be able to use as preliminary data to be utilized in design or analysis of memory and reproduced colors. It will be needed to study on the characteristics of connection between memory colors and reproduced colors, such as age, sex or nationality.

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Investigation of impacting factors on camera calibration for spectral sensitivity estimation

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ABSTRACT

The acquisition of camera spectral sensitivity has become a hot issue in recent years because of its fundamental role in image processing and color reproduction. Although the estimation method based on camera response formation model has many advantages, the implementation procedures for spectral characterization are still tedious and time-consuming. In order for the improvement of calibration efficiency, it was investigated in this study that how the changes of the training samples selection would influence the estimation results and how many color samples at least should be included to achieve a high-fidelity color reproduction. The choice of the illuminants was also discussed to test whether the accuracy of the estimated spectra would degrade at the wavelength ranges with relatively low SPD of illuminant. Differing from the previous methods using relative errors in camera RGB space as cost function, we combine the colorimetric characterization with the spectral sensitivity estimation so as to minimize the estimation errors in device-independent color space like CIE XYZ. The detailed comparisons indicate that this modification could produce better perceived performance.

Keywords: Spectral sensitivity estimation, camera calibration, sample selection, impacting factor

1. INTRODUCTION

Determining the relation between camera output responses and the corresponding scene's radiometric quantities is important for photographic calibration and photometric measurements. The camera response is mainly determined by the spectral radiance of the scene being imaged and the spectral sensitivity of the sensor. As the spectral sensitivity of the camera plays a significant role in images formation, considerable attention has been paid to its capturing, which is also known as the spectral characterization.

The traditional method to acquire the spectral sensitivity of an imaging device is to use monochromator to generate near-monochromatic lights in sequence spanning the visible range and simultaneously record the responses of the camera¹. Besides the monochromator method, some researchers focus on estimating camera spectral sensitivity by using imaging models and camera responses. The prevailing methods for estimating camera spectral sensitivity can be grouped into two categories, i.e., the algebraic method specified with constrains (denoted as AC hereafter) and the basis function method (denoted as BF hereafter). The AC method generally uses Moore–Penrose pseudoinverse to find the solution minimizing the cost function, being subject to some constrains of, for example, positivity, Tikhonov Regularization², Wiener filter³, and first/second order derivatives⁴, in order to satisfy some conditions like nonnegativity, smoothness, unimodality, and band-limitedness. The BF method represents the camera spectral sensitivity curves with a linear combination of some basis functions, and the methods of this category vary depending on the choice of the basis functions.

To obtain more generalized results, the AC method was selected in this study to acquire the camera spectral sensitivity. To our knowledge, the discussions about spectral characterization have been limited to minimizing the algebraically relative errors, rather than the visual perceived errors, between the actual camera responses and the predicted ones reconstructed from the estimated camera spectral sensitivity. For most applications in photography and photometry, since the responses in device-dependent space would have to be transformed to device-independent color space, the minimization of the mean CIEDE2000 (ΔE_{00}) color difference between the actual and the predicted camera responses was set as the cost function.

2. METHODS

2.1 Response Model

A Nikon D3x DSLR camera was employed in the experiments, mounted with a Nikkor AF-S 24-120 f/4 ED VR zoom lens. The lens was set to the focal length of 24mm and f-number of 4 throughout this study.

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Whenever the camera responses are mentioned in this article, it refers to the triplet RGB values reordered from a quaternion in the sensor, to be specific, RRGB Bayer pattern in D3x. The response of the green channel in a triplet is the average of two green pixels in a quaternion.

The camera responses formation model is constructed in the form as follows:

$$\hat{\mathbf{p}} = \left[g \cdot f \cdot \Delta\lambda \cdot \mathbf{C} \cdot \mathbf{S}^T \cdot \mathbf{l} + c_1 \right]^\beta + c_2 \quad (1)$$

where $g = (\pi \cos^4 \alpha / 4F^2)$ is a geometric constant only depending on the position of the pixels or regions $\mathbf{x}$ on the sensor to be investigated, f is the function of exposure time T and ISO sensitivity and can be simply expressed as $f = T \cdot (\text{ISOvalue}/100)$ here, $\mathbf{l}$ is a vector representing the spectral radiance on the location $\mathbf{X}$ in 3D space. $\mathbf{x}$ and $\mathbf{X}$ are related by the general projective camera model [5], $\Delta\lambda$ is the wavelength interval in accordance with the sampling interval of $I(\lambda)$. The camera spectral sensitivity $\mathbf{S} = [\mathbf{S}^R, \mathbf{S}^G, \mathbf{S}^B]$ is the element-wise product of the spectral transmissions and quantum efficiency, i.e., $\mathbf{S}^{(k)} = \mathbf{T}_o \mathbf{T}_c^{(k)} \mathbf{S}_Q$, where $T_o(\lambda)$ is the transmission of optical system including lens, low-pass filter, IR filters, etc., $T_c^{(k)}(\lambda)$ is the transmission of the color filter on $k=R,G,B$ channel. The quantum efficiency $S_Q(\lambda)$, in $\text{m}^2 \cdot \text{w}^{-1} \cdot \text{s}^{-1}$, is informally defined here as the sensitivity of the sensor converting spectral irradiance to the amount of electrons.

The crosstalk matrix $\mathbf{C}$ is added into our model to take account of the crosstalk among the adjacent pixels:

$$\mathbf{C} = \begin{bmatrix} c_{RR} & c_{GR} & 0 \\ c_{RG} & c_{GG} & c_{BG} \\ 0 & c_{GB} & c_{BB} \end{bmatrix} \quad (2)$$

where c_{kk} weights how many photons arriving at the pixel k come from the color filter k over that pixel, and $c_{kk'}$ denotes the crosstalk coefficient from pixel k to k' . Since red pixels and blue pixels are always located diagonally, $c_{RB} = c_{BR} \equiv 0$.

2.2 Optimization Method

The interior-point method is selected as the algorithm to solve the constrained nonlinear optimization problem, as the response formation model, Eq. (1), is a power function and the gradient can be hardly provided during optimization. Similar to other nonlinear optimization algorithms, the interior-point method requires the initial guess to start the minimum search. The initial estimation of camera spectral sensitivity is obtained analogous to Barnard and Funt's work [4], but with the L-curve method to find the suitable regularization parameter [6]. During our optimization, the iteration would be programmatically stopped at the number of function evaluations exceeding 10000 times.

As suggested by Finlayson *et al.* [7], the root polynomial color correction (RPCC) regression is adopted to perform the colorimetric characterization that transforms the camera responses from RGB space into CIE XYZ and then CIELAB color space, so that the ΔE_{00} color difference is evaluated. Therefore, the cost function in this study is defined by

$$F = \frac{\sum_{i=1}^N E_{00}(\mathbf{M}\boldsymbol{\rho}_i, \mathbf{M}\hat{\boldsymbol{\rho}}_i)}{N} + \lambda \max \{E_{00}(\mathbf{M}\boldsymbol{\rho}_i, \mathbf{M}\hat{\boldsymbol{\rho}}_i)\}. \quad (3)$$

where $\boldsymbol{\rho}_i$ and $\hat{\boldsymbol{\rho}}_i$ are the root-polynomial expansions of actual and predicted response of i^{th} sample, respectively. In our experiment, the root-polynomial expansions of 4th degree were used in consideration of the accuracy.

3. RESULTS AND DISCUSSION

3.1 Sample Selection

The X-Rite ColorChecker Digital SG (DSG), illuminated by D65, was selected as the training set to extract the camera responses and their corresponding spectral radiances. From the 140 color patches on DSG color checker, 44 repeated neutral colors around the edge were excluded, thus a total of 96 color samples were adopted as the training and testing colors.

The leave-one-out cross-validation (LOOCV) was used to investigate how the changes of the training samples selection would influence the estimation results and how many color samples at least should be included to achieve a high-fidelity color reproduction. LOOCV selected 95 patches from the totally 96 patches as training samples to obtain the optimized parameters in Eq. (1), then used the remaining one patch as the testing sample to evaluate the performance of the spectral characterization. This process was repeated 96 times by only altering the choice of the testing sample, generating 96 subsets of patches, each of which consisted of 95 training samples. Different subsets of training samples were ranked according to their generalization abilities, i.e., the color difference of the predicted test sample. Poorer prediction result of one testing sample means that this sample varies significantly from others and should be excluded from the estimation of the camera spectral sensitivity to avoid additional noise.

Given the antipant number of samples, k , being enough to achieve good color reproduction, the worst (96- k) samples that produced poorest color difference results were excluded from training phase, then the optimal k samples were utilized to reestimate the parameters in the camera response formation model. Finally, the generalization error was evaluated based on the mean ΔE_{00} color difference of the excluded (96- k) samples as illustrated in Figure 1, along with the standard deviations, as the function of the number k of training samples. It can be fairly deduced that as long as the training samples are appropriately selected, only a few color patches (less than 10) are necessary to obtain a good performance of the spectral characterization. And the spectral radiances of the optimal 24 samples with the highest rank during the LOOCV are plotted in Figure 2.

According to the testing results, the response formation model, with the crosstalk matrix and nonlinearity function added, has been verified to be of good performance to predict camera responses, given the spectral radiance of the target surface. When the initial guess of the camera spectral sensitivity is elaborately provided, a fast convergence can be achieved for the color difference between the actual and the predicted responses. During our optimization, the derivative of the cost function converged at below 1% after approximately 40 iterations.

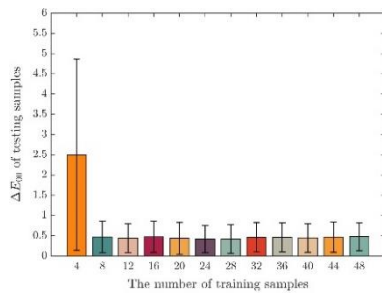


Figure 1. The mean color difference, along with the standard deviation, of the (96- k) testing samples.

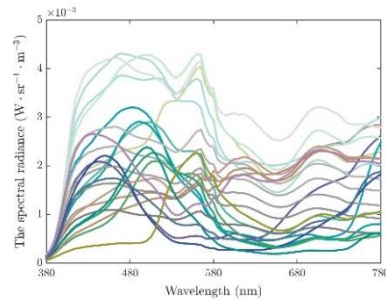


Figure 2. The spectral radiance of the optimal 24 samples obtained from LOOCV.

3.2 Illuminant Selection

To investigate how the spectral radiances of training samples would influence the performance of the spectral characterization, we replaced D65 in the aforementioned experiment with illuminant A and repeated all the captures and measurement processes. As mentioned above, a small amount of training samples could generate a satisfactory result, the X-Rite ColorChecker Classic was adopted for saving the experimental time, from the totally 24 patches of which the color differences of testing samples, as the function of k according to the LOOCV, are shown in Figure 3. Apparently the performance of the spectral characterization using illuminant A is poorer than that using D65. And the estimated camera spectral sensitivity for D3x, using the optimal 16 training samples under D65 are demonstrated in Figure 4.

Considering that the training and testing samples in the previous experiments might be of high correlation due to their being illuminated by the identical illuminant, the cross-validation was carried out through the color samples lit by two different illuminants. Figure 5 illustrates the color differences between the actual and the predicted responses of the 24 color samples under illuminant A, in which the predicted responses were constructed using the estimated camera spectral sensitivity, crosstalk matrix and the nonlinearity parameters obtained from the optimal 12 samples under D65. And the corresponding results by exchanging the training and testing illuminants are shown in Figure 6.

Since an appropriate combination of the spectral radiances of the training samples is the most significant factor that determines the performance of the spectral characterization, the training samples and the illuminant should be carefully selected for the spectral calibration of the camera. As seen from

Figures 5-6, using illuminant A as light source performs poorly in comparison with D65, which is considered to be resulted from the low spectral radiance in the short wavelength region of illuminant A. Although the regularization was utilized to resist noise, the low SNR in the short wavelength region give rise to the fluctuation during iterations of the interior-point method, especially for the blue channel mainly located at the short wavelength side of the visible spectrum.

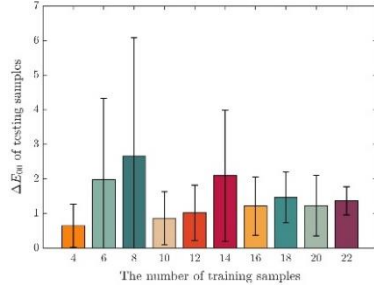


Figure 3. The mean color difference of the (24-k) testing samples.

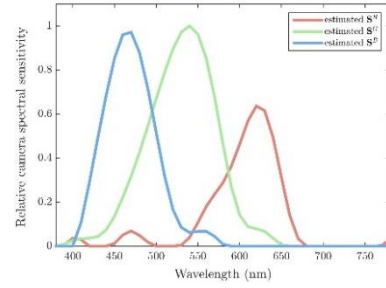


Figure 4. The estimated camera spectral sensitivity using 16 training samples under D65.

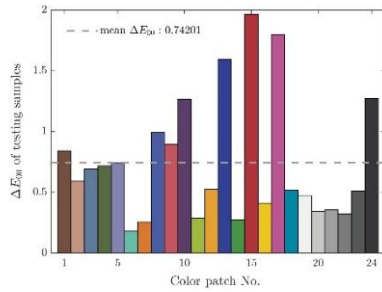


Figure 5. The color difference of the 24 testing samples under illuminant A with the training data obtained under D65.

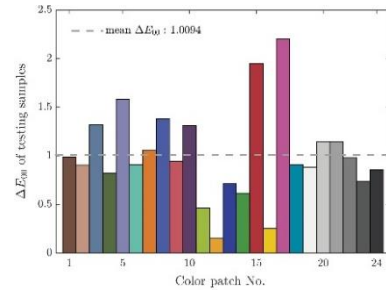


Figure 6. The color difference of the 24 testing samples under D65 with the training data under illuminant A.

4. CONCLUSION

Through the experiments, it has been proven that the procedure of the spectral characterization could be of convenience, i.e., using less than 10 training samples to achieve a high-fidelity color reproduction with the mean ΔE_{00} being below 1.0 for the testing samples. The selections of the training color samples as well as the illuminant are the critical factors for a reliable and accurate camera characterization. The SPD of the illuminant should be as flat as possible over the visible spectrum, so as to reduce perturbations for the calculation of the camera spectral sensitivity. If both the light source and training samples are elaborately selected, the spectral characterization of the digital camera could be carried out in a fairly straightforward way.

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Color area comparison on young and elderly

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ABSTRACT

This research aim to find out the color area of young people compare to color area of elderly by simulating the cataract vision of elderly with the cataract experiencing goggles. It also aim at finding the effective color area of elderly that needed for assigning color in communication design. This psychophysical experiment utilize categorical methods. 200 solid color in variety of colors across the spectrum were prepared as color chips in the size of 1"x1". Subjects were asked to assign all color chips into 4 color groups of Red, Green, Yellow and Blue. Experiment were done in 2 rounds, first without goggles and repeat with goggles wearing on. 40 subjects in the age of 25-40 years old, conducted 1 repetition of naked eyes and goggles vision. Color chips were spectrophotometrically measured and each color coordinate of color chips were plotted on graph. We found that the color area of elderly is shrinked compared to color area of young subjects. The color area efficiency and difference between normal eyes and eyes with goggles were in different degree for each opponent colors. We concluded that it is necessary for assigning color in communication signs that has enough color contrast to suit the clear color vision for elderly.

Keywords: Color area, Basic color, Elderly vision, Cataract, Cataract Experiencing Goggles

1. INTRODUCTION

Elderlies' vision deteriorates by cataract when they are aged. The ageing physical change affect the quality of life, especially the visual performance. Proper color area in design provide effective color discrimination and preserve color communication efficiency for elderly with cataract.

The elderly population in Thailand is increasing, and Thailand is emerging the elderly society. 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 color area comparison between young and elderly. The finding may lead to the guideline for graphic designer in concerning effective color area needed by elderly in color communication design. The use of Cataract Experiencing Goggles allow us to experiment the elderly vision by simulating their cataract vision, without the need to do hard experiment with the real elderly. The Cataract Experiencing Goggles is goggles compose of 3 functional filters: scattering filter, color filter, and neutral density filter, which represent the cataract of elderly at the stage of feeling inconvenient in life.

2. METHODOGY

The psychophysical experimental method was used for this study. Twenty young subjects aged between 25-45 years old with normal color vision were recruited for this experiment. Cataract Experiencing Goggles were used for simulating elderly cataract vision. Subject experiment 2 rounds: one round with normal eyes and another round with goggles.

2.1. Apparatus

Color stimuli for the experiment were prepared to cover color area of the four opponent colors: Red, Green, Yellow, and Blue. These consist of a set of 240 color chips of solid color from process color chart. The color chips were coated with clear resin and mounted on stiff cardboard. Each color chips were spectrophotometrically measured for color value, and put numbering on the back of each chip, as seen in figure 1.

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Figure 1. Color chips for color area analyze were solid colors with coding of each chips.

2.2 Procedure

The 240 color chips were laid on table under daylight illumination of 300-400 lx. Subjects were asked to divide the color chips into four color groups: Red, Green, Yellow, or Blue. The grouped color chips were recorded by chip number, Subject experiment 2 rounds: one round with normal eyes and another round with goggles. For the goggles vision, subjects took 3 minutes to adapt their eyes to the new viewing environment.



Figure 2. Subject analyzed color chips for color area under daylight illumination, with and without cataract experiencing goggles wearing on.

3. RESULT

Each color chips were spectrophotometrically measured for XYZ color value. The $u'v'$ uniform color space is used for analyzing the color area. To get the u' and v' value, XYZ color value were calculated with the following formulation:

$$u' = \frac{4X}{X + 15Y + 3Z}$$

$$v' = \frac{9Y}{X + 15Y + 3Z}$$

Graphs of color area with and without goggles were compared in $u'v'$ color model. The graphs below show difference of normal eyes and eyes with goggles, in 4 opponent colors: Red, Green, Yellow, and Blue.

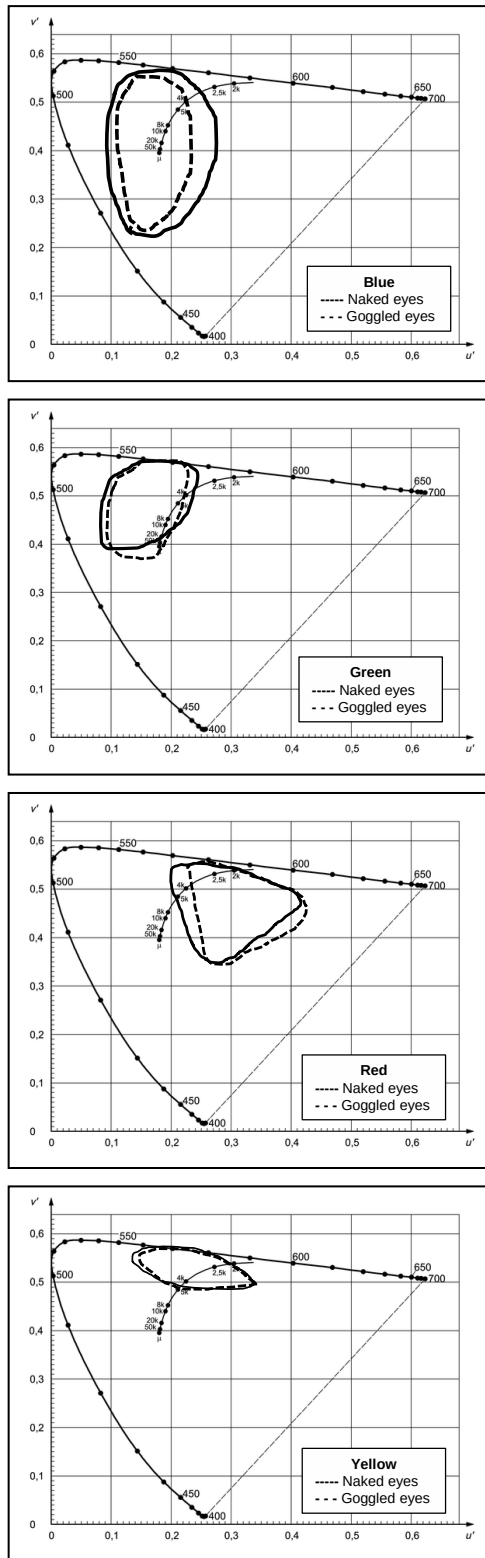


Figure 3. The color area of naked eyes and eyes with goggles compared for Blue, Green, Red, and Yellow, plotted on $u'v'$ graph.

4. DISCUSSION AND CONCLUSION

The color area of elderly shrank compared to color area of young subjects. The color area efficiency and difference between normal eyes and eyes with goggles were in different degree for each opponent colors. For Blue and Green, the color area shrink is stronger than that of Red and Yellow. We concluded that it is necessary for assigning color in communication signs that has

enough color contrast to suit the clear color vision for elderly. To ease the color discrimination for elderly, Red and Yellow colors are preferred to use for clear discrimination.

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Investigation of facial healthiness and attractiveness for Chinese using a facial image database

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ABSTRACT

Colour appearances of 60 Chinese subjects were reproduced on display using colour reproduction technology. Their image characteristics including facial colour, contrast between feature and surrounding skin, and skin heterogeneity were achieved for each facial image. Using categorical judgment technique, perceived healthiness and attractiveness were assessed in psychophysical experiment by 20 Chinese subjects. Effect of image characteristics to either healthiness or attractiveness was investigated. Results showed that facial attractiveness is highly corrected to facial healthiness. Skin heterogeneity affects both facial attractiveness and healthiness significantly.

Keywords: Facial healthiness, facial attractiveness, skin colour, skin heterogeneity

1. INTRODUCTION

Face is identity; a healthy and attractive facial appearance is always highly desired. Interest in the relationship between perceived psychological scale of healthiness or attractiveness and the optical properties of human faces has been greatly stimulated by the increased prevalence of cosmetic surgery and also by applications in graphic art and computer vision [1].

Previous studies have found that for Caucasian women, facial contrast is a cue for age perception [2]. Facial healthiness can be affected by skin colour which varies with the amount of oxygen hemoglobin [3]. On the other hand, perceived facial attractiveness can also be highly affected by factors of culture and environment. A typical example is that Chinese females prefer to looks white whereas Caucasian females generally dislike this look.

The aim of this study is to investigate factors that affect facial healthiness and attractiveness for Chinese subjects. Facial healthiness and attractiveness were assessed for 60 Chinese subjects, respectively. Appearance of their faces were reproduced on a display. A psychophysical experiment was conducted to assess either healthiness or attractiveness using a categorical judgment technique. The relationship between perceived healthiness and attractiveness was investigated for those 60 subjects. Subsequently, image characteristics, including skin colour, facial contrast and skin heterogeneity, and how they could affect facial healthiness and facial attractiveness were analyzed.

2. METHODOLOGY

2.1 Liverpool-Leeds facial image database

A facial image database was collected in University of Liverpool in collaboration with University of Leeds [4]. Facial images of subjects were captured under controlled viewing conditions using a SLR camera with colour characterisation processing. To achieve uniform lighting, a VeriVide DigiEye® light booth was used, the inside of which was painted with a mid-grey matte colour and illuminated by a D65 fluorescent simulator offering evenly diffused illumination. During the data collection, the participant sat

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on an adjustable chair in the viewing cabinet and adjusted their position until their target facial area was within the camera lens. The camera, a Nikon D7000 digital SLR camera controlled by the DigiEye system software, was used to capture images with fixed exposure, white balance and ISO settings. The image capture distance between camera lens and training colour charts (or the subject's face) was fixed to 57.5cm and the capture angle was 0 degrees. Subsequently, skin colour of each subject was measured using a Konica Minolta CM 700d spectrophotometer. Overall, facial images of 188 subjects, including 86 Orientals (41 females and 45 males), 79 Caucasians (65 females and 14 males), 13 South Asians (6 females and 7 males) and 10 Africans (5 females and 5 males) were collected.

2.2 Image Processing

In this study, 60 facial images were selected to represent Chinese faces with neutral facial impression. From the database, each image RGB was transformed to CIELAB uniform colour space [5] via a camera characterisation process. To truly reproduce colour appearance of those facial images, an Eizo CG277 colour professional display was used and the white point was set to D65 (which is same as the illumination for facial image capturing). Colour characterisation was conducted for the display using the method of piecewise linear interpolation assuming constant chromaticity coordinate (PLCC) [6] and the CIELAB values for each image pixel were transformed to display RGB for each facial image. Subsequently, each facial image was edited to remove hair, ears and clothes and scaled to fit the center part of screen. Finally, the image background was set to middle grey ($L^*=50$, $a^*=0$ and $b^*=0$ in CIELAB colour space).

2.3 Image characteristics

For each facial image, skin colour in terms of lightness, redness and yellowness were represented by the grand mean of L^* , a^* and b^* for each pixel of facial area in CIELAB uniform colour space.

To represent facial contrast, lightness (L^*), chroma (C^*) and hue (h_{ab}) of each feature (mouth, eye and eyebrow) and surrounding skin were calculated. For each colour attribute, contrast for each feature was obtained using Equation 1. Overall contrast was calculated by averaging contrast for three features [2]. Thus

$$C_{feature} = \frac{A_{Skin} - A_{feature}}{A_{Skin} + A_{feature}} \quad (1)$$

where C represents contrast and A represents one of the colour attributes in CIELAB uniform colour space.

For skin heterogeneity, four parts (forehead, cheek, nose and chin) of each image were selected. Their MCDM (the mean colour difference to the mean value) was calculated in CIELAB uniform colour space. To achieve MCDM, firstly, the mean of the selected part was calculated in CIELAB colour space. Then, the mean of the colour differences between each pixel in the selected part and the mean of the selected part was calculated for each part. Finally, grand mean was calculated to represent MCDM for four parts. Note that the unit of MCDM is CIELAB colour difference and smaller MCDM represents a better performance in terms of skin heterogeneity.

2.4 Psychophysical experiment

A psychophysical experiment was conducted to assess perceived healthiness or attractiveness by 20 Chinese subjects using the categorical judgment technique. Subjects were asked to view a facial image and then scale (1-7) overall healthiness or attractiveness for the face in the image where 1 represents least healthiness (or attractiveness) and 7 represents best healthiness (or attractiveness). Numbers between one and seven to represent equal intervals of healthiness (or attractiveness) so that the difference between any neighbouring categories be the same. After the experiment, all observer data were averaged and transformed to Z scores using Torgerson's law of categorical judgment [7].

3. RESULTS AND ANALYSIS

3.1 Inter-observer variability

Inter-observer variability indicates the extent to which individual observers agree with the average observer. In this study, 20 observers participated in the experiment and assessed healthiness for 60 facial images. For each facial image, observer variability was measured by Root-Mean-Square difference between each individual observation and mean from all the observers. Subsequently, the overall mean, minima, maximum and standard deviation of observer variability in these 60 images were calculated and results are given in Table 1. Results showed that reliable experimental data were achieved

Table 1. Inter-observer variability for Healthiness and Attractiveness assessment

<i>Inter-observer Variability</i>	<i>Mean</i>	<i>Min</i>	<i>Max</i>	<i>STDEV</i>
Healthiness	1.2	0.8	1.6	0.2
Attractiveness	1.1	0.7	1.5	0.2

3.2 Healthiness and Attractiveness scale

For each facial image, their healthiness scale and attractiveness scale were assessed by 20 Chinese subjects as demonstrated in Figure 1a. To illustrate the relationship between perceived healthiness and attractiveness, Figure 1b was plotted. It can be seen that with increase of healthiness score, attractiveness score increases correspondingly. The correlation coefficient between the two scores is 0.74, indicating perceived healthiness correlates perceived attractiveness well for 60 Chinese subjects.

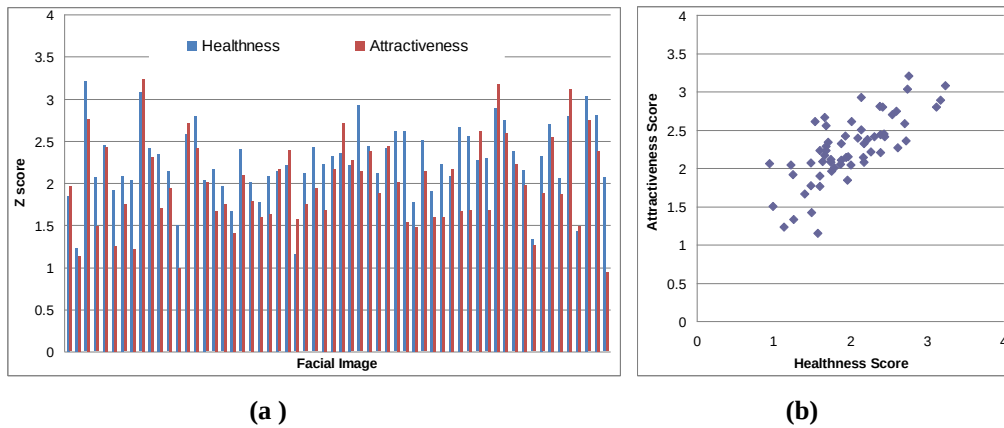


Figure 1 Healthiness and attractiveness score (a) raw data (b) Relationship between Healthiness and attractiveness

3.3 Effect of image characteristics

To investigate how image characteristics (colour, contrast and heterogeneity) affect perceived facial healthiness or attractiveness, image characteristics for each facial image were calculated. Figure 2 represents colour specification of overall mean of each facial image in CIELAB uniform colour space. It can be seen that colour in each facial images are lighter and covers a larger range of yellowness than redness.

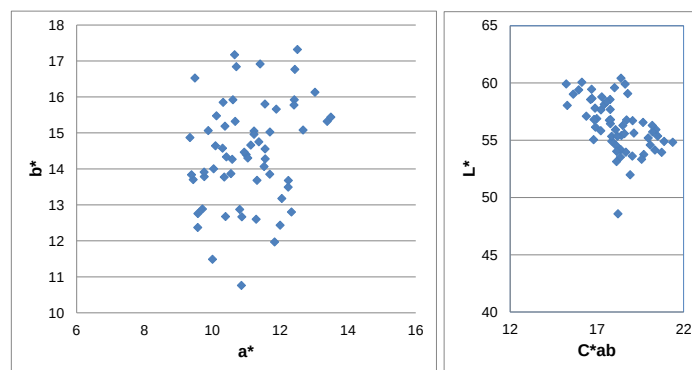


Figure 2 Colour specifications of mean facial colours of testing images in CIELAB

To further investigate their relationship, correlation coefficients between each of facial image characteristics and subjective scale of healthiness and attractiveness were calculated and results are listed in Table 2.

Table 2. Correlation coefficient (r) between facial image characteristics (Colour, Contrast and Heterogeneity) and subjective scale of healthiness and attractiveness

Correlation coefficient	Colour			Contrast			Heterogeneity
	L*	a*	b*	C_L	C_C	C_h	MCDM
Healthiness vs.	0.15	-0.11	-0.09	0.11	-0.10	0.27	-0.62
Attractiveness vs.	0.32	-0.18	0.08	0.16	0.02	0.37	-0.42

As shown in Table 2, correlation coefficient (r) between MCDM and healthiness scale is approximately -0.6, indicating facial healthiness is highly correlated with their skin heterogeneity. Minus means that the smaller the MCDM is, the higher score for healthiness. Effect of skin colours to healthiness is not that large. Compared with colour attributes, lightness has the largest effect and yellowness has the least effect. In term of contrast, it is also found that a large hue difference in facial contrast indicates a facial healthiness for Chinese. Comparing with healthiness, overall tendency of those image characteristics affecting to perceived attractiveness is very similar. However, the r value for attractiveness vs. MCDM decrease to -0.4 indicating effect of heterogeneity to attractiveness is much smaller than that to healthiness. Results also show that skin colour and contrast has a larger effect on perceived attractiveness.

4. CONCLUSION

Using a large set of facial images, healthiness and attractiveness of Chinese subjects were assessed by a psychophysical experiment. Results for those Chinese faces shown indicate that perceived healthiness correlates with their attractiveness well. It was also found that image characteristics can affect both healthiness and attractiveness. Although the overall tendency of those effects to either healthiness or attractiveness is similar, their magnitude was significantly different.

ACKNOWLEDGMENTS

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Proper indoor illuminance for elderly people to see signs from outdoors

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ABSTRACT

It becomes hard for cataract eyes to recognize signs and objects placed inside a building from the outdoor where environment light is strong, which reduces the quality of life QOL of elderly people. A solution for this impediment is to increase the inside illuminance level. It was investigated how much illuminance had to be elevated for elderly people compared to the young people by simulating the illumination situation in an experimental room. The cataract eyes were simulated by cataract experiencing goggles. It was shown that the illuminance should be elevated about 6.5 times.

Keywords: Elderly people, Cataract eyes, Cataract experiencing goggles, Quality of life QOL, Building lighting, Recognition of signs

1. INTRODUCTION

People get cataract in their eyes when aged. The most serious impediment from the cataract is the light entering the eyes from environment scatters in the eyes that covers all over the retina causing scene foggy. It also desaturates colors¹⁾ and blurs the retinal image²⁾. When elderly look at a dimly illuminated indoor from a very bright outdoor the indoor appears only a dark space and they cannot recognize objects in the space, while young people have no difficulty to see them because of no scattering light in their eyes. One way to solve this problem is to increase the illuminance in the indoor space. The present paper investigates how much illuminance should be increased for them compared to young people by simulating the cataract with cataract experiencing goggles³⁾.

2. EXPERIMENT AND PROCEDURE

Two-rooms technique or the environment-stimulus independent illumination technique was employed composing of a subject room and test room as shown in Fig. 1. The subject room had length of 4 m and the test room 1.8 m, and their height 2 m and width 3 m. At the separating wall 17 fluorescent lamps FL of 40 watts each and the daylight type were attached facing a subject to simulate the environment light. The vertical plane illuminance at the subject eyes was variable from 0 to a little over 1000 lx when the subject sat at the distance 3.3 m from the separating wall. In the experiment five illuminance levels were investigated; 0, 259, 528, 789, and 1054 lx. The inside of a building was simulated by the test room, which was illuminated by 12 fluorescent lamps of 20 watts and the daylight type. Two of them, Ft were adjustable for their intensity by a knob operated by the subject. A test stimulus T was placed against the back wall of the test room and the subject observed it through an opening D of which width was 50 cm, which simulated an entrance of a building. The vertical plane illuminance was measured at the same plane of the test stimulus. Figure 2 is a photograph to show the environment illumination at 1054 lx and a test stimulus in the test room through the opening.

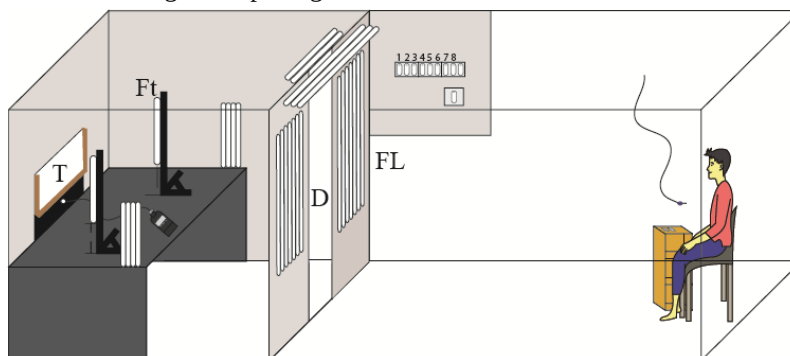


Figure 1. Experimental room.

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Figure 2. The environment illumination at 1054 lx and a test stimulus in the test room.

The subject task was to adjust the illuminance of the test room by a knob at the level when he/she could understand the contents of the stimulus easily for the decision whether he/she wanted to visit the building when he/she happened to walk on a street and to pass by the building. This was not a threshold for readability of the stimulus and rather a vague criterion but we wanted to simulate real situation of elderly people on streets in town. The adjustment was done with naked eyes and with the cataract experiencing goggles for five times at different experimental sessions.

Ten test stimuli were prepared composing of two types of pattern; 4 posters and 6 dishes. Examples of a poster and a dish are shown in Fig. 3. The poster was to invite people to a seminar held in the building and the dish was one of Thai foods “somtum” that was available in a restaurant in the building. The goggles were developed at Panasonic Co. Ltd.³⁾ and had the haze value 18% to show the degree of scattering light and the photopic luminous transmittance 63 %. They had less transmittance at short wavelengths. The goggles simulate the cataract eyes, particularly the eyes that just start to cause inconvenience in daily life.

Five subjects participated in the experiment, four young Thai and one Japanese whose eyes were installed with intraocular lenses after operation for the cataract.

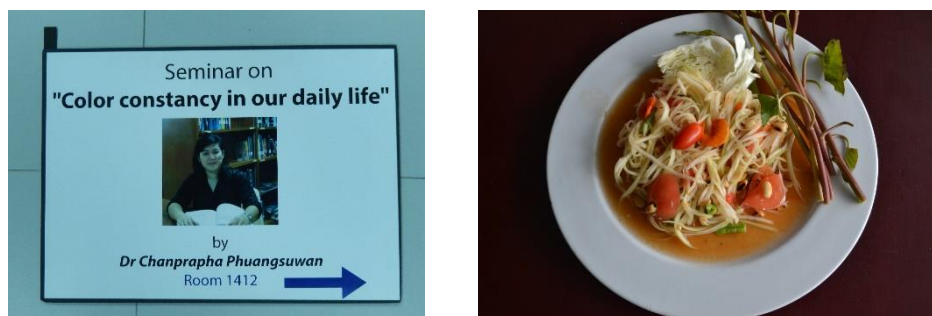


Figure 3. Two types of test stimuli; left, poster; right, dish

3. RESULTS AND DISCUSSION

Results of the subject CP and MI are shown in Fig. 4 for the test stimuli of six dishes. The illuminance of the subject room is taken along the abscissa in lx and the illuminance of the test room along the ordinate. Six curves locating low were obtained with naked eyes and those high were with goggles. The curves of both groups increased for higher illuminance of the subject room showing more illuminance was needed to recognize test stimuli in the test room but the increase with goggles was much larger compared with naked eyes implying more illuminance was needed with goggles. We notice here that curves of two dishes locate lower than other 4 curves with goggles in the subject MI. The two dishes were somtum and spaghetti, which the Japanese subject knew quite well and it was easy for him to identify the dishes. Other 4 dishes were not familiar to him and higher illuminance was needed to identify even the materials used for the dishes. The Thai subject CP did not show such peculiarity about the dishes. Three other Thai subjects showed similar results with the subject CP and we decided to average data of the four Thai subjects to get the mean result, which is shown in Fig. 5. Four curves locating in the middle were from

posters with goggles and it was easier to recognize them than dishes. For the curve of stimulus locating at the top the standard deviations among four subjects are shown by short vertical bars. Large SDs indicate large variance of individuals in adjusting the illuminance of the test room. The vague criterion given to subjects for the adjustment caused the variance.

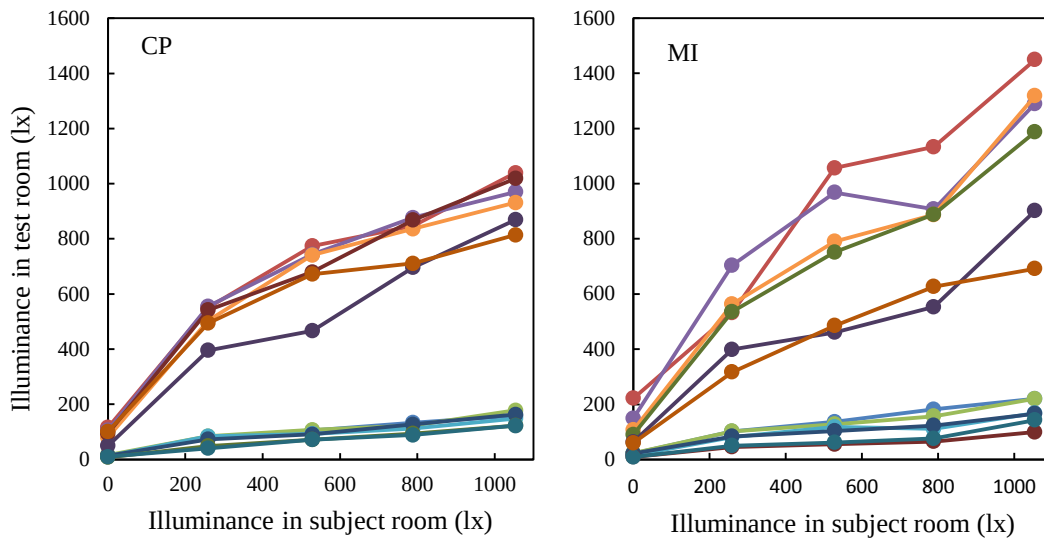


Figure 4. Results of subject CP and MI for 6 dishes of stimuli.

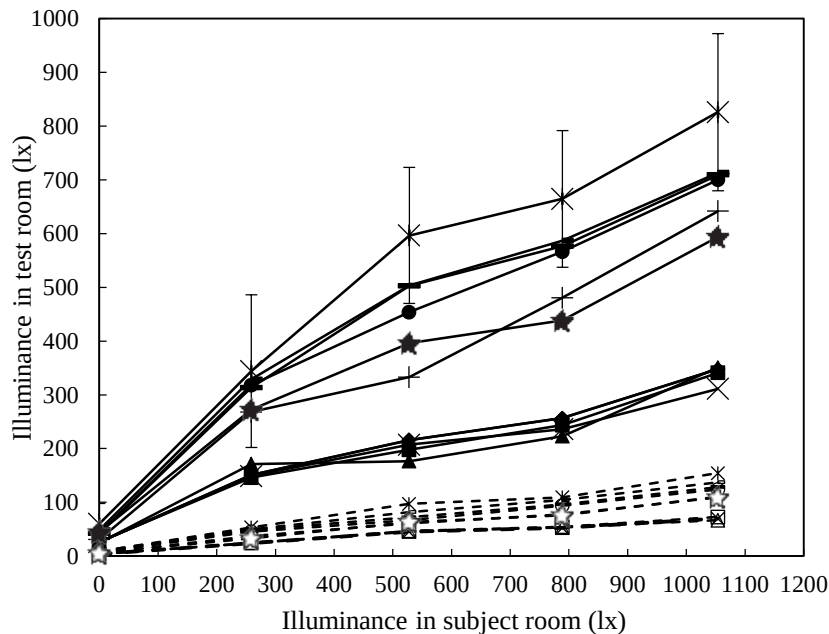


Figure 5. Average data of four Thai subjects.

In order to know how much illuminance should be increased with goggles compared with naked eyes ratio of the illuminance with goggles to the illuminance with naked eyes was calculated for each test stimulus and the average of the ratio was calculated for all the five subjects including the Japanese subject. The result is shown in Fig. 6. Short vertical bars at each data point indicate the standard deviation among five subjects. Although the individual variance is not small the all ratios remain relatively constant for the illuminance level of the subject room by having the average 6.5.

We can conclude that the illuminance in the building should be elevated about 6.5 times from the level designed for young people in order that elderly people also can recognize posters or pictures similarly to young people assuring them the QOL

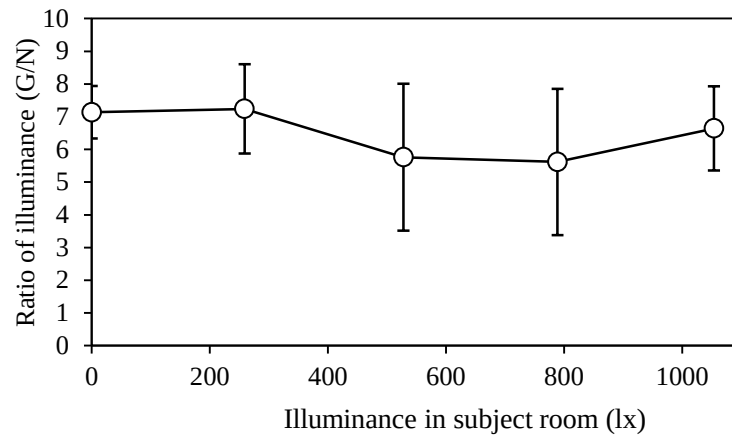


Figure 6. Average of ratio from five subjects.

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Influence of Dye Color and Fabric Thickness on the Evaluation of Texture in *Yuki-tsumugi*

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ABSTRACT

The purpose of this study is to clarify the effects of fabric color and thickness on the visual and tactile sensations described during textural evaluations of several variations of crafted *Yuki-tsumugi* fabric. Specifically, by weaving yarns dyed in different colors (Indigo and Beige) as warp and woof, six different fabrics of varying thickness (Thin, Medium, and Thick) were created as test fabric specimens and then cut into 20 cm x 20 cm square pieces. Visual and tactile evaluations of these fabric specimens were conducted using a five-point bipolar scale that was developed by focusing on nine texture-evaluation words. The results revealed that evaluation of the texture of *Yuki-tsumugi* fabric in terms of “thickness,” “heaviness,” and “fluffiness” was affected by dye color and fabric thickness.

Keywords: *Yuki-Tsumugi*, Dye Color, Fabric Thickness, Visual and Tactile Evaluation

1. INTRODUCTION

Yuki-tsumugi, a high-quality silk fabric that is a part of the proud tradition of Japan, was registered in November 2010 on the UNESCO World Heritage List of the Intangible Cultural Heritage of Humanity [1]. The techniques and culture of this craft handed down through generations have thus received worldwide recognition. *Yuki-tsumugi* fabric is characterized by its method of production, which requires approximately 40 processes by hand, from the spinning of the yarn out of silk floss to dyeing to weaving. The three main processes are as follows. First, silk floss is extracted from silkworm cocoons and spun by hand into yarn (*Tetsumugi* or *Ito-tsumugi*). Next, the yarn is dyed while being beaten on a board using the maker’s color of choice (*Tataki-zome*). Finally, the fabric is crafted by cross-weaving warp and woof using a traditional hand-weaving machine (a hand loom; *Jibata*). *Yuki-tsumugi* fabric created in this manner is described as having tactile characteristics such as “fluffiness” and “warmth” and a texture superior to that of other textiles.

However, the descriptions of these characteristics are mainly from case examples gathered from individuals’ personal experience in wearing kimonos. It is difficult to explain these subjective case examples scientifically. Therefore, in our previous research, we compared textural evaluations of *Yuki-tsumugi* fabric and silk fabric produced in other regions [2]. The results indicated that *Yuki-tsumugi* textiles have tactile characteristics of “fluffiness” and “warmth” when compared with silk fabric produced in other regions. However, this research also indicated that fabric dye and thickness potentially had an effect on the textural evaluation of the fabric.

The present study thus aims to clarify the effects of *Yuki-tsumugi* fabric’s color and thickness on the visual and tactile sensations described in textural evaluations by using several variations of crafted *Yuki-tsumugi* fabric. In particular, six different fabric specimens were created by weaving yarns spun in different widths and dyed in different colors (Indigo and Beige) as warp and woof. Three fabrics with different thicknesses were created by changing the width of the woof yarn with the warp yarn width kept constant. Thin fabric was woven using thin-width yarn as woof, thick fabric was woven using thick-width yarn as woof, and medium fabric was woven using alternately thin and thick yarn as woof. These fabrics were then cut into 20 cm x 20 cm square pieces as test fabric specimens. Visual and tactile evaluations of the respective fabric types were conducted using a five-point bipolar scale. Evaluation terms were developed by focusing on nine texture-evaluation words based on the results of our previous research [3] [4]. Four subjects with normal color vision were employed as observers [test subjects]. The results, showed that evaluation of the texture of *Yuki-tsumugi* fabric, such as its “fluffiness,” “thinness,” and “heaviness,” was affected by dye color and fabric thickness.

2. EXPERIMENT

2.1 Test fabric specimens

Six types of test fabric specimens of different colors and thicknesses were used (Fig. 1). Test fabric sizes were 20 cm x 20 cm, in conformance with Japanese Industrial Standards (JIS) [5]. Test fabric thickness—a basic characteristic in this test—was measured at 20 sites in each fabric specimen. The average of the measurement results are shown in Fig. 1 under each fabric specimen. From the measurement results, it is clear that thickness increases with yarn width.

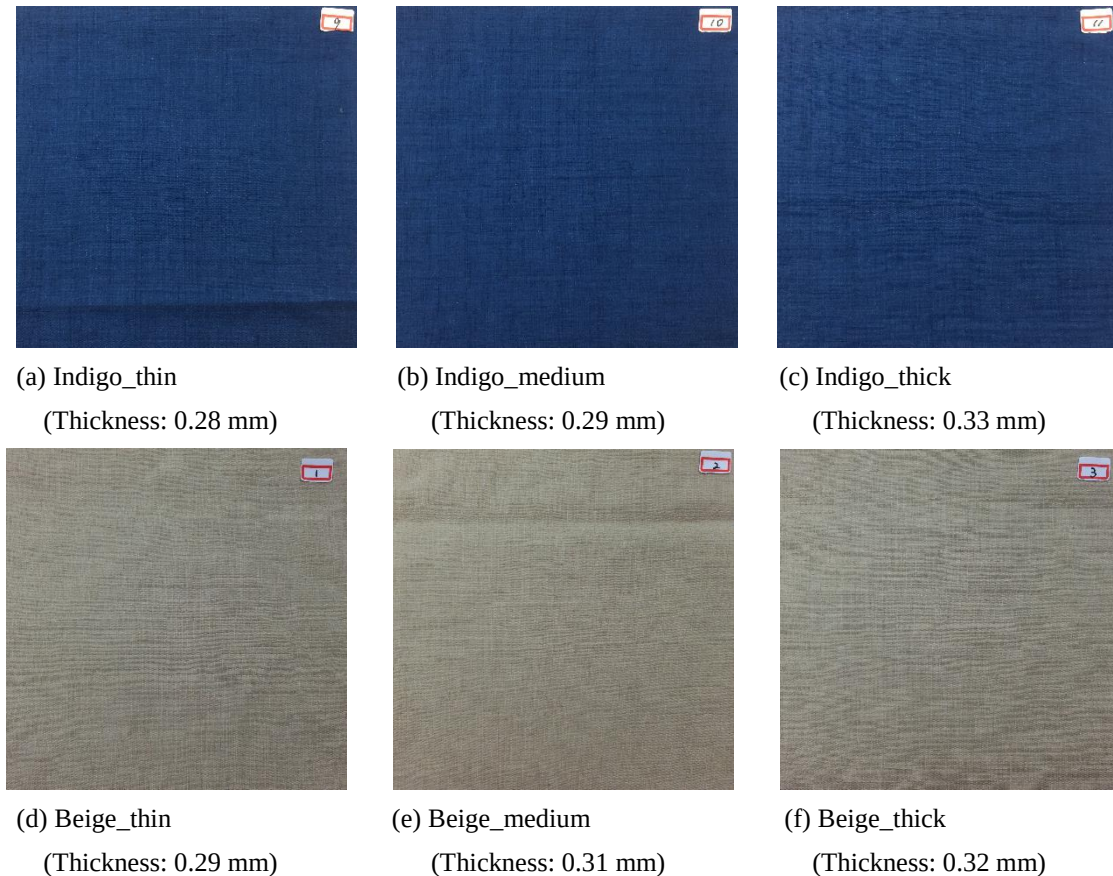


Figure 1. Test fabric specimens (The index shown at upper right was removed during testing)

2.2 Experimental method used in evaluation of fabric specimens

The method involved visual and tactile evaluations by four (4) test subjects of the test fabric specimens described in section 2.1. Standard deviation (SD) was used for the evaluation and using nine adjectives, (Thin(-) - Thick(+), Light(-) - Heavy(+), Not-fluffy(-) - Fluffy(+), Rough(-) - Smooth(+), Crisp(-) - Soft(+), Cold(-) - Warm(+), Wetness(-) - Dryness(+), Not-resilient(-) - Resilient(+), Dislike(-) - Like(+), 5-point scale assessments were made. The experimental procedure for evaluation comprised three steps based on the possibility of variations occurring due to different ways of touching the fabric specimens. Step 1: The subject places the specimen fabric on both palms. Step 2: Using her (his) dominant hand, the subject strokes the specimen in a circular pattern. Step 3: Using both hands, the subject repeatedly grasps and feels the specimen. Fabric specimens were presented randomly to subjects. Fig. 2 shows a subject performing the evaluation.

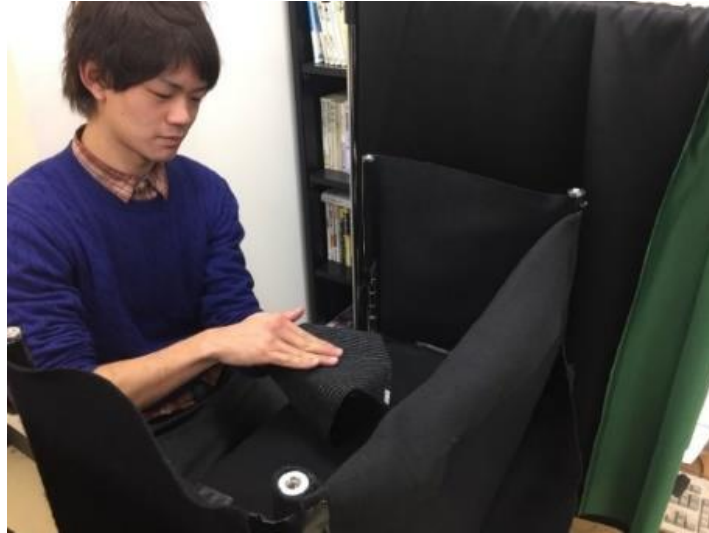


Figure 2. Subject undergoing fabric visual and tactile evaluation experiment

3. RESULTS

Fig. 3 shows the results of visual and tactile evaluations of *Yuki-tsumugi* fabric specimens. From the figure it is evident that in the evaluations of "thickness," "heaviness," "fluffiness," and "softness," as the specimen increased in thickness (Thin→Medium→Thick), there was a corresponding increase in the evaluation of "thick," "heavy," "not-fluffy," and "crisp." It is also clear that fabric dye color had an effect on the evaluation of "thickness," "heaviness," and "fluffiness." Specifically, indigo-dyed *Yuki-tsumugi* fabric, as compared to beige-dyed fabric, showed a tendency to be more "thick," "heavy," and "not fluffy." Meanwhile, for the dye colors and thicknesses used in this experiment, there were no effects seen on the evaluation of "roughness," "warmth," and preference ("like-dislike") of *Yuki-tsumugi* fabric specimens.

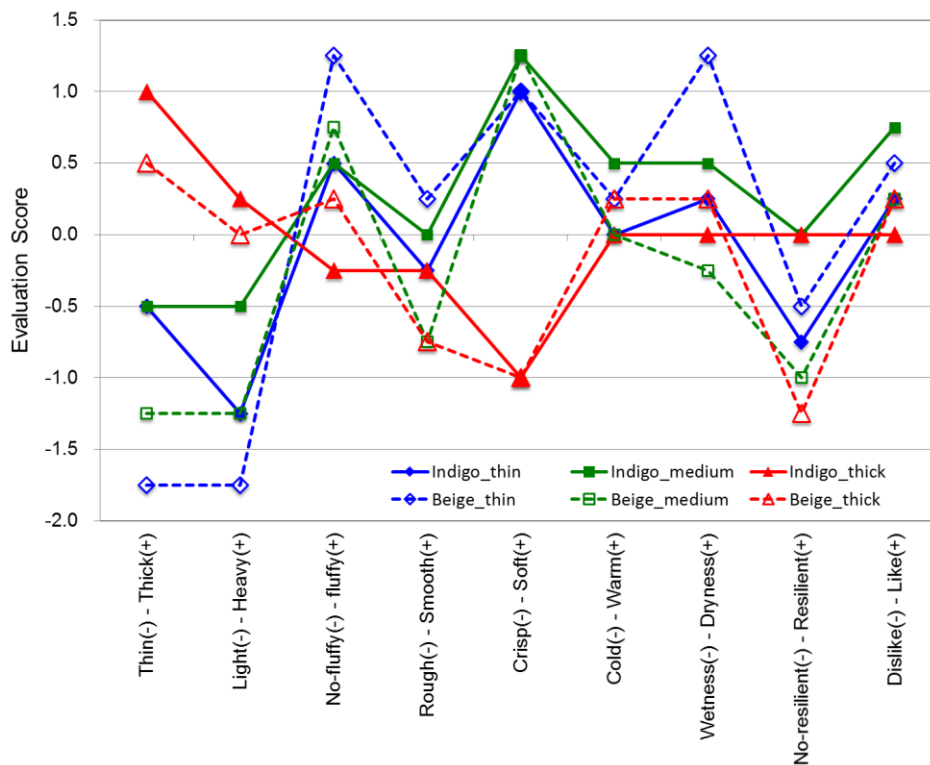


Figure 3. Results of evaluation experiment

4. CONCLUSION

This study aimed at clarifying whether differences in dye colors and thicknesses of a traditional Japanese luxury fabric, *Yuki-tsumugi*, would have an effect on the qualitative evaluation of its texture. The results revealed that *Yuki-tsumugi* fabric dye color and fabric thickness had an effect on the qualitative evaluation of "thickness," "heaviness," and "fluffiness." In future studies, we plan to increase the number of test subjects in performing evaluation experiments to verify these results; we also intend to perform evaluation experiments using other silk fabrics dyed in the same colors as those used in this experiment. Our aim is to understand whether there are differences or similarities between *Yuki-tsumugi* fabric and other kinds of silk fabric when evaluated for the effect of dye colors and fabric thicknesses.

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Neural Networks for Transformation to Spectral Spaces

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ABSTRACT

This work is concerned with mapping between the CMYK colour space and spectral space using Artificial Neural Networks (ANNs). The dimensionality of the spectral space is high (typically 31) leading to a large number of weights (or free parameters) in the network. This paper explores the hypothesis that a computational advantage can be obtained, in these cases, by treating the reflectance at each wavelength as being independent of the reflectance at any other wavelength; the implication of this hypothesis is that instead of using a single large ANN, it is possible to use, for example, 31 separate networks, each of which maps to one dimension of the 31-d spectral space. The results showed that as the number of training samples is reduced the advantage of the population of single-wavelength networks over the standard neural network approach increased.

Keywords: colour space conversion, Artificial Neural Networks (ANNs), CMYK, printing

1. INTRODUCTION

Artificial neural networks (ANNs) are widely used in colour prediction and mapping between different colour spaces¹⁻³. For example, mapping between camera RGB values and CIE XYZ values is an example of a mapping between two 3-d spaces. For a standard neural network, the performance difference with additional hidden layers can be very small; therefore, one hidden layer is sufficient for the large majority of problems. In order to predict spectral reflectance factors (at 31 wavelengths) from, for example, CMYK values then the network would have 4 input units and 31 output units with a single hidden layer of N units; we can therefore write the standard neural network architecture of 4- N -31 (Figure 1).

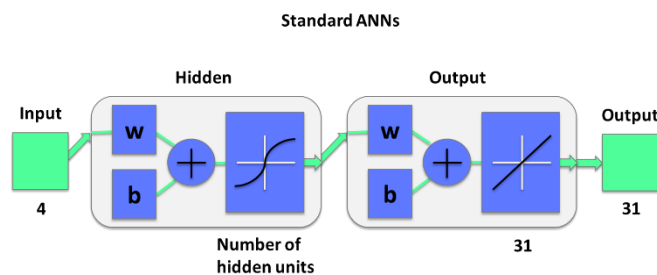


Figure 1. Architecture of a standard neural network with a structure of 4- N -31.

The network shown in Figure 1 has many weights (the free parameters that are optimised during network training). In fact, the network in Figure 1 has $(5 \times N + (N+1) \times 31) = 36N + 31$ (when $N = 10$, for example, this is equal to 391). A number of researchers argue that the number of weights must be less than the number of samples that are used to train the network⁴ in order that the network is adequately constrained. In this work we introduce a new method for applying networks to colour transformations whereby instead of using a single large network to predict the reflectance at all wavelengths simultaneously, 31 smaller networks are used to predict reflectance at a single wavelength (see Figure 2). Even if the network in Figure 2 had 10 hidden the number of weights in each network would be 61.

Although the total number of weights in the 31 networks is much larger than in the single large neural network, the ratio of training samples to weights is much larger for each of the smaller networks than it is for the single larger network. In this work, the single large network architecture will be referred to as a Standard ANN and the population of 31 networks will be called the Wave ANNs. The hypothesis that the Wave ANNs are more efficient than the Standard ANN is tested in this paper using a set of printed sample.

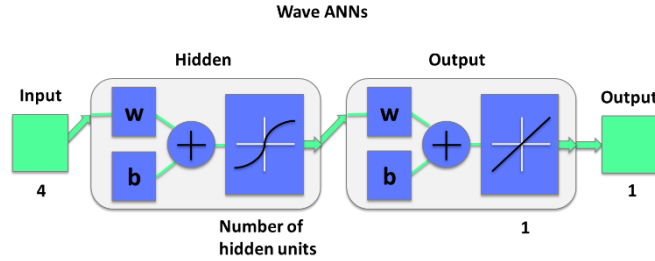


Figure 2. Architecture of a single-wavelength neural network with a structure of 4- N -1.

2. EXPERIMENTAL

A set of 524 printed samples were prepared using a MAN ROLAND sheet-fed halftone offset 4-colour press. Double A Gloss paper coated with $80 \pm 5\%$ gloss and 90% brightness, with a weight of 160 g/m^2 was used as the substrate. The colour of the substrates was $L^* = 94 \pm 3$, $a^* = 2 \pm 2$, and $b^* = -7 \pm 2$. Each sample was specified by an amount of cyan (C), magenta (M), yellow (Y) and black (K), each between 0% and 100%, ink. The spectral reflectance factors of each of the printed samples were measured at intervals of 10nm between 400 and 700nm. The 524 samples were randomly split into a training set of 300 samples and a test set of 224 samples. The training set was used to optimise the weights in various neural networks. During training 80% of the training set was used to optimise the weights and 20% was used as validation samples. Training continued until the error for the validation samples increased six times consecutively (this is to avoid over-training and to ensure good generalisation).

Table 1. Comparison on numbers of free parameters (weights) in the standard neural networks (4- N -31) and the single-wavelength neural networks (4- N -1) with different numbers of hidden units.

Hidden Units	Free Parameters	
	Standard ANNs	Wave ANNs
1	67	7
2	103	13
3	139	19
4	175	25
5	211	31
7	283	43
9	355	55
10	391	61
11	427	67
15	571	91
20	751	121
25	931	151
30	1111	181

The standard neural network had four inputs (CMYK) and 31 outputs (the spectral reflectance factors). Networks were trained with different numbers of units in the hidden layer. Populations of wave ANNs were also trained so that each network in the population predicted reflectance at one of the wavelengths. Trained ANNs were tested by their ability to predict spectral reflectance for the training set (300 samples) and the test set (the remaining 224 samples) and errors were calculated in terms of CIELAB colour differences (illuminant D65 and 1964 CIE observer). Networks with fewer training samples were also tested by sub-sampling the full training set. All networks were implemented using MATLAB's Neural

Network toolbox. Each network was trained six times, starting each time with a different random set of weights, and the average ΔE of these six trials is reported in the study.

Table 1 lists a number of hidden units with their corresponding free parameters in both standard neural network and in single wavelength neural network. Although we have used different sets of hidden units for Standard ANNs and Wave ANNs, it clearly shows in Figure 3 that the ratios of the number of training data to the number of free parameters are inevitably greater for Wave ANNs than for Standard ANNs. So the training data will be more likely to be adequate in the single-wavelength network with less probability of the network being over-trained than in the standard network.

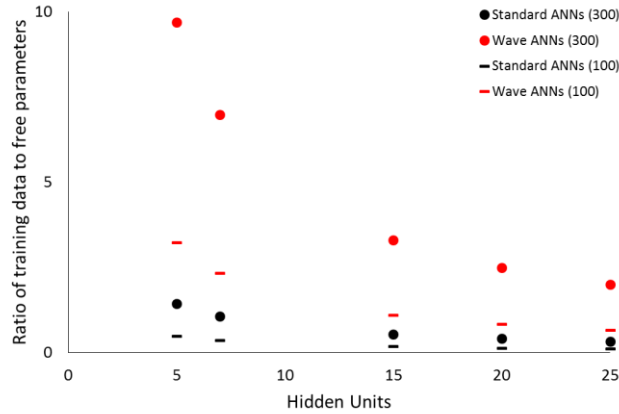


Figure 3. Comparisons of ratios of training data to free parameters between standard ANNs and single-wavelength ANNs with 300 and 100 training data.

3. RESULTS

Mean values of ΔE were calculated for the Standard ANN and the Wave ANN both trained with the same 300 training data. The ΔE was plotted against the number of hidden units in Figure 4. The optimal number of hidden units was determined as that which gives the lowest error for the test set and this was mean $\Delta E = 1.62$ (25 hidden units) for the standard ANN and $\Delta E = 1.55$ (11 hidden units) the Wave ANNs.

As the number of training data reduced from 300, the number of weights in the standard network is large and over-training is more likely to occur. Figure 5 summarises performance (the number of hidden units was determined in the same way as for Figure 4 but was different in each case) on the training set as the number of training samples is reduced.

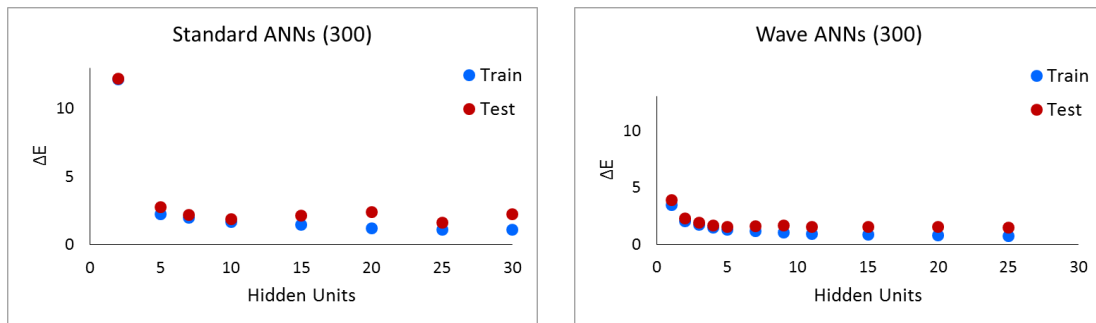


Figure 4. A comparison of ΔE between standard neural network and single-wavelength neural network.

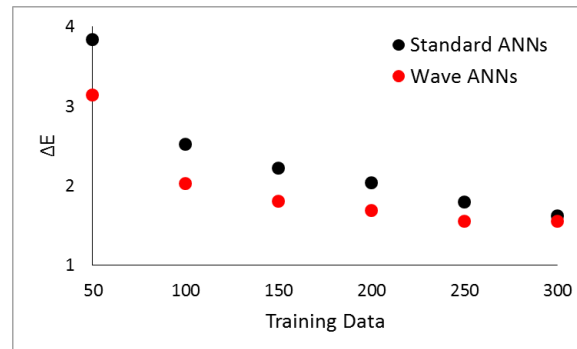


Figure 5. A comparison of ΔE between Standard ANNs and Wave ANNs with different number of training data

4. DISCUSSION

When mapping between the CMYK and the spectral colour space, the number of weights in the neural network is inevitably large due to the high dimensionality of the spectral space (typically 31). A standard neural network requires a large number of training data in order to train the network sufficiently. When the number of training data is less or equal to the number of weights in the network, over-training is possible to occur. Alternatively, instead of using a single large ANN, it is possible to use, for example, 31 separate networks, each of which maps to one dimension of the 31-d spectral space. The number of weights in the network will be greatly reduced and the ratio of number of training samples to the number of weights in the network will be larger. In that way, we can obtain a more reliable network with a better representation. The results proved that single-wavelength neural network outperformed standard neural network even with reduced numbers of training samples. However, further work is required to find out whether the difference is significant. Other numerical methods should also be further explored as a comparison to the Wave ANNs in order to find out the optimal solution for mapping between these colour spaces.

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Surface Colours For A New Reclamation-Architecture

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ABSTRACT

In a recent research carried out at Iuav University of Venice in cooperation with Reclamation Consortiums of Veneto Region have emerged needs of valorisation and requalification of the reclamation systems built after World War II. Reclamation systems made in this age can be seen like functional systems. They are built without any design approach from the point of view of appearance and technology. Often these systems degrade the quality of landscape. The Directors of the Reclamation Consortiums asked Katia Gasparini to write the guidelines to improve the design of the reclamation architecture and valorise the surrounding landscape. This can be done with an innovative low environmental impact, where the priority is given to the appearance, visibility and perception of the artefacts and the environmental quality. The paper will report the progress of this first research approach in which the theme of the colour will be addressed with particular regard to the treatment of the surfaces with innovative coatings (paints, panels, smart materials). Above all, it will deal with the issue of the valorisation of landscapes with bright and colour technologies by low environmental impact. This research was made with the aim of achieving these concepts: sustainability, reversibility, usability, security, visibility.

Keywords: colour, landscape, smart materials, reclaiming-architecture

1. RECLAMATION-ARCHITECTURE

In the last century, the reclamation of the Veneto region has been a very profitable business from the economic and social development point of view. It has been a profitable business thanks to the expansion of agriculture on the drained areas of the swamps and because there were built many drainage systems which were designed to ensure public safety from flooding. This activity also had a very important role for the development of reclamation tools and technologies. For example, systems for hoisting of water, for the construction of large reclamation collectors and for the realization of the related reclamation constructions have been developed¹.

The land reclamation of the Veneto swamps was crucial to properly address the floods that occurred in the past two centuries, for the defence of the inhabited territory². The operations of drainage of flooded districts have been made stemming the leaks created by the flood with the means available at the time. The operations were conducted with the contribution of Reclamation Consortia who have restored the damaged construction. The activities carried out by the Reclamation Consortia of Veneto have made an extended heritage of hydraulic construction, spread over vast areas. Now the Veneto region has a hydraulic network that extends for thousands kilometres and which includes hydraulic constructions of considerable complexity and value, among which in particular the constructions for the water pumps.



Figure 1. Hydraulic Support of “Ponte Rosso” place, 1970 (photo © A.Piva)

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For the purposes of the current research, reclamations constructions can be classified into broad categories that identify the functions of the plant: such as pumping stations, hydraulic supports (Fig. 1), water towers and small artefacts for the protection of control panels for hydraulic supports, located along the banks of the canals. Within these categories are included the most representative buildings such as the historical or contemporary institutional headquarters (Fig. 4) and the artefacts that surround the pumping stations.

The "pumping station" is a technological system equipped with a particular mechanical device adapted to move large quantities of fluids from a lower level to a higher one in a given time, in order to extract renewable energy without large energy consumption for the functioning of the hydraulic system³.

The research, still in progress in partnership with Unione Veneta Bonifiche, came by some remarks of some members of the Associazione Triveneta Dirigenti della Bonifica. The engineers have realized the great difference that exists between the architectural design of structures built in their territories (Veneto) and projects of contemporary artefacts built in other European countries, with innovative technologies and materials. In a special way, have emerged the different approaches and the different identity of design of the artefacts built in Italy in the first half of the twentieth century, compared to those built after World War II to the present.

Examples of the artefacts built in Italy in the first half of the twentieth century are: the implantation of C'à Vendramin, now become museum of Reclamation and headquarters of the same Foundation and the plant called Chiusa di Ceraino (Sciorne taking) situated in Rivoli Veronese, on the Adige Valley, which is still active (Fig. 2). Both artefacts are characterized by the modularity and proportion of the facades, the historical style, the modularity of the windows, the texture of the facade and the use of materials (size, texture, laying etc..) such as brickwork and stone. The colours of the landscape and the architecture of the reclamation of the early twentieth century are the colours of natural materials, essentially, locally available: red brick, white or pinkish stone, black or grey paint of the mechanical equipment of the plant: the facilities of the first industrial era when the mechanisms were produced into unique pieces in iron casting (Fig. 3).

Looking at the artefacts built in the second half of the Twentieth Century is possible to observe an "involution" in design, especially as regards the representative buildings and the "containers" of pumping stations. Currently these artefacts are treated as anonymous building envelopes, without a specific design study and identity: it lacks the design proportions, the architectural project, the integration and dialogue with the natural landscape, the study of the materials and the design of the cladding. Artefacts are built on a rectangular plan, the outer walls are rough plastered or painted with white paint, the roof is built with tiles or corrugated metal plates of grey colour, with two pitched. Also the area on which the artefacts insist, identified in parking areas, maneuvering, processing areas or buffer zones are not covered by the project. It should be noted, finally, the lack of a culture of environmental quality.

2. RECLAMATION-ARCHITECTURE ON THE INTERNATIONAL SCENE: COLOUR, INNOVATION AND CLADDINGS

The case studies selected were categorized into two types: the artefacts for pumping stations and bridges. The category of bridges has been chosen by analogy with the "hydraulic supports" and the hydraulic structures that are placed on the irrigation canals, since one of the objectives of this research is to draw up guidelines for the enhancement of colour and light of these artefacts. There is currently no design approach in this regard.



Figure 2. Chiusa di Ceraino, Rivoli Veronese, VR. Cladding system in pinkish stone, with different textures, iron frames with glass panels such as "cathedral" with blue inserts. The floodgates are made of metal rusty reddish in colour. The original floodgates were made of wood. (photo © K. Gasparini)

The only type of construction that could be used for an approach in this direction seemed the category of bridges. Hydropower plants and pumping stations that were analysed are distributed largely in the European region and specifically in the Nordic countries (Germany, Netherlands), some plant is located in England and one in Spain, one in Italy, South Tyrol, a few cases in the United States or in the Eastern countries. This spatial analysis showed a different approach to the cladding of the artefacts, to the texture and colours. As a general rule, for the construction of the envelope of these artefacts are almost always used dry building techniques, with steel structures and glass cladding, metal or wood. In some cases, the walls are made of cast concrete. In this situation, therefore, the colour that identifies the artefact and the place remains light grey with smooth surface. As for example, the hydroelectric power plant in Kempten (Germany) designed by Becker Architekten, built on the left bank of the river Iller. The sinuous shape of the building and the area on which it stands, similar in some respects to certain architectures designed by Zaha Hadid, is characterized by its light grey almost luminous concrete surfaces that emerge from the context of industrial archaeology identified by the colours of the materials of tradition: brown, reddish, black.

On the contrary, in the hydroelectric plant of Valdoies, Bolzano, the small building is made of smoothed white concrete panels, interspersed with real cleaved surfaces covered with transparent glass. The clear glass let see the light and the colour of the interior at night. Then, in general, when the wet construction technique is linked to contemporary tradition is always to use the material in its original size, free from cladding and colours, which is concrete.

A different approach is used in the Anglo-Saxon countries where emerges a widespread use of the steel frame and clear glass panels. So it would seem that the concept of this region is linked to transparency, to the concept of the window and the showcasing that characterized the turning point of the modern era marked by the construction of the Crystal Palace in London, the "big window". In projects such London Olimpyc by John Lyall Architect or in the pumping station of St Germain (Fig. 5) the systems are exposed. The building envelope is only a transparent limit in a dialogue with the landscape, without damaging it, visually disappearing during the day between the reflections of the surrounding environment. At night the lighting system highlights the existence of the building and exhibits to the place a symbol of the post-industrial era. In this region it seems that the project is still affected by the influence of the industrial revolution and the styles of certain currents of thought that characterized the modern movement.



Figure 3. Chiusa di Ceraino. Focus on the plants originating in iron casting: in the white colour of the wall paint the emerging the colour of black paint and rusty metal (photo ©K. Gasparini)



Figure 4. New headquarters of Consorzio di Bonifica Veronese, 2011 (photo © K. Gasparini)

The Nordic countries, Germany and the Netherlands for the most part, are relying more on the colour of natural or artificial materials and on opaque textures. There are very few interventions that rely on the dematerialization of glass. In this regard, a remarkable intervention is the artefact built in Cologne, the Flood Water Pumping Station designed by Kaspar Kraemer (2008). The building, consisting of a metal grill and glass façade, is illuminated within by a LED system with variable colour according to the water level of the river. When the water level is normal the light is white, when the water is at alert level it turns red. The light is projected on the transparent walls of the building that becomes a landmark on the river, but also a sign of security for the city. Other interventions disseminated in Germany and the Netherlands are characterized by metallic claddings. In this case, the goal is always to integrate, with different approaches, the building in the natural or man-made context. Sometimes it has been used an aluminium cladding in grey colour or mirror-treated stainless steel in urban centres. In both cases, the colour and surface treatment adapt the building to the grey colours of the city and of the asphalt. The mirrored treatment reverberates the surrounding environment, making the building completely disappear. When the artefact is located within a natural environment then the cladding adapts to it and tries to integrate it visually. Here the colours are the ones of burnished Corten steel, green roofs or wooden slats.

3. CONCLUSIONS

From the analysis summarized here emerges a highly innovative approach to new artefacts for the reclamation architecture, in an international context, in which the project and the technology adapt to both new building techniques and new materials and to the consequent problems of management and maintenance of the same and, above all, to the landscape. The water system in Italy seems to have been designed only for itself, it does not interact with its surroundings, there is no attention to the project, just to the functionality of the machine. In the European culture, there is a greater focus and collaboration between the skills involved in the project and greater environmental sensibility. In addition to dry building techniques, materials that are adopted are aimed to integrate the artefact with the environment, imitating the colours, but with contemporary technologies. There remains the problem of the interventions on the existing constructions, to enhance and redevelop those artefacts disseminated in the lowlands and Italian landscapes that have a poor dialogue with the context, and often they disfigure it. In these cases we are analysing various assumptions, for example non-invasive interventions, low cost, made with paint or adhesive coatings that exploit the chromatic potential of these materials to redevelop sites. They can also be photo luminescent or dichroic paints or lighting interventions on historical buildings to enhance their presence and identify an area with landscape law bonds.



Figure 5. St German pumping station, London (photo © A.Piva)

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THE TRANSFORMATIVE IMPACT OF IMAGE BY COLOUR ON VULNERABLE PEOPLE

By Maria Elena Chagoya Image by Colour Coach, Tasmania, Australia

SUMMARY

The participants of “The Positive Impact of Image by Colour for Vulnerable People ”project learned to re-discover their positive self-image, build their self-esteem and feel more confident to achieve their life goals all through simply enhancing and reevaluating their physical appearance by recognition of the impact the colour of their clothing.

They have benefited from this advice by feeling more confident, finding work and having hope after major life changes. The first part of the project was presented in the AIC 2014, in Oaxaca, Mexico, then a format as poster in AIC 2015 in Tokyo, which was well received. I would be honoured to present the results of this continuing project with new participants in ACA China 2016.

1. INTRODUCTION

The proposal of this presentation at ACA China 2016 is about how Image by Colour has helped vulnerable people in society. I am currently volunteering my services in Australia to help people who are vulnerable, disadvantaged or feeling isolated from society. For example:

Victims of discrimination and racism, domestic violence, bullying, people with disabilities, women with emotional or physical hurts, whose self-worth was very low and humanitarian migrant refugees needing to start a new life in Australia.

People with mental ill-health and mental disorders are particularly vulnerable to infringement of their civil and human rights and to discrimination 1.

Racism can isolate and exclude people preventing them from having equal opportunities to integrate within society. The impact of these negative effects increases their sense of distrust, fear and resentment, depression stress and anxiety. 2

In Australian studies, self-reported racism has been associated with substance use, emotional and behavioral difficulties and suicide risk for young Aboriginal people. 3

A 2009 joint report by the Women’s Centre for Health Matters (WCHM), the Domestic Violence Crisis Service (DVCS) and Women with Disabilities ACT (WWDACT), *Women With Disabilities Accessing Crisis Services* found women with disabilities are more likely to experience abuse or violence than women without disabilities .4

The Image by Colour service supports respect of participant’s diversity by creating or enhancing their genuine, unique and harmonious image. This influences, from the first contact, the impression others have of them, through to identifying and matching correct colours in their garments.

2. METHOD

Coaching by customised instructional, training and guidance intervention which is designed to improve the performance and capacity of the participants and team.

The Image by Colour coaching is characterised by intense, sustained non-judgmental assistance and support by giving feedback to set goals, identifying obstacles, and developing plans through participant’s self-image, colours and focusing on strategies to achieve their personal goals.

Image by Colour Coaching integrates one-on-one colour analysis, assessing their wardrobe, supporting their individual needs in their vulnerable state and also by “peer coaching”. This all helps to encourage them with very positive feedback to participants and each other.

Participants received care in a safe and creative environment characterised by such qualities as helpfulness, concern, empathy, kindness, consideration, good will, responsiveness and ways to love themselves.

In this project, Image By Colour Coaching is providing to each vulnerable participant setting garments to start using participants ‘right and powerful’ colours.

2.1 Sample Preparation

The participants were able to identify the difference between warm and cool colours. They also identified their own friendly, powerful and natural colours and sub-tones based on their skin, hair, eyes, personality and culture. By learning how to use, combine, coordinate and contrast enhance the total positive impact and achieve feelings of confidence. In addition through adding accessories and use the right hair colour the participant look younger, more vibrant and energetic with a healthy gleam in their eyes, their skin colour look smooth and radiant.

Participants identified ‘wrong’ colours that affected their appearance: such as what could make them look older, exhausted, ill or dull and how by wearing incorrect election impact negatively in their mood and with others.

The participants with severe levels of disability received extra one-on-one coaching to help them, and their Careers, recognize and identify what range of colours created a positive impact effecting their mood and attitude. Their Careers also received all relevant information to continue experimental procedures to help people in this vulnerable sector.

2.2 Experimental Procedure

The participants in a team with other peers, gained a personal perception of why psychologists have determined that colour is the first concept about a person’s appearance. As its impact is immediate and long-lasting.

The participants recognized how correct and incorrect colours used in a period of 6 months was affecting their mood, apparent age, their attitude on life and overall impressions they could have on others. They used “wrong colours” for some hours, 2 days a week, to measure the impact with others and in their own perception of themselves.

By groups, the participants asked each other: What kind of first impression do you have of me? A first impression is the most important impression you'll ever make --and you only get one chance to make it .5

3. RESULTS AND DISCUSSION

Table 1. Positive Impact of Image by Colour

	Increase selfesteem	Increase confidance in participants
• Economical disadvantage	• 12	• 12
• Disability	• 6	• 6
• Feelings of Devaluation	• 25	• 25



Left side wrong colours - Right side right colours

In the process of the Positive Impact of Image by Colour for Vulnerable People project, the participants also experimented by wearing new clothes with certain brand names displaying a perceived status of expensive clothing, but not in their range of positive colours.

As a consequence, they had the opportunity to compare how they felt and how other people treated them. The general impression was that the effect of expensive clothing with wrong colours only causes the focus of other people's attention on the clothes, not the person.

Discussions were centred about if good quality new clothes with famous brand names are better elements to create a positive image, no matter what the colour.

Participants were able to validate the importance of wearing old clothes or garments in good condition in the right colours. The Image by Colour Coach empowered participants to obtain the skill to coordinate an effective, smart and functional wardrobe that will help create a positive image of themselves, with less effort and cost.

In reflection, it was observed that the key for vulnerable people, is that many accept used garments which are reusable, recycled or old or received as a present, donation or by buying at opportunity or second-hand stores.

In the last period of the Project, the result was participants were able to identify and wear their correct sub-tones and discerning colours in the range of "best" colours to enhance their sense of harmony.



Disability participant

4. CONCLUSIONS

All vulnerable women and men, not just famous or rich people, can develop their self-identify while gaining respect for their diversity through an enhanced genuine and harmonious self-image.

Being able to find, use and coordinate a range of positive, powerful and friendly colours; is the key to portray and create a positive image of yourself all the time, a skill go with you anywhere you live ,any challenge to achieve.

Be mindful that developing this holistic synergy in the vulnerable sector was conducted parallel of social workers, doctors and therapists who provided valuable and specific psychological support according to their personal needs. However dear lovers of colour, the results shows that it is positive impact who participated and continue wearing their positive, powerful and friendly colours and combinations.

The benefit to support vulnerable people, means they learn to be selective, admire and value their image, love who they see in the mirror, and feel confident to enhance and use their skills and talents.

Image by Colour Coaching is a humble yet impressive the way to positively impact vulnerable people's lives – it enables them to enhance their proud and unique diversity, cultural background, personality and gives them peace and confidence to achieve their goals.



Vulnerable participants and Refugees participants

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LED Lighting Preference for Different Color Objects and Light Sources Combinations

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ABSTRACT

Till now, few of works have focused on modeling the LED lighting preference for different color objects and light sources combinations. In this paper, the correlation between human subjective preference for LED lighting and the combination of color objects and lights sources are discussed. In the psychophysical experiments, one hundred observers with normal color vision evaluated 8 bunch of monochromatic flowers(yellow, purple, green, blue, red, orange, pink and mint green)which were respectively illuminated by five LED light sources with different correlated color temperatures(CCTs,2500K, 3500K, 4500K, 5500K and 6500K).And the spectral reflectances of the flowers were measured and the dominant wavelength of the colors were calculated. Afterwards, 6 kinds of flowers (yellow, purple, green, blue, red and orange) and the corresponding subjective scores were used as modeling samples. A two-dimensional curved surface fitting method was developed to fit the correlation between human subjective preference for LED lighting and the combination of color objects and lights sources. To verify the proposed method, the other two kinds of flowers (pink and mint green) and the corresponding subjective scores were used as testing samples and the experimental results showed that the perdition error of the proposed method is only around 3.5%.

Keywords: LED lighting preference, two-dimensional curved surface fitting model

1. INTRODUCTION

The LED lighting has several advantages over traditional lighting, such as adjustability, efficiency, durability and energy saving^{1,2}. Recently, more and more researchers, engineers, artists and designers are paying attentions to its application potentials in the fields of art design, indoor/outdoor lighting³, industrial manufacturing, and so on.

Up to now, several subjective and objective methods on assessing the lighting quality of LED sources^{4,5} have been proposed. However, few of the previous works have focused on modeling the LED lighting preference for different color objects and light sources combinations. In this study, the correlation between human subject preference for LED lighting and the combination of color objects and lights sources are discussed. The authors believe that the research findings will provide valuable reference for the lighting design in related applications, especially for the monochromatic conditions⁶.

In order to quantify the human subjective preference for LED lighting, psychophysical experiments⁷ were designed and implemented. 100 students, 50 males and 50 females with normal color vision were invited as experimental subjects. For each subject, 8 bunch of monochromatic flowers (yellow, purple, green, blue, red, orange, pink and mint green) are respectively illuminated by 5 LED light sources with different correlated temperature (2500K, 3500K, 4500K, 5500K and 6500K) . The subjects were asked to mark their preference for each flower and light combination with a score (1 for most dislike and 5 for most like) and their responses were record by the experimenters.

After the psychophysical experiments, the spectral reflectances⁸ of the flowers were measured and the dominant wavelengths of the colors were calculated. The correlated color temperatures were measured by a spectral radiation meter. Afterwards, 6 kinds of flowers (yellow, purple, green, blue, red and orange) and the corresponding subjective scores were used as modeling samples. A two-dimensional curved surface fitting method⁹ was developed to fitting the correlation between human subjective preference for LED lighting and the combination of color objects and lights sources. To verify the proposed method, the other two kinds of flowers (pink and mint green) and the corresponding subjective scores were used as testing samples and the experimental results showed that the perdition error of the proposed method is only around 3.5%.

In sum, in this study the nonlinearity between subjective preference for LED lighting and the combination of color objects and lights sources were simulated by a two-dimensional curved surface fitting method. The authors believe it will provide valuable reference for the lighting design in related applications, especially for the monochromatic conditions such as store lighting, home lighting and art work lighting.

2. PSYCHOPHYSICAL EXPERIMENTS

2.1. Overview

The experiment was conducted in a dark room with the only one lighting source, the Philips hue LED, which was placed in a standard light box. There were 5 correlated temperatures and 8 bunch of monochromatic flowers. In total, one hundred observers participated in the experiment. Five rating scores were used to assess each flower that is 1 for most dislike and 5 for most like.

2.2. Lighting

Figure 1 (a,b) illustrates the experimental situation used for the visual assessment, showing the viewing geometry of the observers and the viewing distance, which was carefully controlled according to the size of painting to ensure a constant viewing angle subtended at the observers' eyes.

A Philips hue LED lighting source was used to illuminate the flower which can change its CCTs by a specific APP. There are five correlated temperatures (2500, 3500, 4500, 5500 and 6500K) at the same levels of illuminance (200lux). Table 1 shows the photometric and colorimetric data of the 5 lighting conditions used in the experiment. And the Figure1 (c) shows the relative spectral power distribution of the five light sources.

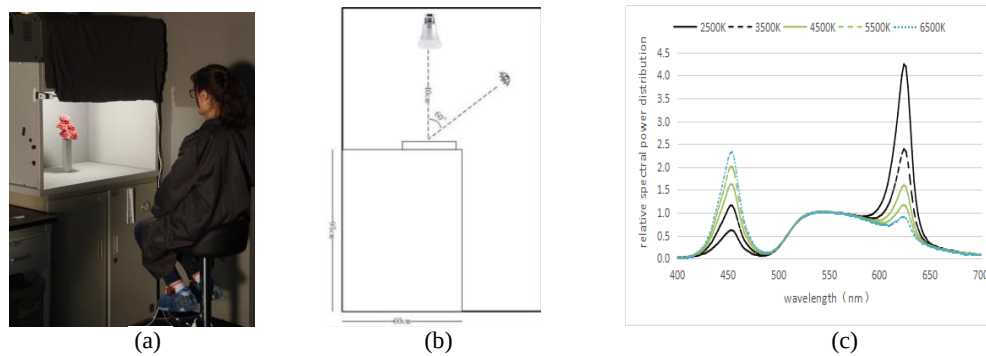


Figure 1 (a) The experimental situation and (b) the viewing geometry of observers
(c) Relative spectral power distribution of the five light sources

Table 1 Parameters of the 5 lighting

Lighting number	Measured illuminance (lux)	Measured correlated temperatures (K)	Target correlated temperatures(K)	x	y
A	200	2442	2500	0.4778	0.4070
B	200	3437	3500	0.4047	0.3826
C	200	4453	4500	0.3600	0.3537
D	202	5524	5500	0.3315	0.3307
E	200	6627	6500	0.3129	0.3126

2.3. Observers and flowers

One hundred Chinese observers(50 males and 50 females) aged 18 – 24 participated in the experiment. They all passed the color blind identification test and have normal color vision.

Figure 2 shows the eight different color flowers used in the experiment. They are yellow, purple, green, blue, red, orange, pink and mint green. Figure 3 shows the spectral reflectivity of the eight flowers. And the dominant wavelengths of the flowers were calculated by their spectral reflectivity. The dominant wavelengths of the flowers were shown in the Table 2.

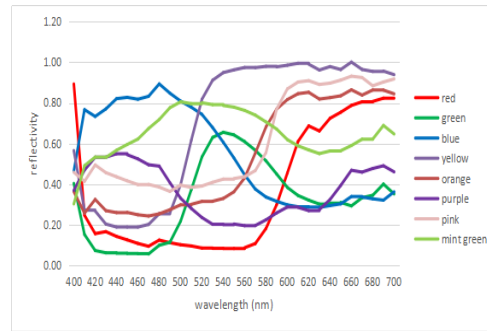


Figure 2 the spectral reflectivity of the flowers

Table 2 The dominant wavelength of the flowers

Color	Purple	Blue	Mint green	Green	Yellow	Orange	Pink	Red
Dominant wavelength (nm)	-568.57	486.52	535.23	566.96	575.60	593.14	604.86	637.73

2.4. Procedure

Before getting in to the laboratory, observers were asked to put up the standard gray clothes and turn off their cellphone, iPad and so on. After a 3-minute adaptation in the dark room, the experiment was carried out by the experimenter reading out the presentation and matters needing attention.

Each observer participated in 40 “lighting source--object” combinations, twenty minutes in total. In each combination, experimenter reading out questions that were answered orally by the observers. Observers didn’t need to write an answer for each experiment to avoid the incomplete chromatic adaption likely to be caused by the observer staring at a questionnaire printed on white paper. Experimenter noted the answers of every observer. In each session, observers went through five lighting conditions randomly. After a 1-minute adaptation, they evaluated the flowers one by five-level scores (1 for most dislike and 5 for most like). They then proceeded to the next lighting condition with adaptation until all five lighting conditions had been seen. The orders of the lighting conditions for each observer, of the flowers in each lighting condition were all randomized, in each “lighting source--object” combination.

3. RESULTS AND DISCUSSION

3.1. The evaluation of observers

Each “lighting source--object” combination was evaluated by five-level scores (1 for most dislike and 5 for most like) and the scores were conducted by normalized processing in order to analyzed with the method of two-dimensional curved surface fitting. Table 3 shows the normalized data.

Table3 The normalized scores data

Color \ CCT	2500K	3500K	4500K	5500K	6500K
Yellow	0.1693	0.2292	0.2367	0.2197	0.1448
Purple	0.1238	0.1945	0.2442	0.2319	0.2054
Green	0.1183	0.2204	0.2687	0.2312	0.1612
Red	0.2258	0.2489	0.2278	0.1721	0.1251
Orange	0.2095	0.2578	0.2176	0.1836	0.1319
Blue	0.102	0.1945	0.2408	0.2476	0.2149

3.2. The model of two-dimensional curved surface fitting

In this paper, a two-dimensional curved surface fitting method was developed to fit the correlation between human subjective preference for LED lighting and the combination of color objects and lights sources.

To verify the proposed method, the other two kinds of flowers (pink and mint green) and the corresponding subjective scores were used as testing samples and the experimental results showed that the perdition error of the proposed method is only around 3.5%, in Table4. Table 4 shows the data of testing sample, too. At the same time, the scores of purple flower were analyzed separately as its negative dominant wavelength and the result is shown in the Figure 3, with high precision. Figure 3 shows the modeling scores(the green lines) of the flowers with negative dominant wavelength and the five points are the experimental scores of different CCTs, which possesses high precision.

Table 4 The normalized scores data of testing samples and the error analysis

CCT		2500K	3500K	4500K	5500K	6500K
Experimental data						
604.86	Experimental scores	0.1972	0.2496	0.2231	0.1802	0.1517
	Modeling scores	0.2138	0.2555	0.2203	0.1806	0.1301
	Perdition error	8.42%	2.36%	1.26%	0.22%	14.24%
		5.30%				
535.23	Experimental scores	0.1081	0.2129	0.2585	0.2346	0.1857
	Modeling scores	0.1119	0.2102	0.2577	0.2377	0.1824
	Perdition error	3.52%	1.27%	0.31%	1.32%	1.78%
		1.64%				
Error		3.47%				

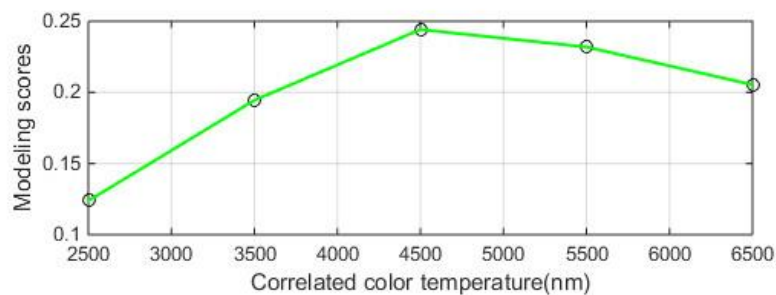


Figure 3 The model of flowers with negative dominant wavelength

3.3. Model analysis

Figure 4 shows the model of the correlation between human subjective preference for LED lighting and the combination of color objects and lights sources, which was drawn by the software platform named MATLAB10 .

MATLAB is a high-level technical computing language and interactive environment for algorithm development, data visualization, data analysis, and numeric computation¹¹. And the Figure 5 shows the X-Y plane projection of the model in Figure 4.

As it can see in the Figure 4 and Figure 5 visually, the color objects with short wavelength possess the higher human subjective preference in the cool light, which has the higher CCTs. Similarly, the color objects with long wavelength possess the higher human subjective preference in the warm light, which

has the lower CCTs. Besides, the combinations of the objects with middle wavelength (550–600nm) and the LED lighting of middle CCTs (3500–5000K) have the highest human subjective preference.

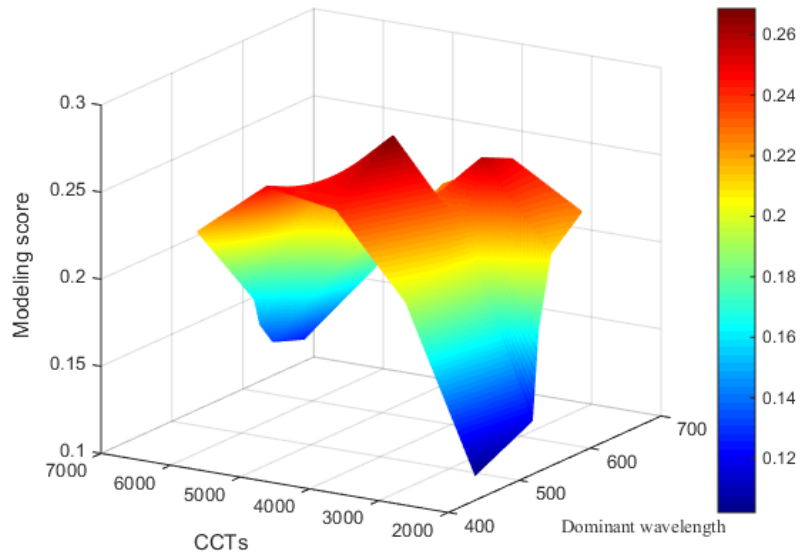


Figure 4 The model of correlation between human subjective preference for LED lighting and the combination of color objects and lights sources

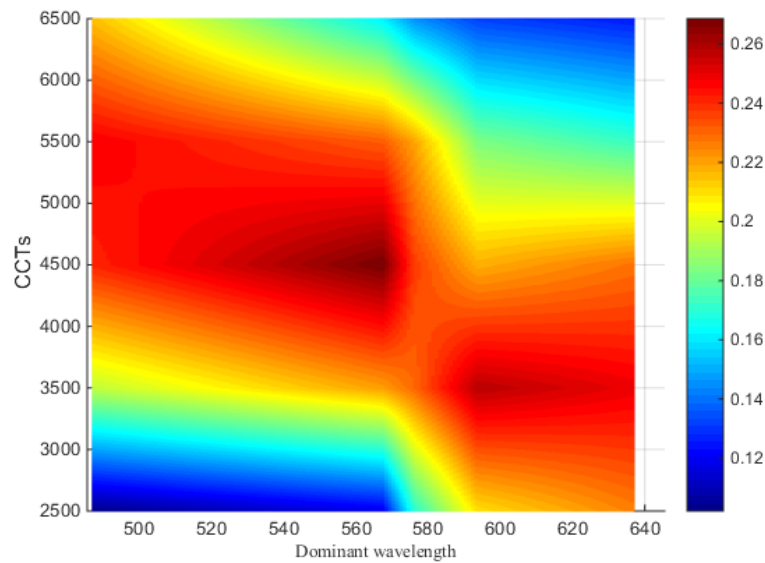


Figure 5 The X-Y plane projection of the model in Figure 4

4. CONCLUSIONS

An experiment was carried out to investigate the correlation between human subjective preference for LED lighting and the combination of color objects and lights sources when viewing different color objects. To achieve that, a two-dimensional curved surface fitting method was developed and the proposed method was found through the psychophysical experiment, whose perdition error is only around 3.5%.

The authors believe that the research findings will provide valuable reference for the lighting design in related applications, especially for the monochromatic conditions.

ACKNOWLEDGMENTS

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Color appearance shift by a surround color for pseudo-cataract observers

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ABSTRACT

As cataract progresses, crystalline lenses become hazier resulting in poor vision. Though cataract is the most common age-associated eye disease, its individual variation is too large to estimate the severity from age. Here we propose a method for estimating a haze value of crystalline lens, as a measure of cataract severity, from a simple color naming procedure. In the present study, a relationship between haze of lens and color appearance was derived from an experiment. In the experiment, participants viewed a stimulus on a display through foggy filters with several haze values. A small achromatic test circle with a large chromatic surround was presented on the display and its color appearance was evaluated by elementary color naming method. Without a filter or through a filter of lower haze value, the achromatic test appeared chromatic with an opposite hue to the surround due to simultaneous contrast. On the other hand, a foggy filter caused an optical scattering from the surround and the test appeared chromatic with the same hue of the surround consequently. The rate of color appearance shift as the surround's luminance was increased was larger with a foggy filter. The obtained relationship is available to estimate the haze factor of the cataractous crystalline lens.

Keywords: cataract, haze value, elementary color naming method, foggy filter

1. INTRODUCTION

Cataract is the prevalent age-related eye disease. Given the increasing elderly people and the patients of cataract, it is important to assess cataract progresses and provide the better visual environment. Several simplified methods of cataract assessment have been proposed on the assumption that a haze factor of a crystalline lens increases as cataract progresses¹⁻⁵.

In this report, we propose another method by measuring color appearance changes caused by surrounding color. There are two antagonistic components in surrounding color effect: perceptual simultaneous color contrast and physical overlay of scattered light. Simultaneous color contrast is perceptual phenomena which induces its opposite color appearance onto the central color stimulus. On the other hand, as cataract progresses a hazier crystalline lens scatters a light from the surround over the retinal image of the central target, inducing color of the same hue (physical overlay of scattered light). Simultaneous color contrast is dominant with a clear crystalline lens and color appearance gradually shift toward the hue of surround color as the lens becomes hazier.

In the present study, the relationship between lens haze factor and color appearance was examined to derive a function estimating haze factor from the color appearance. In the experiment, non-cataract subjects observed a center-surround stimulus configuration through filters of known haze factor and reported color appearance with elementary color naming method.

2. EXPERIMENT

Three young subjects ranging from 21 to 22 years of age participated in the experiment (two males and one female; including the first author).

All stimuli were presented on a 17-inch CRT monitor and controlled by a personal computer which also controlled the experimental timing and recording from a keyboard. Figure 1 is an illustration of example of stimulus display. In the display, a central target and a surrounding stimulus (background) were presented. The central target was a filled gray circle with a solid black line and subtended 1.08 deg

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in diameter. The luminance of stimulus was either 4.54, 15.3 or 32.2 cd/m^2 . The surrounding stimulus was filled rectangle, subtending 8.45×10.52 deg. The color of surrounding stimulus was yellow, green, red, blue, or gray. The luminance of gray surrounding stimulus was the same as that of the central target. For each of the other colored surrounding stimuli, several luminance conditions were set (see Table 1). Filters FOGGY (A) and FOGGY (B) (Kenko) were used to simulate cataract (a pseudo-ataract). Five severity levels of cataract were simulated by the haze factors 0, 2.56, 5.08, 7.55, and 10.11%, measured by Haze Meter (NIPPON DENSYOKU NDH4000). There were 270 conditions: 5 haze factors $\times$ 3 central target conditions $\times$ 18 surrounding stimulus conditions.

Table 1. Colors and luminance of the surrounding stimuli.

Colors	Luminance (cd/m^2)					
Yellow	2.08	3.84	7.87	15.7	31.7	63.9
Green	2.34	4.26	8.7	16.7	31.7	
Red	2.22	4.26	8.5	15.75		
Blue	2.17	4.17	5.82			

The experiment was conducted in a dark booth. The stimuli were viewed monocularly with the right eye from a distance of 123 cm. The subject wore the glasses consisting of the foggy filters. At the beginning of each trial, a central target and a gray surrounding stimulus were presented (blank frame, see Figure 1). After the subjects pressed a key, the gray surrounding stimulus was replaced with colored one and remained for 0.35 seconds. A blank frame was then presented. The presentation duration was determined by preliminary experiments and a previous study⁶ so that clear simultaneous color contrast would be observed. The subjects orally reported color appearance of the central target by the elementary color naming method. In the elementary color naming method, an observer reports the appearance of stimulus by estimating percentages of its whiteness, blackness, and chromaticness in a way that the total percentage of these attributes is 100%. If the chromaticness is perceived, the observer is further asked to estimate percentages of color components, i.e., red, yellow, green, and blue, in a way that the total percentage is 100%. In the present experiment, the subject was allowed to view the test frame repeatedly (until they judged the target's color appearance) by pressing the key. After that, the surround of the test frame was changed to the other surround. There were 1080 trials in total; 4 trials for each condition. In each trial, the color and the luminance of surrounding stimulus and the luminance of central target were randomly selected.

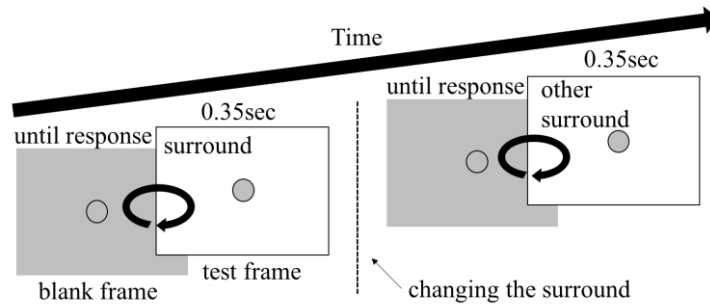


Figure 1. An example of stimulus presentation in the experiment.

3. RESULTS AND DISCUSSION

All the data were plotted in polar coordinates where the percentage of chromaticness was taken as radius, and hue (red, yellow, green, and blue) as angle. Due to the simultaneous color contrast, the appearance of gray central target should shift towards the complementary color of the surrounding color.⁷ On the other hand, foggy filters would cause the scattering light from the surround inside the subject's eye, and the color appearance shift towards the complementary color (caused by the simultaneous color contrast) should be cancelled out. Consequently, the color appearance of central target should be achromatic or shift towards the hue of surround color.

Figure 2 shows the results of one subject (TM) in the haze factors of 0 and 10.11% when the central target luminance was 32 cd/m^2 , and each error bar shows the standard error. As seen in Figure 2a, the color appearance of central target did not change due to no optical scattering. However, when the yellow, red or blue surround was presented, the appearance of central target was slightly deviated from the center

in the complementary color direction, indicating that the simultaneous color contrast took place. When the haze factor was increased (Figure 2b), effects of simultaneous color contrast became weaker, and the color appearance of the central target shifted towards the surrounding color due to scattering from the surround. Similar tendencies were observed in all the luminance conditions of the central target (i.e., 4, 16 and 32 cd/m^2) and the appearance shift was the largest in 32 cd/m^2 .

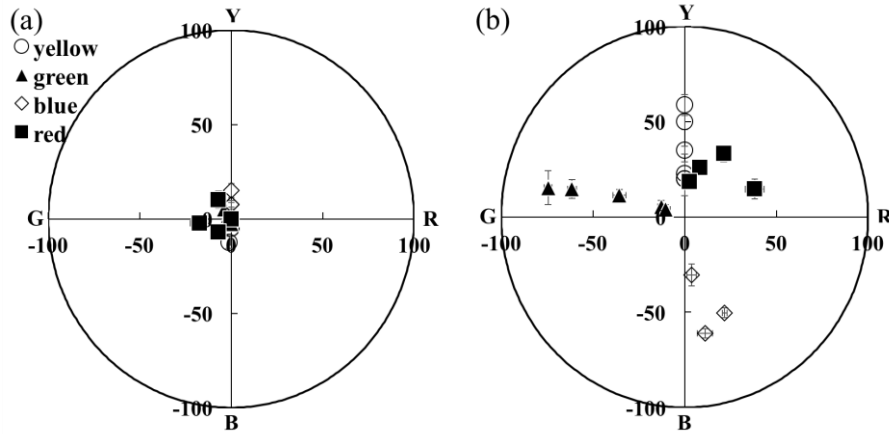


Figure 2. Color naming results by one observer (TM) in the haze factors of 0 (a) and 10.11% (b) when the central target luminance was 32 cd/m^2 .

Figure 3 shows the color appearance change in the center whose luminance was 32 cd/m^2 . The abscissa shows the luminance of the surround in a logarithmic scale. The ordinate indicates Y-B values in Figure 3a and 3b, and R-G in Figure 3c and 3d respectively. The data points were approximated by straight lines. With the haze factor of 0 %, the luminance increase in the surround did not affect the color appearance of the center and the regression lines were almost flat in each chart. With hazier filters, the luminance increase in the surround caused larger appearance change and the slope of the regression lines became steeper. Note that with the yellow surround of the highest luminance, the central target appeared almost dark gray by the brightness contrast from the surround, as shown by the rightmost points on Figure 3a.

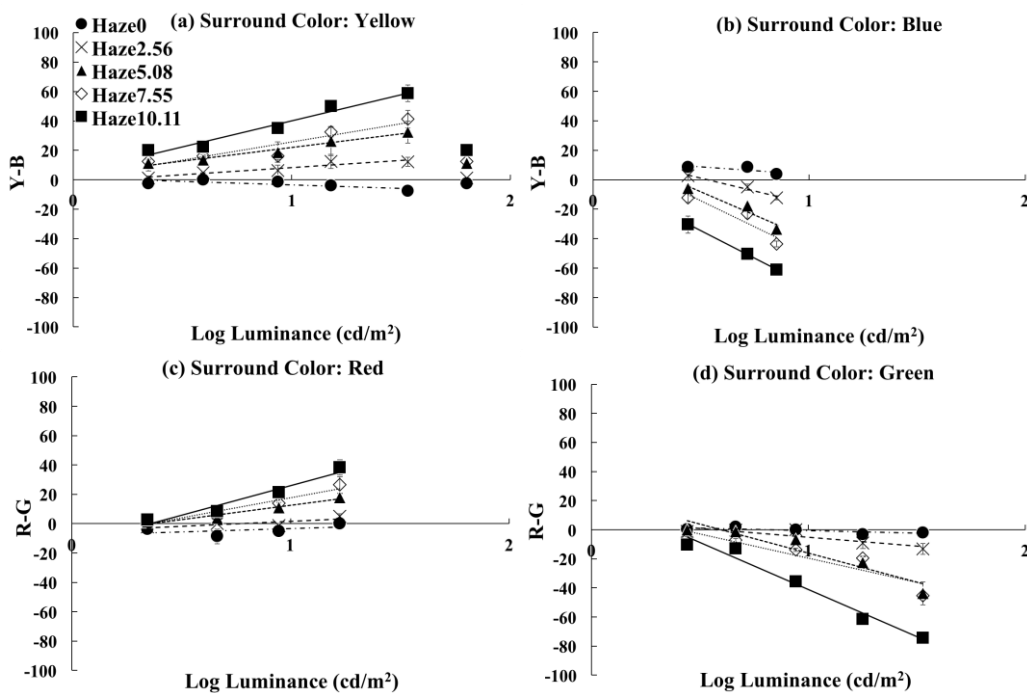


Figure 3. Color appearance change in the central target whose luminance was 32 cd/m^2 . Observer TM.

The slope S of the regression lines from Figure 3 was shown in Figure 4 as a function of haze factor H . The slope S should be zero at $H = 0\%$ because no appearance shift should be caused by the luminance increase in the surround. Thus the relationship between the slope S and the haze factor H should be expressed by Equation (1). The coefficient a calculated for each surrounding color was shown in Figure 4.

$$S = aH \quad (1)$$

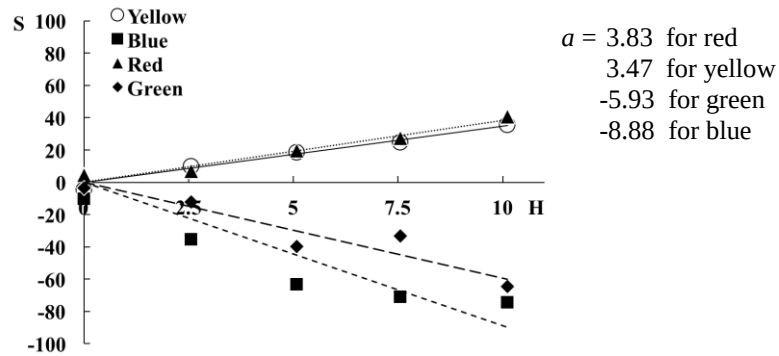


Figure 4. The rate of color appearance change with luminance increase in the surround (S , slope in Figure 3) as a function of the haze factor H for the central target of 32 cd/m^2 . Observer TM.

The haze factor of cataractous crystalline lens would be estimated using Equation (1). A procedure would go on as follows. Firstly, a cataract observes the same center-surround stimulus configuration and orally reports the color appearance in the central target by the elementary color naming method. The color naming task is repeated with the surround of several luminance levels. Then the rate of color appearance change with the surround luminance is calculated as S . Finally, the haze factor H of the cataract lens is estimated by the inverse function of Equation (1).

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Whiteness (W) and lightness (L*) relationship

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ABSTRACT

In developing photographs of scenes to give the same impression of lightness constancy for the real scenes a function to relate the lightness L^* to the amount of whiteness W that can be obtained by the elementary color naming method became necessary. Fifteen Thai young subjects and two Japanese participated in the experiment and the function was derived, which differed from previous result obtained for 4 Thai subjects and from the data given by NCS, but slightly.

Keywords: Elementary color naming, Whiteness, Lightness, Lightness constancy, Photograph

1. INTRODUCTION

It is useful if we can perceive the color constancy and the lightness constancy in a photographic scene but we cannot normally. The concept of recognized visual space of illumination RVSI says that we can get the constancy if we can perceive a 3D scene in a photograph. Phuangsuwan et al developed a D-up viewer and a stereoscope with which a 2D photograph was perceived as a 3D scene and showed the color constancy in the photograph^{1, 2)}. However, the D-up viewer or the stereoscope are not available at any time and at any place and it was desired to give the same color appearance in an ordinary photograph as for the real space. The modification was done for the lightness constancy in a photograph and the result

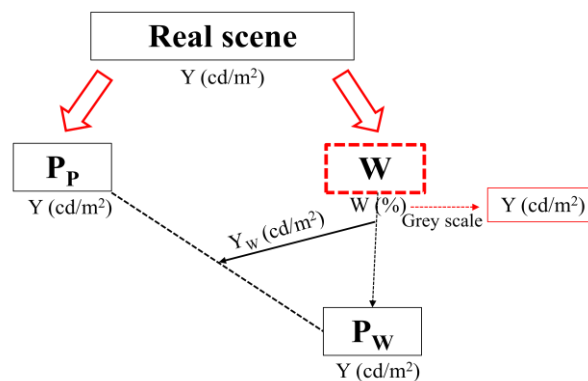


Figure 1. Flow chart of picture modification.

was satisfactory to some extent^{3, 4)}. Figure 1 shows the flow chart of the modification. The right-hand flow shows the determination of the amount of whiteness and blackness for a real space by the elementary color naming method. The left-hand side flow shows a photograph modification process. P_p is a photograph of a real scene and this will be modified to reproduce the whiteness W . P_p is specified by the lightness L^* and it is necessary to relate W to L^* to get a photograph that gives the same impression of lightness appearance for the real scene. It is important to derive the W and L^* relation. We have a relation in the natural color system NCS developed in Sweden but the data were based on European subjects. Phuangsuwan et al reported an equation to relate W to L^* based on Thai subjects but only 4 subjects⁴⁾. In this report the relation was obtained by 15 Thai subjects.

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2. METHOD

Sixteen achromatic patches covering the metric lightness L^* of 21 to 93 with steps of about 5 were prepared. A subject was presented with one of them at a time through a square mask of $3 \times 3 \text{ cm}^2$ at distance of about 65 cm giving $2.6^\circ \times 2.6^\circ$ arc of visual angle under fluorescent lamps of the daylight type of which chromaticity point on the CIE xy diagram is shown by an open triangle in Fig. 2. The open square is for D65 and open circle for the CIE light source A. The solid curve shows the black body locus.

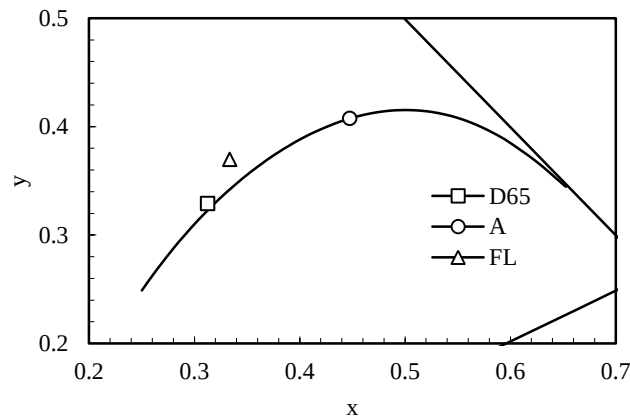


Figure 2. Illumination in the subject room shown by an open triangle.

The mask for the test patch was made of a gray paper of $L^*=55$ and the measurement were carried out in a room illuminated at 900 lx at the patches.

Fifteen Thai and two Japanese participated as subject in the experiment and they were asked to judge the amounts of whiteness and blackness for each patch in percentage, which were presented in a random order. Five such sessions were repeated in different sessions. Three subjects were well trained for this kind of experiment but others were naïve and participated to the experiment for the first time. Except the three subjects they were all undergraduate students of the university.

3. RESULTS AND DISCUSSION

Results of two subjects SS and CP are shown in Fig. 3, where the lightness L^* is taken along the abscissa and the amount of whiteness along the ordinate in percentage. Short vertical bars indicate standard deviation of five repetitions. The subject SS was a naïve subject while the subject CP well trained for psychophysical experiment. The former subject showed smaller standard deviation and the experience was not reflected in the results. Mean of these curves from all the 15 Thai subjects was taken and is shown in Fig. 4 with standard deviation among subjects. The individual variance is not large.

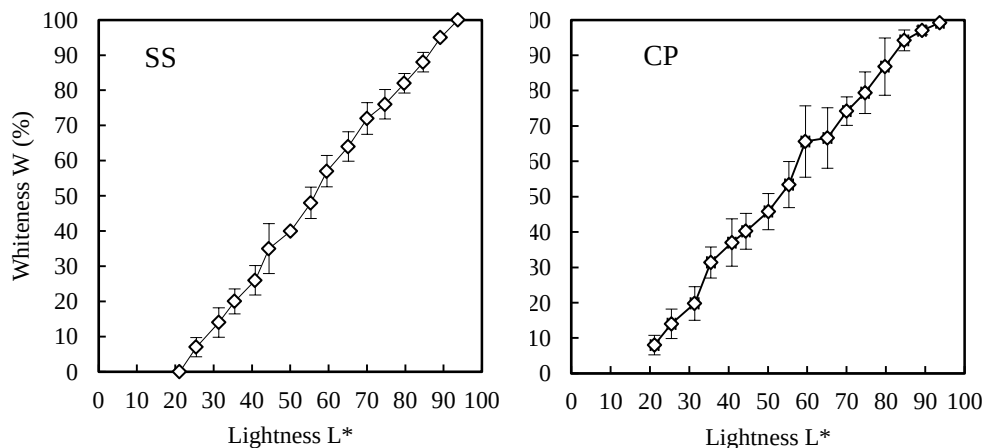


Figure 3. Results from subject SS and CP.

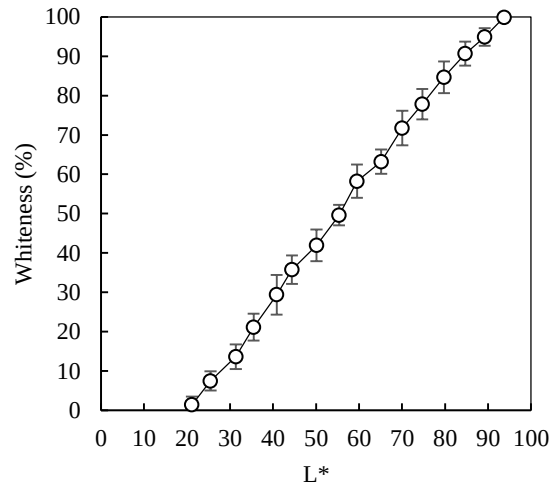


Figure 4. Average of 15 subjects with standard deviation.

In Fig. 5 other previous two results are plotted together with the present result, the present result by open circles, the previous result by Phuangsuwan et al.³⁾ by open squares, and NCS by open triangles⁵⁾. It

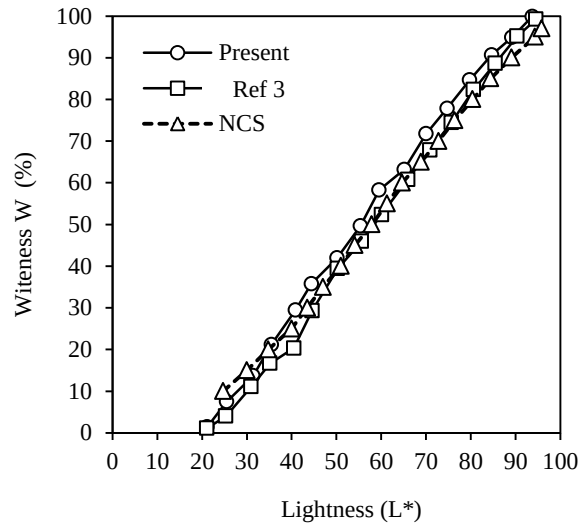


Figure 5. Comparison of the results from present with Ref 3 and NCS.

is seen that the present result locates upper than other two results indicating more white judgment for each patch. The previous results³⁾ were obtained in a room illuminated by fluorescent lamps of daylight type but the illuminance was not controlled, while the present data were obtained at a constant illuminance. The NCS data were obtained under the CIE D65. These differences of experimental condition might have caused the difference in the results. In spite of the difference in detail among three results they are all approximated by lines to show a simple relationship between L^* and W . The regression lines are

Present results	$W = 1.394L^* - 27.6,$
Ref 3	$W = 1.401L^* - 31.9,$
NCS	$W = 1.278L^* - 26.5,$

and they are shown in Fig. 6.

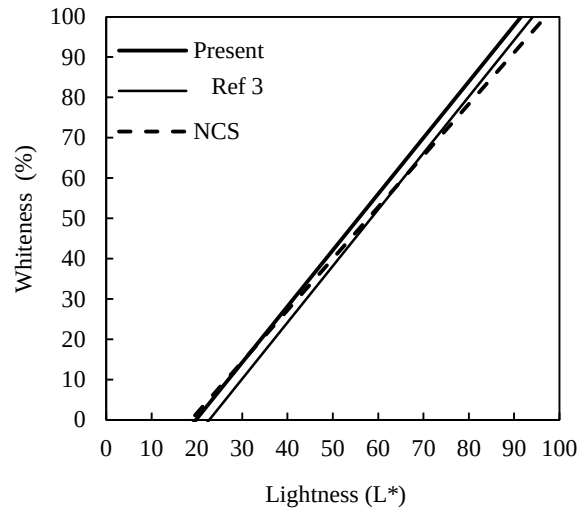


Figure 6. The regression lines of the present result, Ref 3 and NCS.

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Study on Spectral Color Reproduction Based on Ordinary Lighting Environment

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ABSTRACT

This paper proposes a method to reconstruct the surface spectral reflectance based on conventional lighting environment even without knowing the light source spectral power distribution and the spectral sensitivity of the camera. In our method, we shoot two ordinary light color samples in office environment and finally reconstruct the surface spectral reflectance by using the mechanism of basis vector and polynomial model. The imaging quality was evaluated by the mean square error and color difference. Analyzing the single light source and dual light source model, the experimental results show that the dual light source model can effectively improve the accuracy of spectral reconstruction.

Key words: spectral color reproduction, basis vector, polynomial model, digital camera signal, dual light source

1. INTRODUCTION

The spectral reflectance is the most accurate way to describe the color. Except for special materials (such as fluorescent substances), the spectral reflectance of object surface color is barely restricted by the illuminant, observer condition and equipments, so it is suitable for high-fidelity color reproduction and transmission¹. Spectrophotometer can measure the spectral reflectance of the object, but a large area of the sample can not be efficiently measured using non-contact method. Efficient measurement method of spectral reflectance becomes an important research topic in the field of color science^{1,2}. Multispectral camera with dozens of channels can be used for measuring spectral reflectance of each pixel effectively, but present multispectral camera is not widely used due to complex structure, high cost, poor efficiency and etc.³.

As a popular electronic product and main image acquisition tool, digital camera is widely used in our daily life. However, general commercial digital cameras with three-channel images have several limitations. First, in the process of color images acquisition, they only get colorimetric information in certain condition. Furthermore, the captured color data is much influenced by device and illuminant. Moreover, metamerism phenomenon dissatisfy the needs of high-precision color reproduction^{3,4}. This paper proposes a method based on conventional lighting environment to reconstruct the spectral reflectance of each pixel of the imaged surface without knowing the spectral distribution of the light source and the spectral sensitivity of the camera. The proposed method effectively avoids metamerism phenomenon and achieves cross-media color reappearance. This research uses general commercial digital camera to collect RGB signals of test sample and training sample in two kinds of office light source

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separately and reconstruct the surface spectral reflectance by using the mechanism of basis vector and polynomial model. Employing the knowledge of colorimetry and computer graphics, eventually we finish the color reproduction of test samples to as well as the evaluation and discussion of the reproduction effect.

2. THE ALGORITHM OF SPECTRAL RECONSTRUCTION

Assume reflectance of the surface is an n -dimensional column vector. The spectral reflectance of m samples can consist of a matrix R , which satisfies $R = \{r_1, r_2, \dots, r_m\}$, The matrix R that can be expressed by a series of linear array of the basis vectors^{5,6} is given by Eq.1:

$$R = \sum_{i=1}^k e_i a_i = EA \quad (1)$$

Where e_i is the extracted basis vector, $E = (e_1, e_2, e_3, \dots, e_k)$, the coefficients $A = (a_1, a_2, a_3, \dots, a_k)^T$.

There is a linear relationship between camera response C and reflectance $\tilde{R}$ may be defined as:

$$C = Q\tilde{R} \quad (2)$$

Finally, reflectance of the verification target $\tilde{R}$ is estimated by Eq.3.

$$\tilde{R} = E(A_0 C_0^T (C_0 C_0^T)^{-1}) C \quad (3)$$

Where C is the new color sample's camera response, C_0 is the training sample's camera response. Signal vector C that is expressed as $[r, g, b]^T$ under a certain illuminant and observation conditions. It is

extensible, that is, we could improve the accuracy by adding more items⁷ such as r^2, g^2, b^2 , etc. In this paper, when using digital camera signals of dual-mode light source to reconstruct spectral reflectance, the basic channel number of digital camera should be increased from 3 to 6⁸. With reference to the single light source lighting condition, extending the signal vector we can get 24 signal vectors, which is:

$$C = [1, r, g, b, r', g', b', rg, rb, gb, r'g', r'b', g'b', rr', gg', bb', r^2, g^2, b^2, r'^2, g'^2, b'^2, r g b' g' b' b'] \quad (4)$$

Where r, g, b and r', g', b' respectively correspond to the collecting three-channel signal of digital camera under the two kinds of light source.

3. EXPERIMENT

In our experiments we selected the ColorChecker Digital SG (SG) of X-rite company as training samples and selected the ColorChecker Color Rendition Chart (RC) as test samples. With given spectral reflectance by the company, color card SG and color card RC could be regarded as the standard spectral reflectance in this experiment. The white balance of digital camera is set to 'custom white balance' before the experiment and shooting model adopts full manual mode. Color samples are placed in the center of the field of view as far as possible while shooting. In addition, the camera and the target object remain stationary. We just change the lighting environment. The experiment used the remote control in order to ensure the accuracy. RGB signals which are obtained respectively for two kinds of samples under two ordinary lighting conditions in the office using the Canon EOS 400D digital camera are normalized to the range of [0, 1]. Color card is an important tool used for color measure and reappearance quality evaluating. Three methods were designed in the experiment: natural light (referred to as D), fluorescent

lamp light with the curtains drawn (referred to as F) and a combination of the two light source that is called dual light source mode (referred to as DF). As the change of the angle of light emitting in the room should be as small as possible, the experimental time was chosen at 13:00 to 15:00, and it must be sunny. Using Canon EOS 400D to collect the RGB signals of RC color card under different illuminant, then we reconstruct the surface spectral reflectance of the color card by using the mechanism of basis vector and polynomial model.

4. RESULTS AND ANALYSIS

Table 1 shows the experimental results according to the method above, which illustrates comparative analysis of the spectral reconstruction accuracy with three light source modes. Objective evaluation of color reproduction is based on the CIEDE 2000 color difference (the CIE 1931 standard observer) and root mean square error to evaluate the accuracy of spectral reconstruction, thus indirectly evaluating color reproduction quality .

Table 1. The experimental results of RC color spectrum reconstruction and comparison under the three kinds of light source mode

Light Mode	RMSE			$\Delta E_{00} - D65$			$\Delta E_{00} - A$		
	Mean	Max	Std.dev.	Mean	Max	Std.dev.	Mean	Max	Std.dev.
D	0.0131	0.0382	0.0074	3.5668	9.6653	2.2847	3.8100	8.8787	2.2549
F	0.0105	0.0296	0.0062	2.4638	10.8557	2.0228	2.9632	12.5686	2.9917
DF	0.0101	0.0272	0.0055	2.1103	5.7156	1.2483	2.7999	8.2516	2.1611

Table 1 shows that the spectral reconstruction accuracy under the dual light source is much better than it under the single light source. Because the effective channel of digital camera was doubled, the spectral reflectance reconstruction of training data information was more adequate. Figure 1(a) and (b) show the RC color cards were imaged using dual light source mode. According to the picture, the difference of appearance of color cards between different light source are clearly shown. It provides adequate information to reproduce the spectral reflection. Figure 1(c) and (d) show the rendered images of the spectral reflection reproduction using the dual light source mode (under D65 and A light source).

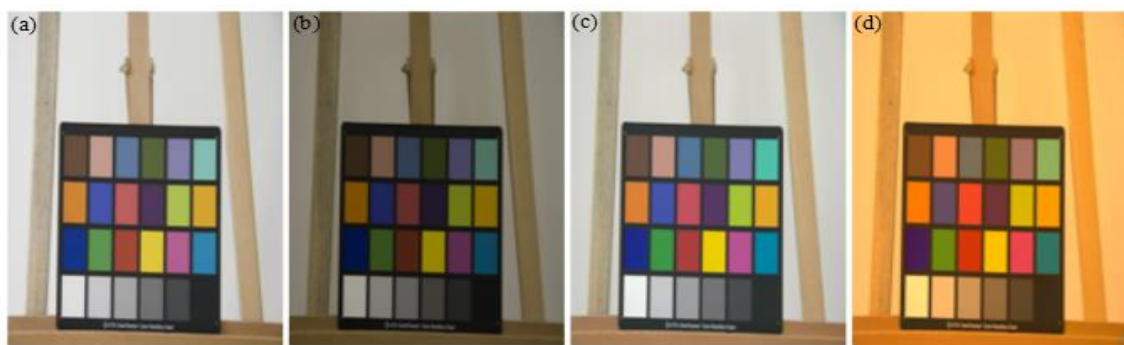


Figure 1. Photographed under the dual light source mode and rendered RC color cards under illuminant D65 and A. (a) Natural lighting; (b)Fluorescent lamp lighting; (c) rendered picture under illuminant D65; (d)rendered picture under illuminant A

5. CONCLUSIONS

This paper proposes a method to reconstruct the spectral reflectance in the circumstance of ordinary lighting environment, and combines colorimetry and computer graphics to achieve the true reproduction

on object surface color. We compare and analyze the spectrum reconstruction precision in two kinds of patterns of single light source and dual light source respectively. The preliminary experiment result shows the dual light source pattern with basis vector method and polynomial model is able to efficiently improve spectrum reconstruction precision. The future research will study training sample selection and illumination uniformity, which heavily impact spectrum reconstruction precision, and explore suitable optimization method so as to improve the quality of color reproduction.

ACKNOWLEDGMENTS

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Poster Papers

Color vision system in Garment brand and culture construction

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ABSTRACT

Objective The purpose of this thesis is probing into the analysis and construction of the permanent color vision system in garment brand culture.

Method Based on ergonomics of the traditional and modern garment, this paper is exploring technology elements of garment brand via the physical characters of color, human visual perception, and human psychological effect.

Conclusion Through the difference of the garment brands, people can see color as one of the core elements in garment design not only being used in all aspects of the industry chain, but also being used together with design methodology, aesthetics, marketing techniques, sociology etc, which embodies the cross-field and rich garment culture and technical connotation of color.

Key word: garment brand; garment culture; color system; ergonomics; industry chain

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Comparison of spectral matching methods for LED-based lighting system

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ABSTRACT

A spectrally tunable lighting system (STLS) composed of a large number of LEDs with different spectral power distributions (SPDs) has been designed and constructed, which involves the LEDs classified into 11 different kinds of channels. By the control of the output intensity of each type of LED, the lighting system can reproduce the SPDs of a variety of light sources in the visible region. In this study, two spectral matching techniques were tested, including gradient descent method and non-negative least square method. Different methods would predict different optimal spectral shapes for a given target SPD. Therewith the spectral matching accuracies were analyzed between the target and achieved SPDs and also their efficiencies were compared for those tested methods. Finally, a more suitable approach was determined for predicting the desired visible spectral power distribution of LED-based lighting system.

Key words: spectrally tunable lighting system (STLS), spectral matching method, spectral matching accuracy, spectral matching efficiency

1. INTRODUCTION

A spectrally tunable light source plays a vital role in the applications of radiometry, photometry and colorimetry.^[1] Consequently, the spectral matching of light sources is required to simulate individual SPDs of light sources to meet the demands of various fields. The most noteworthy advantage of LED for spectral matching is that the SPDs of single-color LEDs are often narrow-band so that the STLS utilizing plenty of LEDs with different SPDs can simulate the arbitrary SPD of a light source. Then it is convenient, by combining multiple sources, to design an illuminator that has some desired spectral properties. In this paper we describe such a multi-LED lighting system.

To guarantee the flexible spectral matching, the illuminator comprises 11 different kinds of channels, including single-color narrow-band LEDs across the visible spectrum as well as blue-pumped phosphor white LEDs with different CCTs. In the previous researches on spectral matching, the most widely employed spectral matching algorithms are iterative methods, which include steepest gradient descent method used by NIST^[2] and non-negative least square method^[3]. However, the existence of spectral shift would result in a deviation between the predicted and actual SPD of LED lighting system. And it is insufficient to perform only the preliminary spectral matching as the final consequence. So it is necessary to further optimize the preliminary spectral matching result to decrease the error between the simulated and actual SPD of the LED light source and output the optimal actual SPD.

2. METHODS

2.1. Construction of the STLS

The STLS was designed to be stable and easy to maintain. The basic structure is the 1.8-meter quadrate platform, which is located above the ground, and the height of the platform is above 2 meters off the floor. Thousands of LED dies are mounted on the quadrate platform's panel horizontally so that the optical axis of each LED is vertical to the illuminated plane. In the measuring experiment, a neutral grey target board was placed on the table, which was under the center of the platform. The spectral data of the mixed light was obtained indirectly by a Konica Minolta spectroradiometer of CS-2000 when the neutral grey target board was illuminated by the tested light source. The neutral grey wall and curtain were used to prevent the possible adverse experimental effect.

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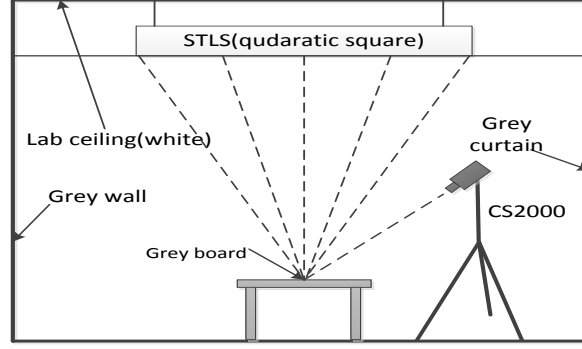


Fig. 1 The STLS platform in an immersive room.

2.2 Spectral Matching Methods

The gradient descent method of spectral matching can be expressed as

$$k_i^{(j)} = k_i^{(j-1)} - a \frac{\partial \sum_{380}^{780} \left(\sum_{i=1}^n k_i^{(j-1)} S_{\text{LED}i}(\lambda) - S_{\text{TARGET}}(\lambda) \right)^2}{\partial k_i^{(j-1)}} \quad (1)$$

where k_i denotes the power coefficient for the i th LED channel, $S_{\text{LED}i}(\lambda)$ and $S_{\text{TARGET}}(\lambda)$ stands for the SPD for the i th channel and the target respectively, the superscript j stands for the iterations, and a is the weighting coefficient. Eq. (1) will continue the iterations until the following solution converges:

$$\left| \sum_{380}^{780} \left| \sum_{i=1}^n k_i^{(j)} S_{\text{LED}i}(\lambda) - S_{\text{TARGET}}(\lambda) \right| - \sum_{380}^{780} \left| \sum_{i=1}^n k_i^{(j-1)} S_{\text{LED}i}(\lambda) - S_{\text{TARGET}}(\lambda) \right| \right| \leq \Delta \quad (2)$$

where Δ should be below 0.001. It is very critical for the gradient descent method to select an appropriate weighting coefficient a in Eq. (1) to ensure the convergence of solution. When the weighting coefficient a is far smaller than the empirical value, the program may run for a long time and not achieve an evidently good result. If the weighting coefficient a is much bigger than the empirical value, it would run fast but produce a poor accuracy. Thus the selection of coefficient a must consider the tradeoff between efficiency and accuracy.

The expression of the non-negative least square method is

$$\mathbf{k} = \arg \min_{\mathbf{k}} \left\| \sum_{i=1}^n S_{\text{LED}i}(\lambda) k_i - S_{\text{TARGET}}(\lambda) \right\| \quad (3)$$

where the meaning of all the variables are the same as Eq. (1). The non-negative least square method is speedy but uncontrolled without any constraint. Therefore, this study concentrated on the comparison between the gradient descent method and non-negative least square method.

2.3 Optimization of Spectral Matching

The lighting level of LED depends on the electrical power input to the LED. The heat converted by the loss of the electrical power leads to a rise of temperature in the LED 'PN' junction and so causes the shift of spectrum^[4]. According to the measurement results of our experiments, however, the shift extent of the actual SPD is discovered to be distinctly variant for different channels. It is indicated that the spectral shifts in the region of red and blue channel are the most obvious and the maximum shift value of peak wavelength between the lowest and the highest lighting level is beyond 10 nm while the spectral shift of other channels change very little. Hence, comparing to the preliminary spectral matching, the optimization would apparently improve the accuracy of the actual SPD in the wavelength region of red and blue channels. Although the peak wavelength shifts with the increasing lighting level, the FWHM (full width of half maximum intensity) of single-color LED changes little. It means that the relative SPDs at two arbitrary lighting levels for the same type of single-color LED are nearly overlapped in the shape.

The principle of the optimization of spectral matching is straightforward and is implemented on the basis of the preliminary spectral matching result. The SPD of each channel at the preliminary spectral matching is the absolute SPD of the corresponding maximum intensity, and the SPD of each channel at the optimization spectral matching is based on the lighting level of the preliminary spectral matching. Because the power coefficients $\mathbf{k}$ of the simulated result approximate gradually with the decreasing error

between the simulated and actual SPD, the SPD of each channel acquired by the preliminary spectral matching can be normalized to the maximum intensity and used as the SPD of each channel for the optimization spectral matching.

3. RESULTS AND DISCUSSION

It is not easy to make comprehensive description about the quality of spectral matching. Three measures, i.e., parameter p , root mean square error (RMS) and goodness-of-fit coefficient (GFC), were adopted to evaluate the quality of LED spectral matching, in which parameter p is the ratio of the integral absolute difference between the test and target SPD to the integral target SPD. When RMS and parameter p are closer to 0 but GFC is closer to 1, it means that the result of spectral matching is better. On account of the spectral matching range from 430 nm to 650nm in the visible light, the three evaluation parameters were also calculated within the same wavelength range.

A normal illumination level of 500lx for indoor illumination was selected as the matching illuminance. The absolute SPD of the target source was computed by the matching illuminance and then compared with its actual measurement. Table 1 shows the comparison between gradient descent method and non-negative least square method via the preliminary spectral matching, and Table 2 lists the corresponding comparison via the optimal spectral matching. It can be seen from Tables 1 and 2 that the matching time of non-negative least square method is faster than gradient descent method and their spectral matching accuracies vary for different target SPDs. In Table 1, it is found that the evaluation parameters of the actual SPD of D65 light source simulated by the gradient descent method are obviously poor, especially GFC is below 0.99, indicating this matching is quite unsatisfactory, while those of A light source by the two matching techniques are generally good and so relatively desirable. Afterwards, by comparing Tables 1 and 2, the accuracy of the optimal spectral matching is rather improved though the spectral matching time apparently increases very much. The spectral matching time in Table 2 prolongs to about 3 seconds for the gradient descent method and 1 second for the non-negative least square method respectively. Fig. 2 illustrates the comparison between the actual SPDs of the preliminary and optimal spectral matching by the non-negative least square method for A and D65 light source. It can be seen that the optimal spectral matching improves the accuracy in the blue and red channels, confirming that the optimization step of the spectral matching is very meaningful.

Table 1. Comparison between gradient descent method and non-negative least square method via the preliminary spectral matching.

Target source	Gradient descent method				Non-negative least square method			
	Parameter p	RMS	GFC	Match Time	Parameter p	RMS	GFC	Match time
A	0.0324	0.000140	0.9952	0.61s	0.0373	0.000143	0.9946	0.22s
D50	0.0383	0.000144	0.9956	0.64s	0.0484	0.000157	0.9924	0.15s
D65	0.0761	0.000184	0.9894	0.45s	0.0467	0.000152	0.9918	0.24s
D75	0.0552	0.000161	0.9912	0.52s	0.0583	0.000168	0.9911	0.22s

Table 2. Comparison between gradient descent method and non-negative least square method via the optimal spectral matching.

Target source	Gradient descent method				Non-negative least square method			
	Parameter p	RMS	GFC	Match time	Parameter p	RMS	GFC	Match time
A	0.0262	0.000123	0.9943	3.30s	0.0243	0.000120	0.9964	0.92s
D50	0.0216	0.000117	0.9966	2.64s	0.0237	0.000119	0.9969	1.12s
D65	0.0259	0.000122	0.9956	2.74s	0.0158	0.000109	0.9952	0.99s
D75	0.0341	0.000141	0.9958	2.57s	0.0373	0.000142	0.9947	1.06s

Similarly, the spectral matching results of A and D65 light source in Table 2 are used as an example in Fig. 3. As can be seen, the simulated SPD approximates to the actual one, demonstrating that the simulated SPD of the optimal spectral matching effectively predicts the actual one in the experiment.

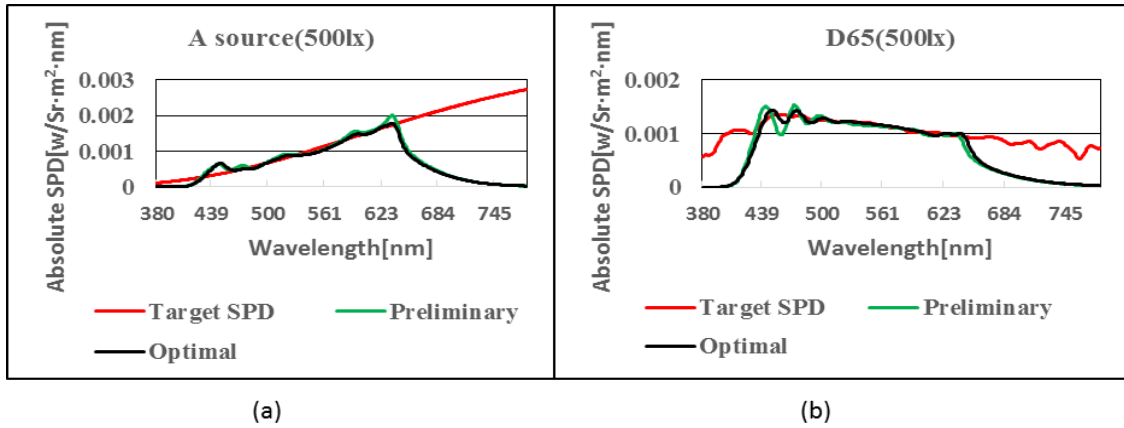


Fig. 2 Comparison between the actual SPDs of the preliminary and optimal spectral matching via non-negative least square method at illuminance of 500 lx, (a) A light source, (b) D65 light source.

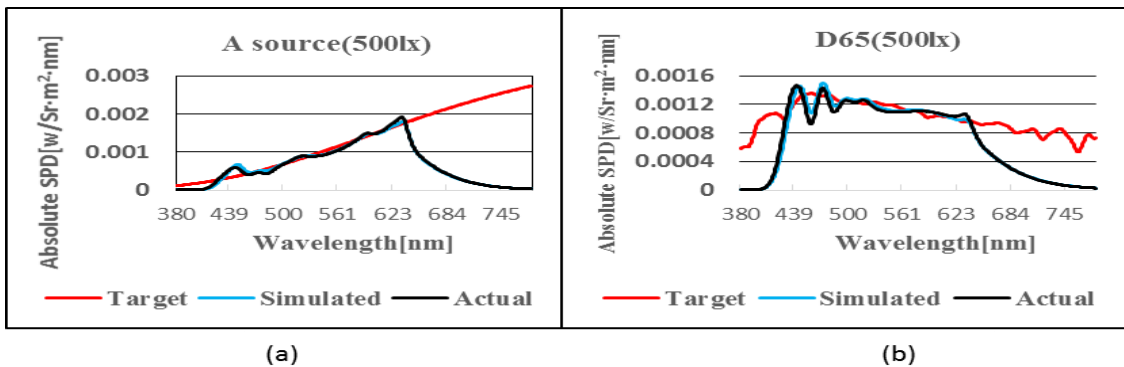


Fig. 3 Results of the optimal spectral matching at illuminance of 500 lx via non-negative least square method, (a) A light source, (b) D65 light source.

4. CONCLUSIONS

The non-negative least square method runs quicker than the gradient descent method since the iterations of the non-negative least square method are fewer than gradient descent method under the circumstance of the same accuracy. By the process of the spectral optimization, the simulated SPD of the optimal spectral matching is satisfactory. In addition, the optimal spectral matching improves the accuracy in the blue and red channels compared with the preliminary one. According to the experimental results, the optimal SPD of non-negative least square method is constant under the same constraints because its algorithm is uncontrolled while that of gradient descent method varies with the weighting coefficient α . Hereby, the non-negative least square method is considered to be recommended for matching the LED SPD without too many constraints due to its quick calculation. However, the parameter p , RMS, and GFC are just the parameters evaluating the spectral characteristics of specific SPD without taking into account other important properties such as color rendering, and CCT, which will be further involved in the future work.

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Instrumental difference for measuring skin colours between a spectrophotometer and a tele-spectroradiometer

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ABSTRACT

This paper studied the uncertainty of measuring skin colours between two measuring instruments: a de:8° spectrophotometer and a tele-spectroradiometer. The results indicated that the former had less uncertainty than the latter. There is a systematic difference between two instruments. i.e. the tele-spectroradiometer results are lighter and more colourful than the spectrophotometer results.

Keywords: skin colour, spectrophotometer, tele-spectroradiometer

1. INTRODUCTION

Human skin colour is a widely studied topic, due to its wide applications e.g. medical field, graphic industry, cosmetic industry, etc. However different applications focus on different aspects, and the measurement methods are different. For example, the contact method like spectrophotometer has been widely used for medical field to diagnose skin related diseases. For graphic applications, contact measurement for the colour reproduction and communication. The non-contact method has been used for the appearance related application such as cosmetic, Chinese medicines, skin lighting. However, researchers have not paid enough attention to the measurement difference of contact and non-contact methods. In some of the databases, the measurement results were obtained using different methods. This would lead to quite different results for the same sample, which is very confusing. The aim of this work is to discuss the instrumental difference for measuring skin colours using a spectrophotometer and a tele-spectroradiometer.

2. EXPERIMENT SETUP

A d:8° geometry spectrophotometer Datacolor 600 and a JETI Specbos 1211UV tele-spectroradiometer were used in the experiment to measure human skin colour. (In the following section, d:8° and TSR were referred as Datacolor 600 and tele-radiometer respectively) In order to obtain a comprehensive database, 47 subjects from 17 countries, were recruited to the experiment. They were 20 Chinese subjects (10 males and 10 females), 10 Caucasian subjects (7 females and 3 males), 10 Pakistanis (10 males), 5 Africans (5 males) and 2 Sri Lankans (2 males). The 47 subjects were divided into four groups according to the skin tones of the subjects. Since the 5 Africans subjects and 2 Sri Lankan subjects had similar dark skin tone, they were included into one group. The general information of the subjects are shown in Table 1.

Table 1. General information of 47 subjects participated in the experiment.

Group	No. of subject	No. of female	No. of male	Average age
Chinese	20	10	10	24.3
Caucasian	10	7	3	22.9
Pakistani	10	0	10	28.5
Dark	7	0	7	27.6
total	47	17	30	25.4

All subjects recruited had good health, i.e. they were not under any therapy or treatment which may lead to unstable skin condition. They were instructed not to use any skin care or makeup products before the experiment. During the experiment, glasses and accessories were removed. Before the measurement, all subjects should relaxed for ten minutes to adjust the measurement environment. For each subject, eight parts of the body were measured, and they were forehead, right cheek, left cheek, hand back, fist back, palm, dorsal forearm, and ventral forearm.

When measuring using the TSR, a VeriVide ceiling light including a D65 florescent simulator was used. During measuring, visual assessment using Pantone Skintone Charts was undertaking as well. When measuring using spectrophotometer, the instrument was made to ensure the skin colour to be stable, so that the instrument would not give too much pressure to the skin. In order to analyze the stability of the measurements, each part of the body was measured three times.

3. ANALYSIS

3.1. MCDM

Before further analysis, it is necessary to confirm the validity of the data. The index to evaluation the validity here is MCDM (Mean Colour Difference of the Mean). The definition of MCDM is shown in equation 1.

$$MCDM = \frac{\sum_{i=1}^n \Delta E_{abi}^*}{n} \quad (1)$$

Where,

$$\Delta E_{abi}^* = \sqrt{(L_i^* - L_{mean}^*)^2 + (a_i^* - a_{mean}^*)^2 + (b_i^* - b_{mean}^*)^2} \quad (2)$$

$$L_{mean}^* = \frac{\sum_{i=1}^n L_i^*}{n} \quad (3)$$

$$a_{mean}^* = \frac{\sum_{i=1}^n a_i^*}{n} \quad (4)$$

$$b_{mean}^* = \frac{\sum_{i=1}^n b_i^*}{n} \quad (5)$$

In this case, $n=3$. MCDM can demonstrate the inter-repeatability of a device. The MCDM of d:8° and TSR are shown in Table 2.

Table 2. The average eight MCDMs of two measurements of the four groups

d:8 °	handback	fist	palm	dorsal	ventral	forehead	leftcheek	rightcheek	mean
Chinese	0.32	0.09	0.19	0.11	0.64	0.14	0.12	0.18	0.22
Caucasian	0.52	0.50	0.31	0.22	0.52	0.29	0.39	0.65	0.43
Pakistani	0.27	0.58	0.68	0.41	0.09	0.15	0.27	0.33	0.35
Dark	0.34	0.08	0.28	0.26	0.28	0.12	0.18	0.15	0.21
Mean	0.36	0.31	0.36	0.25	0.38	0.18	0.24	0.33	0.30

TSR	handback	fist	palm	dorsal	ventral	forehead	leftcheek	rightcheek	mean
Chinese	0.23	0.27	0.39	0.57	0.72	0.25	1.50	0.54	0.56
Caucasian	0.29	0.57	1.02	0.12	0.46	0.33	0.27	0.82	0.48
Pakistani	0.27	0.41	0.83	0.22	0.40	0.24	0.66	0.41	0.43
Dark	0.33	0.31	0.36	0.12	0.34	0.37	0.96	0.22	0.37
Mean	0.28	0.39	0.65	0.26	0.48	0.30	0.85	0.49	0.46

Compared the general mean MCDMs of d:8° and TSR, it is obviously that TSR had greater uncertainty than d:8°. This is expected, because d:8° was contact measurement while TSR was non-contact measurement. During measurement, contact measurement can aim at the same measuring target more accurately. However for non-contact measurement, there was a distance between TSR and the measuring target. Any little shift would be amplified by the measuring distance. Despite the difference, the mean MCDMs of the two measurements were within acceptable range, which confirm the validity of the measurement data.

Among the four skin colour groups, the Dark group had the lowest MCDM than the other three groups. For one reason, the difference of measuring devices had lower discrepancy when measuring dark colour; for another, dark skin colours tend to be less influenced by the environment.

Which part of the human body can represent human skin colour? First of all, facial skin colour is prior to limbs' skin colour. That's because facial tone is more important in daily life. It plays an important role in the social activity. What is more, most of photographs include human faces rather than other parts of human body. According to table 2, among the eight body locations, forehead seemed to have the lowest MCDM value than others generally. Therefore the colour of forehead was proposed as the representative skin colour of human.

3.2. Colorimetric difference

The results from different instruments could be quite different. It is important to understand their colour shift. Figure 1 shows all the measurement results using the two measuring methods. All the colours are calculated using the CIELAB colour space under D65 illumination and 10° colorimetric observer.

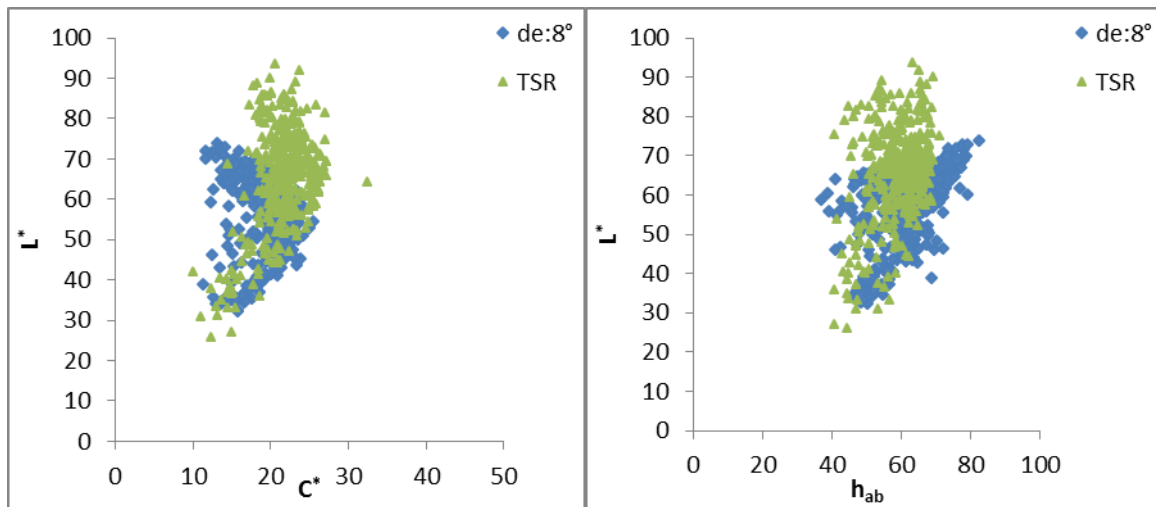


Figure 1. All the measurement results in $L^*-C_{ab}^*$ and L^*-h_{ab} planes

Figure 1 showed that, the results of TSR and $de:8^\circ$ were quite different, although their colour gamut had similar some similarity in both planes. It can be seen that the TSR results are in general lighter and more colourful than those of $de:8^\circ$ instrument.

Table 3. The mean difference of the two measurements using $de:8^\circ$ and TSR. Values were calculated using the result of TSR minus $de:8^\circ$

difference	ΔL^*	ΔC_{ab}^*	Δh_{ab}^*	ΔE^*
forehead	14.37	1.76	0.38	14.49
right c	3.41	2.45	0.06	4.21
left c	6.49	2.48	0.42	6.96
handback	8.63	2.94	-1.72	9.27
fist	-0.09	1.58	-1.70	2.33
palm	20.04	5.00	-2.09	20.76
backarm	6.36	3.65	-1.35	7.46
frontarm	7.47	3.89	-1.78	8.61
mean	8.34	2.97	-0.97	9.26

Table 3 shows the mean difference of the two measurements of the eight body locations. The mean colour difference is quite (mean ΔE_{ab}^* of 9). There is a clear trend can be found, i.e. the TSR results are systematically lighter by 8 ΔL^* units and more colourful by 3 ΔC_{ab}^* units.

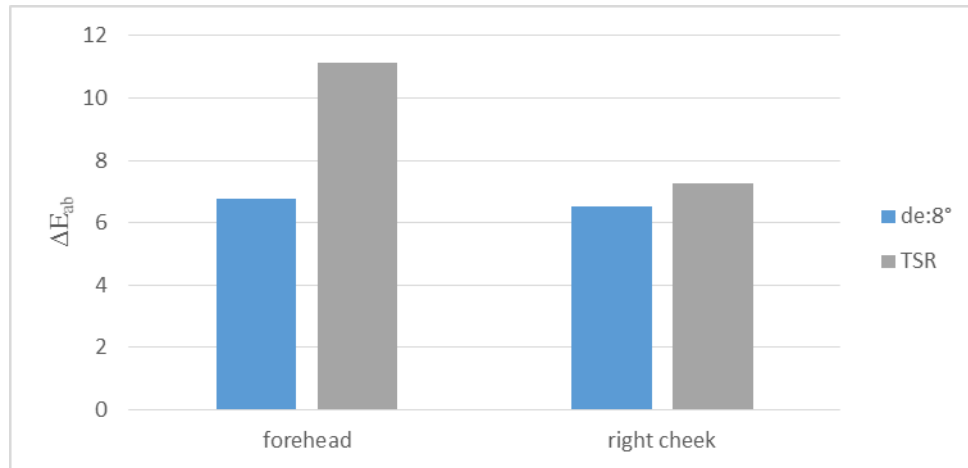


Figure 2. The colour difference of visual assessment and the measurements of de:8° and TSR

Finally, both instrumental results were compared with the visual assessment results. During the TSR measurement, a visual assessment was also conducted by three well trained observers. The visual assessment only included two locations and they were forehead and right cheek. The colour differences were calculated between two measuring methods and the results are shown in figure 2. It can be seen that the de:8° measurement was closer to the results of visual assessment. This suggested that measuring results were closer to the results of human perception. Though, more reach needed to give the verdict, here de:8° results gave a more reliable results to measure skin colour than those of TSR.

4. RESULT AND CONCLUSION

A large scale experiment was conducted including 50 subjects. The measurement uncertainty of the two methods mentioned above were discussed. Each locations of the eight body parts was measured four times, then the uncertainty were compared in the terms of ‘mean colour difference of the mean’ (MCDM). The results showed that forehead colour measurement was of less uncertainty compared to others of the body. And the measurement of d:8° spectrophotometer was more stable than TSR.

The colorimetric difference were also discussed. It was found that the results of the two methods were quite different in some specific aspects. Data measured using TSR had lighter and more colourful colours than the d:8° spectrophotometer. But the two measurements gave very similar hue angle distributions. What is more, the colour difference of lighter skin colours between tele-radiometer and spectrophotometer was much more prominent than darker skin colours.

ACKNOWLEDGMENTS

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Comparison of the chromatic adaptation between LED and fluorescent lamps to investigate the color constancy by adapting-adapted color appearance

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ABSTRACT

LED and fluorescent lamps were compared for the chromatic adaptation by utilizing the two-rooms technique and the elementary color naming. A subject judged the color appearance at the window between the subject room and the test room when the subject room was illuminated lamps of various colors while the test room was illuminated white. It was found that the adapted color and the adapting color are not normally opponent. The state of the chromatic adaptation was exhibited by the difference between the adapting and the adapted color and it was almost same both with the LED and the fluorescent lamps.

Keywords: Chromatic adaptation, Illumination, Elementary color naming, Color constancy, Opponent colors theory, Recognized Visual Space of Illumination RVSI

1. INTRODUCTION

It is generally considered that the color constancy is achieved by understanding and cancelling the illumination in a space. This expression can be put to another way that a person recognizes a space, understands the illumination that fills the space, and adapts to the illumination, which are the essential points in the concept of the recognized visual space of illumination RVSI. It is a big issue to investigate the strategy of the visual system how to understand and cancel the illumination but here in this paper we investigate the state of adaptation of the visual system to illumination on the assumption that the understanding for the illumination is already established in the visual system. The experimental technique is the two-rooms technique composing of a subject room and a test room which are connected by a separating wall with an window through which a subject observes a test stimulus placed in the test room. The illuminations of the two rooms can be independently adjusted and the technique may be called the environment-stimulus independent illumination technique. When the subject room is illuminated by a colored light, say red, and the test room by a white light the window appears very vivid greenish blue because of the chromatic adaptation to the red illumination if the test stimulus in the test room is uniform and large enough to cover the entire window. We can investigate the state of the chromatic adaptation, consequently the color constancy, by measuring the color of the test stimulus for various colors of the subject room. In this experiment we employed two kinds of lamps, fluorescent and LED and compared the state of the chromatic adaptation.

2. EXPERIMENT AND PROCEDURE

Figure 1 shows the apparatus. The subject room was illuminated by either five fluorescent lamps of the daylight type Lf or LED lamps attached at the ceiling. Lf was covered by a colored film to present a colored illumination. The test room was illuminated by two horizontal fluorescent lamps Lt of the daylight type same as for the subject room. They were adjustable in intensity. The window size was 40 cm wide and 30 cm high in the case of fluorescent illumination and 6 cm x 6 cm in the case of LED illumination. They gave the visual angle of $13^\circ \times 10^\circ$ and $1.9^\circ \times 1.9^\circ$, respectively when a subject viewed them at the distance 180 cm.

A uniform white board T without any scratches or texture was attached on the back wall of the test room of which size was 90 cm wide and 60 cm high, large enough to cover the window W entirely when a subject looked at the white board binocularly. In this way the test patch T appears as if a paper was pasted at the window. In other words T was perceived as an object in the subject room.

An achromatic patch of N6 was attached on the side wall as indicated by N. By observing the patch binocularly from the test room through a small window W of 2 cm x 2 cm the color appearance of the illumination in the subject room was measured, which was called the adapting color. The color appearance at the window when a subject judged in the subject room was called the adapted color.

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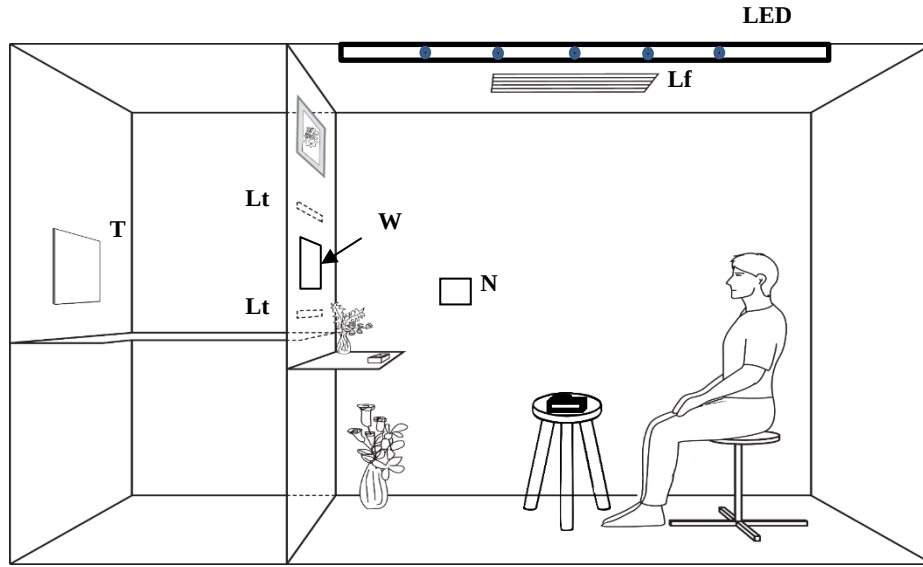


Figure 1. Apparatus

Seven colors were prepared for the subject room by fluorescent lamps as shown by open triangles in Fig. 2. Nineteen colors were prepared with LED as shown by open circles in the same figure.

In the fluorescent experiment the illuminance in the subject room was fixed at 50 lx and that in the test room at 9 lx. In the LED experiment it varied from 79 to 288 lx depending on colors. The illuminance in the test room was kept at 30 lx. In both experiments subjects perceived object color for the adapted color at the window.

The subject's task was to judge the color appearance at the window by the elementary color naming method, namely the amounts of chromaticness, whiteness, and blackness by percentage, and amounts of unique hues in the chromaticness again by percentage. Five subjects participated in the experiment, four Thai and one Japanese. They were all normal for color vision as tested by Ishihara test and 100 hue test.

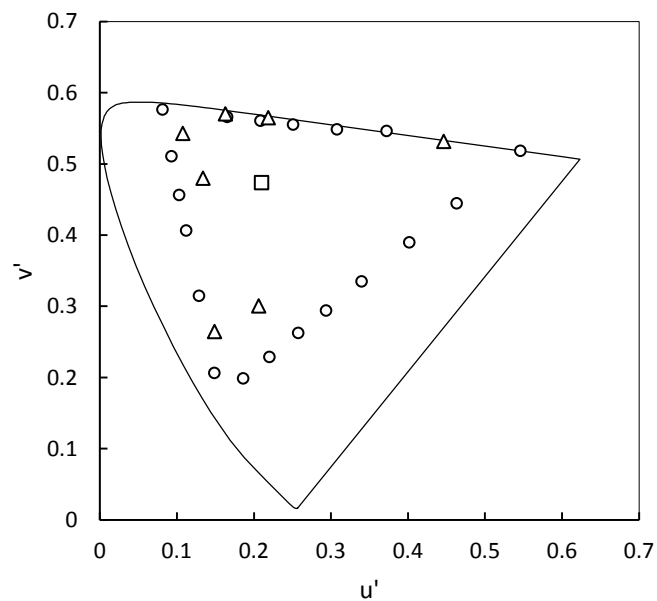


Figure 2 Chromaticities of fluorescent (triangles) and LED (circles).

An open square shows the equi-energy white.

3. RESULTS AND DISCUSSION

Results of two subjects are shown in Fig. 3 for a violet color illumination of LED ($u^*=0.221$ and $v^*=0.227$) by a polar diagram, which is used in the opponent-colors theory.

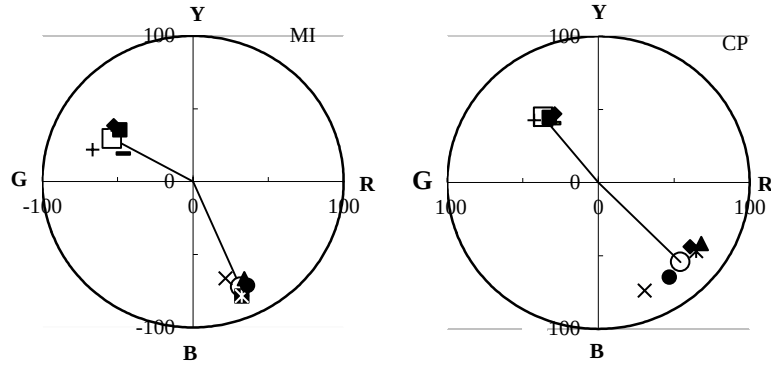


Figure 3. Adapting (lower right) and adapted (upper left) color for a violet illumination.

R, Y, G, and B indicate unique colors of red, yellow, green, and blue and the angle shows apparent hue determined by the amounts of unique colors. The origin of the diagram indicates zero and the circumference 100 % of the chromaticness. Small symbols at the lower right indicate results of adapting color after five repetition and a large open circle connected by a line shows their mean. Likewise, small symbols at the upper left and a large open square for the adapted color. The variance of five data points is not large but the variance between the two subjects is large showing individual difference in judging the color appearance.

We specify the apparent hue angle θ by the angle from the unique red axis in the anticlockwise direction. Then the state of the chromatic adaptation can be known by the difference of the adapted color from the adapting color, $\Delta\theta$. Figure 4 shows $\Delta\theta$ for the adapting color θ_{adapting} by open circles for the FL and open squares for the LED.

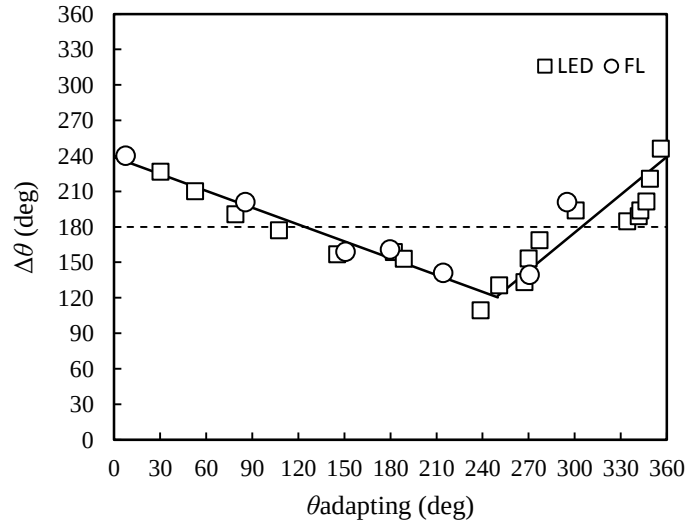


Figure 4. Adapting-adapted color $\Delta\theta$ for the adapting color θ_{adapting} .

Solid lines are regression lines and a dotted line are at $\Delta\theta=180$ deg.

Both results of FL and LED experiments came very close with each other in the $\Delta\theta$ vs θ_{adapting} relation implying that there is no difference in chromatic adaptation between the two types of lamps, which at the same time implies the color constancy will take place equally in both lamps. The data together can be approximated by two lines shown by solid lines, of which equations are given by

$$\begin{aligned}\Delta\theta &= -0.475\theta_{\text{adapting}} + 239 & 0 \leq \theta_{\text{adapting}} \leq 250, \\ \Delta\theta &= 1.067\theta_{\text{adapting}} - 145 & 250 \leq \theta_{\text{adapting}} \leq 360.\end{aligned}$$

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The Origin of the Relationship between Five Colors and the Directions in the Yin-Yang Five Elements Theory: The Importance of Allusion

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ABSTRACT

In Chinese astrology, there were four or five god-beasts (the Blue Dragon, the Vermilion Bird, the White Tiger, the Black Turtle, and the Yellow Dragon). These god-beasts were thought to have gained their colors after descending to earth from the heavens. The symbolism of their hues inspired people, a kind of allusion seen in Chinese and Japanese culture, as well as Eastern culture generally. The order of the colors represents the changing colors of the travelling sun and its effect on the world. The five colors of the Yin-Yang Five Elements Theory represent the five basic colors in Chinese and Japanese, and are important as they reflect cultural meanings that remain even today. The Yin-Yang Five Elements Theory relates to *feng shui*, also rooted in color and direction. The perspective in both focuses on relationships and transitions, making them somewhat different from the classical Four Elements Theory in the West. As with many things in Japan and China the directions, colors, and relationships are part of a rich set of symbolism and allusion. Dry landscape gardens (*karesansui*) and Buddhist vegetarian food (*shojin-ryori*) also exemplify this manner of thinking.

Keywords: Yin-Yang Five Elements Theory, Chinese and Japanese culture, allusion

1. INTRODUCTION: THE CLOSE RELATIONSHIP BETWEEN THE FIVE COLORS AND THE FIVE DIRECTIONS

The Yin-Yang Five Elements Theory has its roots in ancient China, but remains important today in Japan as well. In the modern world, it can also be seen in the practice of *feng shui*. In the Yin-Yang Five Elements Theory, the five colors are blue, red, yellow, white, and black. They also represent the five directions: east, south, center, west, and north. In ancient China, it was believed that in the directions around the center, there were four sacred animals – the Blue Dragon of the East, the Vermilion Bird of the South, the White Tiger of the West, and the Black Turtle of the North. It was also believed there was a Yellow Dragon in the center. However, it is stated that it is still a mystery what the basis is for east to be represented by blue and west by white (Seda, 2003: 164). We would like to explain why east is blue, south is red, west is white, north is black, and the center is yellow in this theory, with some discussion of the importance of the concept encompassed in the connecting center, yellow. We will also briefly compare it with the classical Four Elements Theory in the West.

The Yin-Yang Five Elements Theory is related to the practice of *feng shui*, which is said to be rooted in color and direction, because they are both heavily emphasized. The number of colors and directions, five, seems to come from combining dualism such as heaven and earth with triadism such as air (a gas), water (a liquid), and earth (a solid). The wind represents the atmosphere (gasses), water represents such things as rivers and seas (liquids), and earth represents land and geological features (solids). In *feng shui*, the ideal conditions for building a house would be based on the idea of the four guardians of the four compass directions, and would have the house in the center positioned with a river to the east, a road to the west, good open space to the south, and hills and mountains to the north.

Like many things in Japanese and Chinese culture the directions, colors, and relationships among things are part of a rich set of symbolism, and something that might seem minor can actually be an allusion to a larger truth or set of ideas. This can be seen at work in dry landscape gardens (*karesansui*), which are thought to represent a whole world or universe with a seemingly simple layout, in Buddhist vegetarian food (*shojin-ryori*) in which vegetable dishes are sometimes made to suggest or allude to meat-based dishes, and in symbolism throughout literature and art. The cultural anthropologist Edward Hall (1976) would have referred to these as examples of a “high context” system of communication, where a widely shared system of background knowledge makes it easier for the members of a community to

indirectly suggest and communicate meanings to each other through allusion, and without necessarily expressing an idea in words.

2. THE FOUR SEASONS AND THE INTERVALS BETWEEN THEM: THE IMPORTANCE OF *ma* AND CYCLES

The four seasons are connected with the Five Elements Theory, with spring as wood, summer as fire, fall as metal, and winter as water. The 18 or 19 days before the first day of spring, summer, fall, and winter are earth. This designation of the period before the start of each of the four seasons is an example of the importance placed on *ma* (intervals between and connecting things). Directionally speaking, spring/wood is rising upwards, summer/fire is up, fall/metal represents a central/stopping position, winter/water is down. We described *ma*/earth as coming between each of the seasons, but the main one can be thought of as the one between summer and fall. These *ma* (intervals) can be the source of transitions, such as the transition of the season from spring to summer – rather than happening instantaneously it is a process of gradual change. We believe this gradual change represents moderation, and is important in our lives as global citizens.

The knowledge and experience humans have gained through life in the natural environment is called *feng shui*, or *fudo* (in Japan). It is thought that the different climates of China and Korea compared to that of Japan are reflected in these names. In South China and the Korean Peninsula where there is plenty of land, but not as much water, the term is *feng shui* (wind and water). In Japan where water is plentiful and land is scarce, the term is *fudo* (wind and earth). The Five Elements Theory comes from an area with monsoons, and these monsoons change such things as temperature, the amount of available water, and the direction of the wind. They cause cold winter winds to blow from the north, so people plant trees to the north to block it, and homes are built with rivers and lakes to the south which will cool the hot southern winds. The word monsoon comes from the Arabic word *mawsim*, which means seasons, and the Chinese characters for it, 季節風, mean “seasonal wind.” It represents the idea that the direction of the winds changes with the season.

Yin and Yang in Yin-Yang Theory have an oppositional relationship, but while the concept represents two opposites, it also contains the idea that Yin and Yang are connected and sometimes similar. Between Yin and Yang is *taiji* (太極), a kind of unity before duality and the origin of Yin and Yang (Suzuki, 2002: 89). This idea of *taiji*, which values harmony and moderation, shows a characteristic of Eastern thought.

3. THE CHINESE CONCEPTION OF HEAVEN

According to Yosuke Nakajima (1986: 126), in the Later Han Dynasty, the philosopher O Ju (Wang Chong; 27-c.90) wrote in “Ronko” (Lunhen) that in the four directions in Heaven “there are constellations such as the Blue Dragon and the White Tiger,” and when their spirits came to Earth they took bodily form. He goes on to explain that “these four animals were to become the heads of blooded [non-spirit] animals.”

Although they already had colors in their names, they actually gained the colors when they gained bodily form. The colors represent human perspectives and attitudes toward gods, such as fear or hope.

In Chinese philosophy regarding Heaven, to the east there is a Blue Dragon, to the south there is Vermilion Bird, to the west there is a White Tiger, and in the north there is a Black Turtle. Essentially, the animals come from imagining the constellations in Heaven.

3.1 The Blue Dragon

The Blue Dragon is a legendary Chinese god-beast (one of the guardian deities of the four cardinal points) with the form of a dragon. The blue of this dragon is not only “blue” in the sense of the Japanese word, but also encompasses green. In Chinese it represents one of the five elements, wood, and the dragon’s body is imagined to be green. This dragon has also been imagined as the god of water, so the blue also normally represents such things as oceans, lakes, swamps, rivers, and ponds, and is the imagined color of an animal living in the water. The original idea this creature is thought to be based on was the Indian cobra, but in China there are no cobras, and so the concept was translated as dragon. The blue of the Blue Dragon is the color of the god that brings happy things, and also encompasses green. The color name represents the intense awe that people of that time would have felt at seeing something heavenly like the god-beast.

The Yin-Yang Five Elements Theory was created during the Western Han dynasty (206 BC - 9 AD), and has evolved little by little with the progression of time. The Blue Dragon has its origin in the way the seven (astrological) mansions in the east allude to the shape of a dragon when they are connected.

There has also been an idea of five dragons. The dragon is the best known of the four beasts.

3.2 The Vermilion Bird

The god-beast protecting the south is the Vermilion Bird, and it is at the heart of the Hydra (a kind of sea serpent) in the western constellations. The brightest star in the Hydra is the alpha star in its center, and it is a noticeable star of the second magnitude that looks orange. Because of its color, it alludes to the Vermilion Bird, which is a sign of auspicious things to come. Like the other god-beasts, it was thought that the Vermilion Bird gained its full vibrant color on arrival to earth. The allusions associated with the colors elicited certain feelings in people – in the case of the Vermilion Bird, the association was with hope and good luck. The Vermilion Bird is similar to the phoenix, and also the mythical Indian bird-god Garuda. It was envisioned as a large bird that shined and produced heat like flames. Garuda is also the name of the well-known Indonesian airline, Garuda Indonesia.

3.3 The White Tiger

Another of the god-beasts was the White Tiger to the west. The origin of the “white” was from bones, namely the bleached out white of the skull. The whiteness of bone exposed to wind and rain gave the color the meaning of lightness and purity, as well as emptiness. Because it was thought that paradise was to the west, as in Pure Land Buddhism, white was related to this idea, too. The sun sets in the west, bringing the end of the day, and so the color white was associated with the end of life. There is also an idea that white represents death and new life, because after the end of the day, the western sky is white, and the eastern sky at the start of the day is also white (cf. Wan and Umemoto, 2003: 182-83). White represents not only the start and end of the day, but also the start and end of color. This is an important cultural meaning of white.

3.4 The Black Turtle

The god-beast protecting the north is the Black Turtle (often depicted as a turtle with a snake), represented by the characters 玄武 (while the actual character for turtle is 龜). The Black Turtle was imagined to be the deification of the seven northern mansions (something like constellations in Western astrology). The name 玄武 is made up of two characters, 玄 and 武. The first character stands for black, and in the Yin-Yang Five Elements Theory is the color of the north, alluding to winter and the north. The other character, 武, is composed of two components: 矛 (a kind of weapon like a pike) and 止 (stop; prevent). Here it means shield. A turtle’s shell is hard like a protective shield, hence the name. Another idea is that the character 武 also means “something that can wind itself around its prey” like a snake. These two ideas together produce the combination of the turtle and the snake. The Black Turtle is often depicted as a long-legged turtle (the legs themselves an allusion to the snake’s body) with a snake wrapped around its shell. Sometimes the turtle’s tail is a snake. It is a kind of recursive set of allusions referencing each other. The way of thinking that produced this series of allusions and connected ideas is a philosophy that values keeping and protecting relationships and concepts – not easily throwing them away even if they seem relatively unimportant at the time.

3.5 The Yellow Dragon

It is said that the center position among the four god-beasts in the Five Elements Theory is occupied by the Yellow (or Gold) Dragon. The yellow color represents the metal gold. The dragon has a shining gold body. It lives on the plains, spatially in the center, and temporally in the intervals between the seasons. In ancient China yellow was a respected color representing royalty (especially the imperial court), and from that the yellow body of the Gold Dragon was given high rank. In a sense, it is the connection between all things: all the directions and all the seasons. An important concept here is that in traditional Western thought things may be seen as divisible into clear and separate categories, whereas the focus of this “center” concept is its position connecting the various other elements. Valuing it as the central and most important concept is recognizing the importance of fine, gentle transitions and the understanding that categories are usually not so clear. In other words, it values both differences and commonalities simultaneously.

3.6 The Brilliance and Usefulness of the Yin-Yang Five Elements Theory

In Japanese and Chinese, one word for blue (青色; *ao-iro*) represents not only the color of the clear sky and the coastal seas, but also the color between blue and yellow – the color of leaves – green (緑色; *midori-iro*). There is also another word for blue written differently, but with the same pronunciation (蒼; *ao*), and it also represents the color of the sky and sea, as well as encompassing green. In modern times we think of three pairs of opponent colors: white and black, red and green, and blue and yellow. The Yin-

Yang Five Elements Theory might seem to have only five colors, but with the understanding that *ao* (blue) refers to both the colors blue and green, it can be said that the Yin-Yang Five Elements Theory also has the six opponent colors.

From the time of the ancient Greeks, it was believed that all color was born from light and darkness, or white and black. Aristotle believed this, too, and it has been an important idea in Western thought about color since those times. In fact, Newton's experiments showed that scientifically color is not born from light and darkness, but that light contains the spectrum of colors. Even so, there have been great thinkers even after Newton that have been influenced by these classical ideas such as Johann Wolfgang von Goethe (1749-1832) and Arthur Schopenhauer (1788-1860), connecting them to modern times. This ancient idea was also present in the Yin-Yang Five Elements Theory.

Aristotle believed that the basic colors matched the four classical basic elements (fire, air, water, and earth). That is, air and water are themselves naturally white, and fire and the sun are yellow. Earth is naturally white, but takes on different colors from dyeing. This is demonstrated by ashes, because when the moisture is burned out, ashes become white. The basic colors such as white and yellow here are included in the Yin-Yang Five Elements Theory. It is a very great and practical idea.

3. CONCLUSION: ALLUSION IN EASTERN CULTURE

In Chinese astrology, the 28 solar stages along the zodiac are divided into four sets of seven stages, and they allude to the four god-beasts (the Blue Dragon, the Vermilion Bird, the White Tiger, and the Black Turtle). These god-beasts gain their vivid color when they come to earth, and their hues inspire people, reminding them of their supernatural power. This kind of allusion is also seen in Japanese gardens and paintings, and in dry landscape gardens (*karesansui*), and is an important part of Eastern culture.

The order of the colors (blue, red, yellow, white, black) represents the changing colors of the travelling sun and its effect on the world. White was said to be the end and start of the day, but after the day starts the world becomes blue. As the sun rises, it seems to be red. At midday it is yellow. As it sets the sky is white, and then there is blackness. The cycle starts again.

The five colors discussed above (blue, red, yellow, white, and black) are known as *seishoku* (正色), meaning something like "true colors." In addition to these, there are also five *kanshoku* (間色), which means something like compound colors, and includes green, crimson, yellow, *hanada-iro* (縹色: pale indigo blue, light blue), and purple. Yellow is included in both, demonstrating its importance.

The five colors of the Yin-Yang Five Elements Theory do not simply represent five colors. Using blue, red, yellow, white, and black as the five basic colors reflects a perspective on color from Chinese and Japanese, even if it contradicts 21st century science. The five colors of the Yin-Yang Five Elements Theory are meaningful as they stand for the five basic colors in Chinese and Japanese (language). These cultural meanings have not been lost in the 21st century. The Yin-Yang Five Elements Theory is deeply embedded not only in Japanese Shinto, but also Buddhism, Taoism, and Confucianism. Furthermore, this idea lives on as one kind of wisdom in modern Japanese culture.

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Effect of Drying Temperature on Print Quality for Offset Printing with Soybean Ink

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ABSTRACT

This study aims to investigate the effect of temperature in drying unit on printing quality in the aspect of color. Four levels of temperature, consisting of 65, 75, 85, and 100 C°, were conducted. The printing condition belongs to ISO12647-2.[3,4,5] At the beginning, the temperature of drying unit at swan neck of offset printing machine was approximately 33 C° as same as outside temperature in Bangkok and increases to 65 C°. The press was run continuously without operator interference and 1,000 sheets were printed, from which 278 were randomly selected for analyzing. Then, a next temperature was conducted. The color gamut of each temperature setting up was analyzed. The expected results will show the difference of density and color gamut when the temperature in drying unit change. The result of this study might be used as a guideline for operating drying unit in offset printing system.

Keywords: Drying temperature, Offset printing, Print quality

1. INTRODUCTION

In recent years, soybean ink was used as conservation environmental aspect. It becomes famous in printing house because of a renewable resource and conserving the finite petroleum supplies. Soybean oil does not evaporate the way petroleum does, and does not release harmful VOCs into the air that contribute to smog. It can decrease VOC emissions because it contains less than half the VOCs, requires less alcohol, works more easily with alcohol substitutes, and can be washed up without solvents. These inks reduce emissions from >30% VOC to as low as 2 - 4% VOCs [1]. However, one of the disadvantages of soybean ink is slower drying time, particularly on uncoated paper because it penetrates paper more slowly and is set primarily by oxidation. This ink contains amount of petroleum and soybean oils varied from printing system and color of ink. To achieve appropriate drying times, a proper amount of soybean oil is required. The higher the soybean oil is, the higher the temperature for drying is. This issue counteracts the environmental benefits of using soybean ink [2]. Moreover, the color of some colorant is changeable by ray and heat.

Green printing is defined as a movement in the printing industry to use natural resources to develop sustainable solutions for the future of printing and print advertising (Argent, 2009). Choosing low-volatile organic compound (VOC) inks, using recycled or tree-farmed paper, working with local suppliers, and reducing the use of chemical products in the plate-making and printing areas are all part of this effort. In this article, we discuss using soy oil based ink or vegetable oil based ink for offset printing as one of the elements of green printing.

There are many environmental and technical design advantages to the use of vegetable-based oils. Vegetable oil in printing inks is a renewable resource and conserves finite petroleum supplies. Soybean oil does not evaporate the way petroleum does, and soybean oil does not release harmful VOCs into the air that contribute to smog. Petroleum-based inks contain relatively high levels of VOCs, which are regulated by the updated Clean Air Act, as are the alcohol in fountain solutions and the solvents used to wash presses between jobs. VO inks will reduce VOC emissions because they contain less than half the VOCs, require less alcohol, work more easily with alcohol substitutes, and can be washed up without solvents. These inks reduce emissions from >30% VOC to as low as 2 - 4% VOCs (Eco- and Mild Solvent, 2009). The printing press can be cleaned with a water-based cleaner, replacing a high-solvent cleaner and further reducing VOC emissions. The printed product is easier to de-ink in the recycling process and results in a less hazardous sludge (Evans, 1997).

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However, the disadvantages of VO inks include their slower drying time, Most VO inks contain some petroleum oil to speed up drying or setting time and the amount of vegetable oil replacing the petroleum oil can vary by manufacturer and by press type and ink color. Pure formulation VO inks cannot be used in heat-set ink processes. To achieve appropriate drying times for these processes, vegetable oil may replace a portion of the petroleum oil. If no petroleum oil were used, print shops would increase their energy use for heating and drying the ink, thus counteracting the environmental benefits of using VO inks (Alternatives to Petroleum, 1997).

Print attributes are the individual characteristics within the printing process that can be measured and monitored during production so as to maintain a consistent quality. The most commonly monitored print attributes, and the ones of most interest to the researchers, are solid ink density, ink trapping, hue error, dot gain, print contrast, grayness, and gray balance (Lustig, 2001).

The purpose of this study is to identify the effect of temperature in drying unit on printing quality in the aspect of color differences in color gamuts of soybean inks that are used in multicolor (CMYK) offset printing. The following questions were investigated. Is there a difference in the color gamuts of the Soybean inks when temperature in drying unit increase?

2. RESEARCH METHODOLOGY

This research included an experimental research method. A layout was created for a 21.5” x 25.5” press sheet utilizing a custom Four-Color target. The target contained the following elements: CMYK tone scale, RGB overprints, color control bars, and other multicolor images. During the printing, these elements are used to evaluate the subjective and objective aspects of the image quality (see Figure 2). Figure 2 represents a partial portion of this test target. The data contained in this study were obtained by measuring the printed patches of this target (see Figure 2).



Figure 1. Four-color (CMYK) test chart.

The layout was processed through Prinergy Evo Raster Image Processor (RIP). It was output using a conventional halftone screen at 175 lines per inch (LPI), with elliptical dot shape by using the Creo Trendsetter Computer to Plate (CTP) device and two sets (VO and SB inks) of linear CMYK (four) offset plates were made, each set for the two types of ink. Linear plates were made by not using the previous dot compensation curve at the RIP in order to have input dots equal to output dots. Output dot values on the plates were measured and recorded for the plate curve (see Figure 3) by using Troika LithoCam plate dot reader via the LithoCam 2.5 interface application.

After the plates were made for the SB inks, a pilot test was conducted to achieve the target ink density values according to GRACoL standards. During the pilot test, 1000 (*N*) sheets were printed. Once density values had been achieved according to the standard ink density values, the press was run continuously without operator interference and another 1000 (*N*) test sheets were printed, from which a total of 278 (*n*) sheets were randomly selected for the analysis. The machine (ink/printing units) was cleaned for the second run. Table 1 presents the variables, materials, conditions, and equipment associated with the prepress and press parts of this experiment.

The same procedures were applied for printing with the VO inks. The sample size was selected in order of the specific confidence interval ($\alpha = 0.05$). A random sampling technique was used to identify the sample size because of the large size of total population. During the printing, an X-Rite ATD Scanning Densitometer was used to control the solid ink density on the press. After the printing, an X-Rite 528 Spectrodensitometer was used to collect the colorimetric and densitometer data from the sample. Christensen (1980) provides an objective method to determine the sample size when the size of the total population is known. The total population for this study is 1000 (N) printed sheets. The following is the formula to determine the required sample size. It was determined that the sample size for this study is 278 (n) printed sheets.

3. RESULT AND DISCUSSION

2.1 Data Analysis and Research Findings: Vegetable Oil-based Inks vs. Solvent-based Inks

A total of 278 randomly selected samples (printed sheets) were analyzed for each set of ink. Colorimetric and densitometer data were generated by using an X-Rite 528 Spectrodensitometer from the printed sheets. Descriptive and inferential statistics were the statistical procedures used to analyze the data. An independent samples one-tailed t-test was conducted to determine if any statistical differences exist between the mean scores of print attributes (dot gain and print contrast) of both inks. Colorimetric data and ΔE was used to compare the color gamuts of both inks. In comparing the differences between two colors, a higher ΔE is an indication of a greater color variation and lesser the ΔE is an indication of less color variation. However, the subjective judgment of color difference could differ from person to person. For example, people see colors in an image, not by isolating one or two colors at a time (Goodhard & Wilhelm, 2003). In addition, people see colors by mentally processing contextual relationships among colors where the changes in lightness (value), hue, and chroma (saturation) contribute independently to the visual detection of spatial patterns in the image (A New Test Method, 2003). The results of analysis are presented in the following section.

2.2 Color Variation in the Midtone (50%) dot area of Vegetable Oil vs. Solvent-Based Inks

The CIE $L^* a^* b^*$ values associated with the CMYKRGB colors in midtone (50% dot area) color areas of VO vs. SB inks are compiled in Table 3. Numerical and visually noticeable color differences (ΔE) were found when comparing the VO inks (color) with the SB inks in the midtone area of the printed image on all seven colors (CMYKRGB). VO inks produced higher $L^* a^* b^*$ values in yellow, red, and green inks (bigger gamut) than for SB inks. In contrast, both inks have not produced same/similar color gamut in the midtone areas (see Figure 6), except the printed proof consists of same colors in magenta, cyan, and blue. The 2D color gamut comparison (see Figure 6) reveals a significant color difference between the two inks.

Color(s)	Vegetable Oil			Solvent			Color
	L^*	a^*	b^*	L^*	a^*	b^*	Difference
	Color 1			Color 2			ΔE
	n = 278			n = 278			
Yellow	91.56	-4.84	46.23	91.23	-2.01	39.15	7.63
Red	70.43	27.88	26.95	72.17	27.63	22.97	4.35
Magenta	73.45	30.8	-4.38	72.80	33.17	-4.27	2.46
Blue	63.77	13.22	-18.68	63.03	12.52	-20.75	2.31

Color(s)	Vegetable Oil			Solvent			Color
	L*	a*	b*	L*	a*	b*	Difference
	Color 1			Color 2			ΔE
	n = 278			n = 278			
Cyan	74.38	-14.21	-19.23	78.69	-15.01	-20.88	4.68
Green	76.86	-21.99	-22.78	75.86	-21.58	15.00	7.85
Black	65.09	0.51	0.64	69.34	0.89	1.11	4.29

Table 2. Color Variation in the Midtone (50% Dot) area of CMYKRGB of Vegetable Oil vs. Solvent-Based Inks.

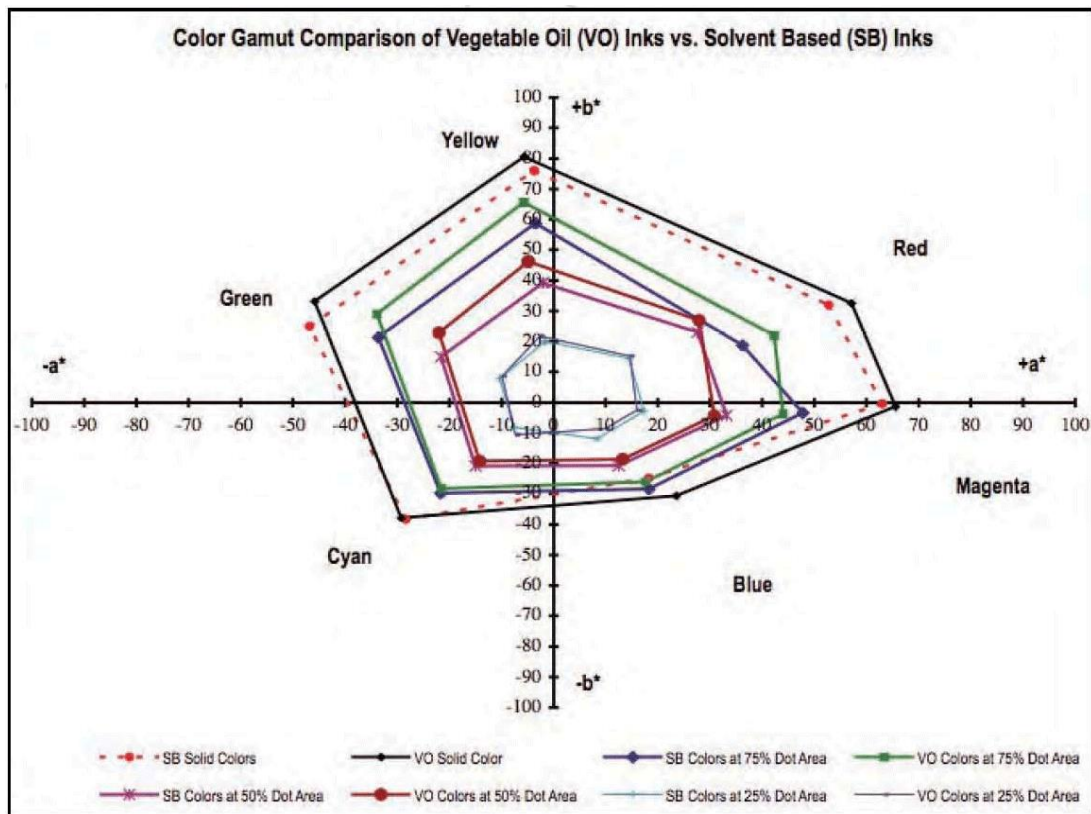


Figure 2. CIE L* a* b* 2D-model for VO Inks vs. SB inks CMYK color gamut comparison.

4. CONCLUSION

The conclusions of this study are based on results of the data analysis. The findings of this study represent specific printing or testing conditions. The screening technologies, paper, ink, dampening solution, film and plate imaging system, and printing process that were used are important factors to consider when evaluating the results. The findings of this study may not be generalized to other printing conditions. However, the findings of this research suggest that VO inks provide greater print contrast than do SB inks under specific printing conditions. This provides greater detail in the shadow areas (CM) of printed images. The black and yellow inks' print contrast ran counter to this conclusion, which suggests the need to explore other factors or variables that may have contributed to this result. Variables to explore include print order or printing unit: ink color interaction.

SB inks had statistically significant higher levels of dot gain for three of the four ink colors. A lower dot gain in VO ink resulted in a better color gamut in the midtones and shadow areas. Again, further study is needed to attempt greater control of variables. A more deliberate process of press calibration would also be recommended in a future study. The margin for error is much smaller with SB inks, requiring a carefully calibrated and controlled press platform. Qualitative analysis is also something to be pursued. A panel of experts could provide qualitative analysis regarding their preference for one ink or the other.

In comparing the color gamut of both types of inks from highlight color areas to solid color areas, VO inks produced better visual colors than the SB inks. This suggests that the VO inks are environmentally friendlier and can be used for better color reproduction. This experiment revealed that the VO inks produce better colors than do SB inks. Green printing is an environmentally friendlier, healthier, and safer approach to printing that requires only a small amount of energy. The question is, how many printers are going green? Additionally, if printers are not doing so, why not? Answers to these questions would require additional study to determine the status of using VO inks in the printing industry..

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The Mechanism and Rejuvenation of Color Fading By Ultraviolet Aging

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Virtual restoration of fading painting art has important practical significance and practical value for the study and appreciation of works of Art This paper presents a reconstruction method based on aging experiment and computer graphics technology of color. The paper focus on the pigment color fading rule caused by ultraviolet, and builded the robust multivariate regression model using the chroma information measured under the changed aging time, then established fading point and initial color mapping function based on the distance weighted interval mapping algorithm. The experimental results show that, the color fading model used can better describe the color fading rules, the overall coefficient of determination is 91.9%, the relative error is 1%, and weighted root mean square error is 8.9%. The model can represent the color appearance in diverse aging stagehand and rejuvenate the original appearance.

Simulation Algorithm for Dichromatic Color Appearance Using Projector Lighting

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ABSTRACT

A new simulation method was proposed to present a dichromatic color appearance on objects' surfaces by using a projector lighting. In the proposed method, firstly, for a given surface under a reference illumination, the simulation that dichromats experience on the surface was calculated as a target's color using the algorithm of Brettel et al. (1997)¹. Then, the most appropriate RGB input values to the projector were derived to render the target's color, with respect to the surface's spectral reflectance and the projector's spectral power distributions of RGB primaries. The validity and performance of the proposed simulator was evaluated colorimetrically.

Keywords: Color Deficiency, Simulation, Lighting, Projection Mapping

1. INTRODUCTION

Simulation of color vision deficiency is informative for normal trichromats. Several dichromatic simulators have been proposed and implemented on displays and computer applications. Brettel et al. proposed an algorithm to achieve a simulation of dichromats color vision on display¹. Such a computer simulation of color deficiency was verified^{2,3} and extended to a simulation of anomalous trichromat⁴.

For color universal design in real environments, the color-barrier-free lighting has been proposed^{5,6} and expected to be one of the prominent application of solid-state lighting, e.g. LED and OLED³. The idea of color-barrier-free lighting is to make confused colors discriminable to color deficient observers by modifying the spectrum of illuminant. However, to our best knowledge, dichromat simulators are not yet developed which are available for surface colors. Here we propose a concept of simulation lighting for dichromat color vision using a technology of projection mapping. In the present report, one of the algorithms is described in which color of a projector light is adjusted according to a spectral reflectance of an object and applied to protan (L-cone deficiency) simulation.

2. ALGORITHM OF SIMULATION LIGHTING

Figure 1 shows a supposed setting for the simulation lighting. The objective of the lighting is to provide normal trichromat observers with color appearance which dichromat observers experience under a reference illuminant. In the proposed algorithm, optimal RGB input values to the projector are calculated according to a spectral reflectance of an object's surface.

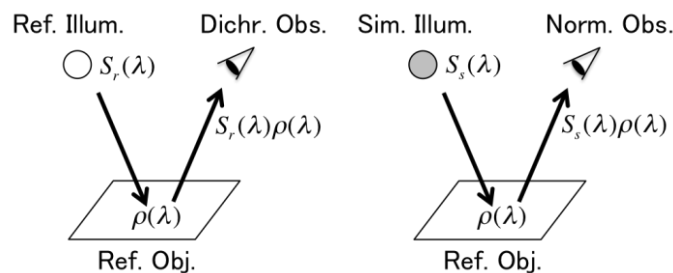


Figure 1. The setting for simulation lighting.

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Figure 2 shows a flow of calculation. Suppose that a dichromat observer sees an object surface with a spectral reflectance $\rho(\lambda)$ under a reference illuminant with spectral power distribution $S_r(\lambda)$. A spectral power distribution of a light reflected from the surface is expressed as $S_r(\lambda)\rho(\lambda)$. The CIE1931XYZ tristimulus values are calculated by Equation (1). Then the cone excitation values (L_r, M_r, S_r) are obtained by multiplying (X_r, Y_r, Z_r) with a transformation matrix. In the proposed algorithm, the transformation matrix of Smith & Pokorny (1975)⁷ is used as shown in Equation (2). Then the cone excitation values (L_t, M_t, S_t) of a target color are computed by the algorithm of dichromat simulation by Brettel et. al. (1997)¹. These cone excitation values (L_t, M_t, S_t) represent those of a normal trichromat when he/she sees a simulated color that a dichromat observer experiences under the reference illuminant.

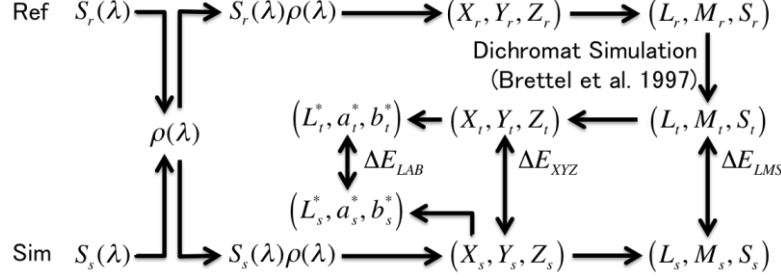


Figure 2. Calculation flow of simulation lighting.

$$\begin{aligned} X &= K_m \int_0^\infty S(\lambda) r(\lambda) \bar{x}(\lambda) d\lambda \\ Y &= K_m \int_0^\infty S(\lambda) r(\lambda) \bar{y}(\lambda) d\lambda \\ Z &= K_m \int_0^\infty S(\lambda) r(\lambda) \bar{z}(\lambda) d\lambda \end{aligned} \quad (1)$$

$$\begin{aligned} L &= 0.15514 X + 0.54312 Y - 0.032865 Z \\ M &= -0.15514 X + 0.45684 Y + 0.032865 Z \\ S &= 0.00000 X + 0.00000 Y + 0.008010 Z \end{aligned} \quad (2)$$

In simulation lighting, the same surface of $\rho(\lambda)$ is illuminated by a simulation illuminant $S_s(\lambda)$ and reflects a light $S_s(\lambda)\rho(\lambda)$. Ideally, the XYZ tristimulus values and the LMS cone excitation values calculated from $S_s(\lambda)\rho(\lambda)$ should be equal to those of the target color. Practically, using a certain optimization algorithm, the optimum spectrum is to be obtained that minimizes the color difference between the target and the simulation colors. In this report, the color difference was calculated in LMS, CIE1931XYZ and CIELAB color spaces and optimum spectra were compared with each other.

3. EXPERIMENT

3.1. Experimental Conditions

As reference surfaces, 10 color chips with matt finishes were selected: 5R6/6, 5YR6/6, 5Y6/6, 5GY6/6, 5G6/6, 5BG6/6, 5B6/6, 5PB6/6, 5P6/6, 5RP6/6 in Munsell color notation. The reflectance spectra of the interval 380-800 nm with 5 nm resolutions were extracted from a database with 1 nm resolution⁸ and used for all computations. The left chart of Figure 3 shows their reference spectra.

A projector (EPSON, EB-W420) was used for lighting and its color was controlled with 8-bit depth in each RGB channel. Spectra of RGB primaries of the projector were measured by the illuminance spectrophotometer (Konica Minolta, CL-500A) at a distance of 1.5 m. The right chart of Figure 3 shows the spectral irradiances ($W/m^2 nm$) for each primaries with maximum input values and a constant. The spectral power of the projector $S(\lambda)$ was expressed as a linear summation of those of primaries, $r_{max}(\lambda)$, $g_{max}(\lambda)$, $b_{max}(\lambda)$, and the constant $S_0(\lambda)$. Due to the nonlinearity of projector, coefficients of each primaries spectra were defined by input values RGB to the γ -th power as shown in Equation (3).

$$S(\lambda) = \frac{R}{255}^\gamma r_{max}(\lambda) + \frac{G}{255}^\gamma g_{max}(\lambda) + \frac{B}{255}^\gamma b_{max}(\lambda) + S_0(\lambda) \quad (3)$$

The light of the projector with $(R, G, B) = (255/2, 255/2, 255/2)$ was adopted as a reference illuminant. Colors of reflected light from 10 reference color chips were calculated in CIE1931XYZ and then converted to LMS. To get target colors LMS values for protan (L-con deficiency) simulation were computed by the algorithm of Brettel et al.. In the searching procedure, first LMS, XYZ, or LAB were computed for all the combinations of RGB set at intervals of 5 from 0 to 255. Then color differences in each color space were calculated and the best combination of RGB values that gives the smallest color difference was selected for simulation lighting.

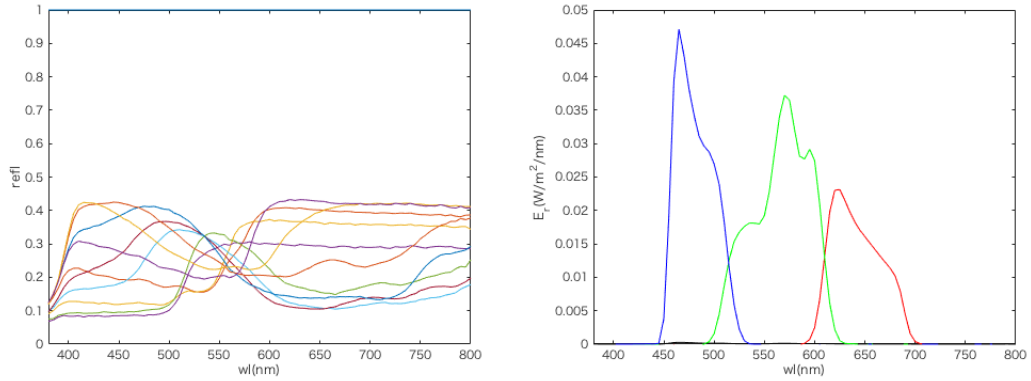


Figure 3. The reflectance spectra of the 10 color chips (left) and the spectral irradiance ($\text{W/m}^2 \text{ nm}$) of projector primaries (right).

3.2. Experimental Results

Reference colors of 10 color chips under the reference illuminant are shown by circles in Figure 4. A color of the standard white with a reflectance of 1.0 across all wavelengths was also calculated for CIELAB and is plotted on the center of the chart. Target colors were computed by the dichromat simulation for protan (L-cone deficiency). As shown by asterisks in Figure 4, all target colors line up along the line of yellow-blue direction.

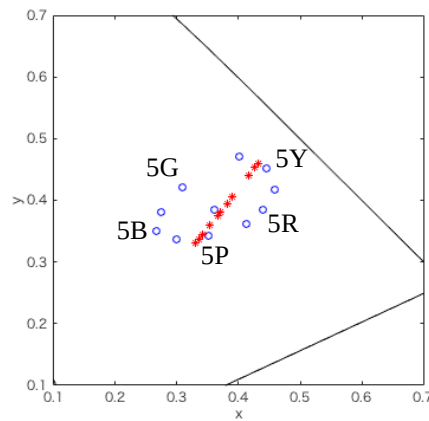


Figure 4. The reference colors (circles) and the target colors (asterisks) for simulation.

The optimal RGB values were derived so that they gave the minimum color difference in each LMS, XYZ, and LAB color spaces. Table 1 summarizes the RGB values for 5 reference color chips and the white as examples. In computations of any color spaces, the RGB values were set to compensate the color of the chip; for instance, larger R values were required for 5G6/6 and 5B6/6.

Table 1. The optimal RGB to the projector for protan simulation for 5 reference color chips and the standard white.

Color	W	5R6/6	5Y6/6	5G6/6	5B6/6	5P6/6
ΔE_{LMS}	160, 120, 145	50, 130, 135	80, 135, 55	235, 130, 110	225, 130, 115	125, 125, 135
ΔE_{XYZ}	145, 125, 130	50, 130, 130	100, 130, 125	250, 125, 130	245, 120, 130	115, 130, 125
ΔE_{LAB}	140, 125, 125	40, 130, 125	110, 130, 130	255, 125, 130	245, 125, 130	120, 130, 130

4. DISCUSSION

The best RGB values to the projector of lighting for dichromat simulation varied depending on which color space the color difference was calculated. The spectra for 5Y6/6 computed from 3 different color spaces indicate remarkable differences as shown on the left chart of Figure 5. The differences are larger in the ranges of short and long wavelength. That is quite understandable from the large differences in R and B values in Table 1. The right chart shows the spectra for the same color chip 5Y6/6 but selected from the combinations of RGB set at intervals of 3 from 0 to 255. Note that the difference in spectra was obviously reduced compared to the left chart. That comparison suggests color space in which color difference is computed does not produce an essential difference in derivation of optimal spectra and the difference may become negligible when the color or the spectra of light is adjusted with fine tuning.

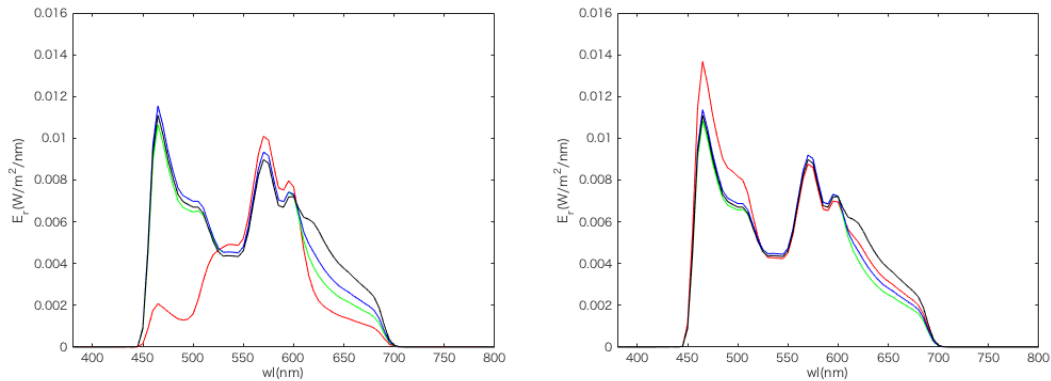


Figure 5. The optimal spectra computed with a larger interval of 5 (left) and a smaller interval of 3 (right) on 5Y6/6. Red lines, LMS color space; green, XYZ; blue, LAB; black, the reference illuminant.

In this report, no specific optimization procedure was employed but all possible combination of RGB were examined to chose the best combination. Such a procedure did consumed a lot of time and required large memory for computation. A better optimization method must be necessarily employed to compute many points in a scene and particularly for the real-time simulation. It is desirable that the simulation lighting should work without any knowledge of reflectance spectra of objects. Incorporation of reflectance spectra acquisition into the simulation lighting may be another issue.

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Lighting for a sense of continuity between real and virtual spaces

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ABSTRACT

A concept of sense of continuity was applied to a relationship between real and virtual spaces. We obtained the best lighting condition for the sense of continuity between a room (real space) and a scene presented on a PC display (virtual space). In the experiment, a photograph of a room with various illumination conditions was presented on the display. An observer adjusted the intensity and the color of the room light to get the maximum sensation of continuity between the virtual space on the photograph and the real space where he/she physically belonged to. After each trial, the observer rated the satisfaction of the sense of continuity. All observers rated relatively high at the end of each adjustment suggesting that light control was effective to the sense of continuity. Contrary to our prediction, the light intensity was set lower in comparison with those of the scene on the display.

Keywords: sense of continuity, videotelephone, communication, virtual space, LED lighting

1. INTRODUCTION

Technology of videotelephony like Skype and Facetime has made it possible to communicate people all over the world through the Internet. The atmosphere or the sense of sharing the same space is hardly obtained on that situation compared with face-to-face communication. It is desirable that the technology inducing such a sense of belonging to one space should be incorporated into the communication technologies

It has been reported that a sense of continuity through a window between the outside and the inside of a room can be induced by appropriate control of illumination^{1,2}. Observers inside a room felt as if they belonged to the same space when a certain condition is fulfilled although the two spaces were divided physically. The sense of continuity was also examined for a view from outside to inside a room³. Tolerable range of illuminance and color were measured for the sense of continuity between two rooms^{4,6}.

Here we propose to introduce the concept of the sense of continuity into real and virtual spaces. In the present study, we examined the condition required for the maximum sensation of continuity between the virtual space on a PC display and the real space where an observer was in. In the experiment, the observer compared a photograph of a room presented on a LCD monitor with an experimental room where he/she was in. The observer's task was to adjust the illuminance level and the color of LED lamps of the room until the sense of continuity between two spaces would be the maximum.

2. METHOD

Four undergraduate students participated in the experiment. All participants had normal or corrected-to-normal vision. Figure 1 shows the schematic profile of the experimental room and the photograph of a view from an observer. A photograph of the same experimental room was presented on a 23-inch LCD (EIZO ColorEdge CS230) with a resolution of 1920 x 1080 pixels. Six LED bulbs (Philips Hue White and Color 9W E26 bulbs) were fixed on a frame above the display and their intensity and color was controlled by an observer through a keyboard.

In the experiment, one of the photographs of the room with different illumination conditions was presented on the display. The observer was asked to adjust the intensity and the color (hue and saturation) of LED bulbs to get the maximum sensation of continuity between the virtual space on the photograph

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and the real space where he/she physically belonged to. After each trial, the observer rated the satisfaction of the sense of continuity from 0 to 10. Luminance and CIE1931xy-chromaticity were measured with a color-and-luminance meter (Konica Minolta, CS-100A) at measuring points of the wall (real space) and the display (virtual space) as shown by circles on Figure 1.

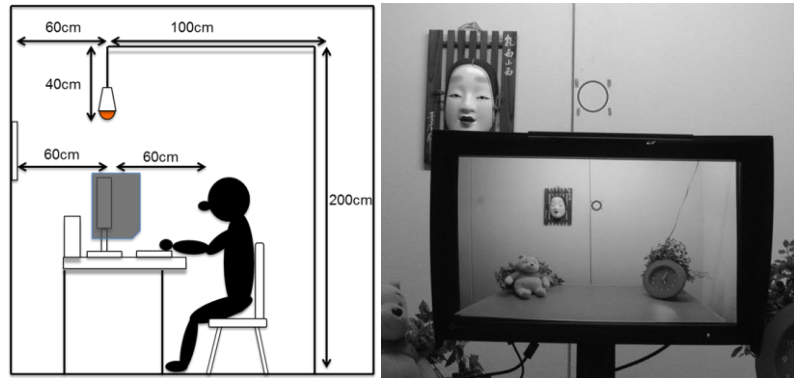


Figure 1. The schematic profile of the room (left) and the view from the observer (right).

The pictures presented on the display were photographs of the experimental room set at 3 illuminance levels of 75lx, 150lx, and 300lx and 3 different color temperatures of 2800K, 5000K, and 6500K, as shown in Figure 2.



Figure 2. Photographs presented on the display. They were taken in the experimental room at the illuminance 75lx, 150lx, and 300lx and the color temperature 2800K, 5000K, and 6500K.

Participants adjusted the illuminant under two instructions, “normal observation” and “display observation”. In normal observation, they were instructed to look around the room without staring the display as much as possible. In display observation, on the other hand, they were instructed to fix their eyes on the display and see the room only by peripheral vision. One experimental session consisted of adjustments for 9 photographs under one of the instructions. In total, 4 adjustments were made for each conditions.

3. RESULT AND DISCUSSION

In all trials, observers did find the best intensity and color of illuminant for the maximum sense of continuity without difficulty. The satisfactory rating was summarized in Table 1. Thus the sense of continuity was achieved, to a certain degree, between the real and the virtual spaces by appropriate setting of illuminant for the real space.

Table 1. The mean of the satisfactory ratings.

Instruction	normal observation			display observation		
Photograph	75lx	150lx	300lx	75lx	150lx	300lx
2800K	6.5	7.1	6.6	7.0	6.8	6.1
5000K	6.1	7.4	6.4	6.9	7.0	6.9
6500K	5.1	4.4	5.6	5.0	6.1	5.9

The chromaticity and the luminance of the wall in the real space are compared with those of the corresponding point on the display. Figure 3 shows the CIE1931xy-chromaticity at the measuring points on the wall (filled symbols) and on the display (open symbols) from the normal observation condition. Each symbol represents the average across all observers. The mean satisfactory rating is shown just below each data point. The chromaticity of the wall set by observers followed that of the photograph presented on the display. However there were consistent displacement in all conditions of color temperature; observers' settings of the illuminant were yellowish compared to those from the photographs. This tendency was similarly found in the display observation condition.

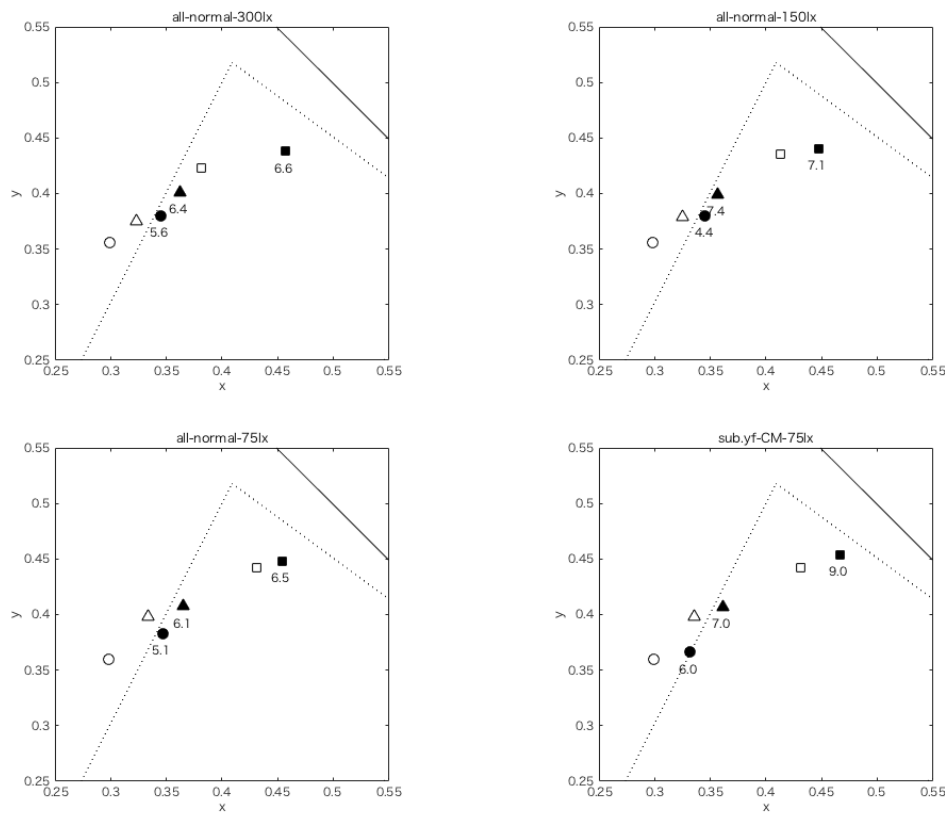


Figure 3. The mean chromaticity at the wall (filled symbols) and the display (open symbols). Continuity settings in the normal observation condition (tops and bottom-left) and color matching in the additional experiment (bottom-right). Squares, 2800K; triangles, 5000K; circles, 6500K. Dotted lines, gamut of LED; solid lines, the spectral loci.

The discrepancy in chromaticity could have resulted from two factors: ceiling artifact by gamut of LED and metamerism in color matching. Color gamut of LED bulb publicized by Philips is shown by dotted lines. Maximum continuity settings in 5000K and 6500K seem to be affected by the gamut. The satisfactory ratings were slightly lower in 5000K and 6500K than those in 2800K. These results suggest the best chromaticity of illuminant for the maximum sensation of continuity may have located outside the gamut. On the other hand, while there was no restriction by the gamut in 2800K, the observers' settings departed from the display color, suggesting that the ceiling artifact by the gamut cannot be a major factor in the discrepancy in the chromaticity.

In metameric color matching, the chromaticity measured by a colorimeter does not necessarily assure the subjective color equality because the spectral sensitivities are not the same. The effect of metamerism was investigated in an additional experiment. One of the observers conducted color matching between the

wall of the room and that of the photograph by adjusting color of LED bulbs. The results of color matching to the photograph of 75lx are shown in the bottom-right of Figure 3. The shifts between colors of the wall and the display existed even in the color matching and their direction and distance were almost the same as in the continuity settings. The satisfactory ratings are high even in 5000K and 6500K while the matching seemed to be affected by the gamut. According to the above results and discussions, it could be concluded that the chromaticity shift in the observer's setting may not have reflected the characteristics of the sense of continuity.

The left chart of Figure 4 shows the relationship between luminance at the wall (real space) and that on the display (virtual space). As a whole, the luminance of the wall was in proportion to that of the display but not the same. The luminance of the wall was lower than that of the display in all conditions. Particularly in the display observation condition, the observers set the luminance of the wall quite lower in comparison with that of the display. The mean ratio of $Y_{\text{room}}/Y_{\text{display}}$ was 0.74 in the normal observation and 0.47 in the display observation. In the color matching task of the additional experiment, on the other hand, the luminance of the wall was almost the same as that of the display as shown in the right chart of Figure 4. The mean ratio of $Y_{\text{room}}/Y_{\text{display}}$ was 0.89 in the color matching task.

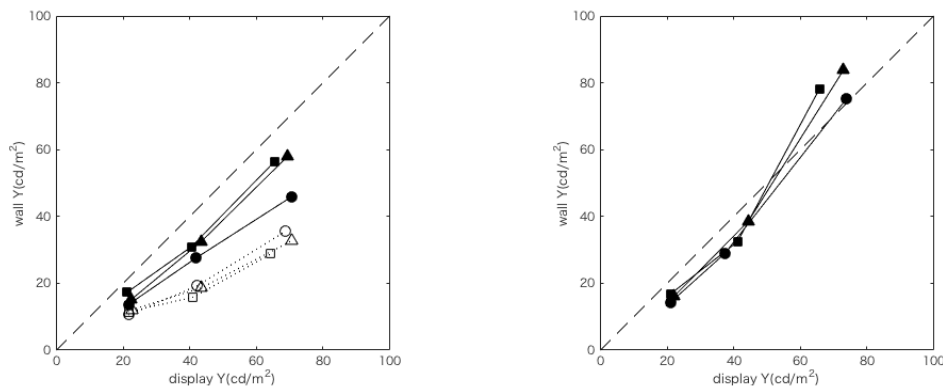


Figure 4. Luminance in the settings of the maximum sense of continuity (left) and in color matching task of the additional experiment (right). The abscissa represents the luminance of the display and the ordinate that of the wall. Filled and open symbols show the normal and the display observations in the left chart. Squares, 2800K; triangles, 5000K; circles, 6500K.

In conclusion, while viewing a display the light control in observer's space modulated the sense of continuity between real and virtual spaces. The condition for the maximum sensation of continuity was not the same as the color matching of a particular object. Particularly it was shown that the intensity of the room light should have been set lower than that in the virtual space the observer was viewing.

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The effects of luminance and color on vection

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ABSTRACT

When observers view a large visual stimulus that moves uniformly, they often perceive illusory self-motion (vection). In the present study, we investigated the effects of luminance and color of vection-inducing stimulus on vection. In an experiment, participants viewed moving random dots simulating optical flow during forward locomotion. The dots were presented on a black or white background in one of equiluminant colors, namely white (or gray), red, green, or blue. The participants pressed a key whenever they felt vection. After each trial, they also rated vection magnitude (from 0 to 100). Vection onset latency and duration, calculated from the key press data, and rating showed that, irrespective of the luminance of dots and background, red and blue dots produced stronger vection as compared with that induced by achromatic dots. Vection induced by green dots was weaker as compared with that induced by achromatic dots. When a black background was used, vection was induced more strongly by blue dots than by red dots. When a white background was used, vection was induced more strongly by red dots than by blue dots. These results indicated that the background luminance effects on strength of vection.

Keywords: vection, color, optical flow, self-motion

1. INTRODUCTION

When an observer in a stationary train views an adjacent moving train through a window, the observer feels as if his/her train is moving. This illusory self-motion induced by visual information is called vection. The recent technology enables us to create various visual contents and movies with high quality (e.g., high resolution and three dimensional information) and, as a result, there are many movies and attractions inducing vection to us in today's society. On the other hand, during vection, there is inconsistent information between visual and other senses and, as a result, this may cause motion sickness.

Color is one of the important factors for inducing vection. Several studies have examined effects of stimulus color by using a single colored stimulus and reported mixed results. For example, Seya et al. (2015) reported enhancement of vection by red stimulus as compared with vection induced by achromatic stimulus, while Seno et al. (2010) reported inhibition of vection by red stimulus. A possible reason is the methodological differences, namely the stimulus luminance and depth cues used. In Seya et al., the luminance of stimulus was quite low as compared with that used in Seno et al. On the other hand, the stimulus used in Seya et al. included various types of depth cues such as changing velocity, size, and disparity, while only changing velocity cues were added to the stimulus in Seno et al. In the present study, we examined the effects of color on vection by using dots with limited depth cues (changing velocity cues only) and by manipulating the luminance of dots.

2. METHOD

2.1. Participants

Eight participants took part in the present experiment (20 - 24 years of age; 6 men and 2 women). They had normal or corrected-to-normal vision. All the participants gave written informed consent before the participation of the experiment.

2.2. Apparatus and Stimuli

A personal computer (Apple Mac Pro Early 2009) was used to control the experiment and generate stimuli that were rear-projected on a screen (90 cm by 120 cm) by a projector (Vivitek D755WT) with a refresh rate of 120 Hz (Figure 1A). The experimental program was written using MATLAB. The stimulus simulated optical flow, within a tube space, observed during forward locomotion at 20 km/h (Figure 1B).

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The size of tube was 20 meters in depth with a diameter of 30 meters. One thousand dots were presented in equiluminant red, blue, green, or white (gray) on a black or white background. The luminance of dots was 0.5, 1.0, or 3.5 cd/m^2 . The luminance of background was set at 40% lower or higher than dots' luminance (see Table 1). The simulated size of dots was 4 cm in diameter. The velocity of dots was changed, depending on the simulated distance from the participant. Fixation cross was presented at the center of the screen and it was achromatic and equiluminance with dots, subtending $1\text{ cm} \times 1\text{ cm}$.

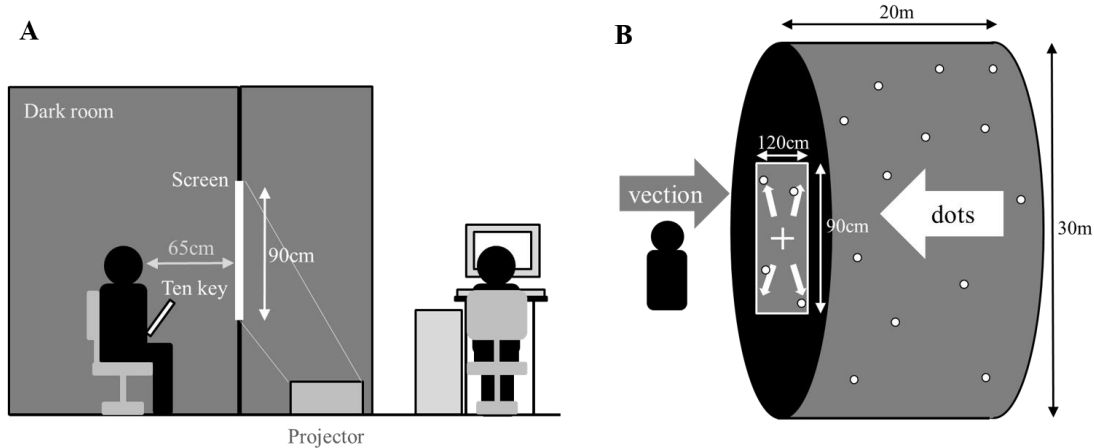


Figure 1. Illustration of experimental environment (A) and stimulus (B)

2.2. Conditions

There were four color conditions; achromatic, red, green and blue. All dots in each trial were presented in one of those colors on an achromatic background. There were three dot luminance conditions; 0.5 cd/m^2 , 1 cd/m^2 and 3.5 cd/m^2 . Two background luminance conditions were used; 40% lower or higher than dots' luminance (Table 1).

2.3. Procedure

Experiment was conducted in a dark room. Participants sat comfortably on a chair at a distance of 65 cm from the screen in a dark room and viewed stimuli. At the beginning of each trial, stationary dots were presented for 5 seconds, after which they moved for 60 seconds, followed by the presentation of stationary dots for 5 seconds. The participants were asked to view the stimuli and to press the button, during the presentation of moving dots, whenever they felt vection. After each trial, they were also asked to report magnitude of vection by using magnitude estimation (ME) method (from 0 to 100). A value of 0 meant no self-motion perception and only dots appeared to be moving. A value of 100 meant that the participant perceived himself/herself as moving through a stationary environment. A value of 50 meant that the dots on the screen appeared to be moving in one direction and the participant perceived self-motion in the opposite direction, at the same speed. Before the experiment, all participants practiced the task.

There were 48 trials, with two trials for each condition of all 24 conditions. The order of the conditions was randomized across the participants. In the analysis, vection duration and vection onset latency was calculated from the key press data. Mean ME values were also calculated for each condition.

Table 1. Luminance of stimulus for each condition

		Background condition					
		Low luminance			High luminance		
Luminance (cd/m^2)	dot	0.5	1	3.5	0.5	1	3.5
	background	0.3	0.6	2.1	0.7	1.4	4.9

3. RESULTS AND DISCUSSION

3.1. Stimulus Luminance and Vection

Figure 2 shows the result of mean duration, latency, and ME values. Each of them shows same tendency. Duration was shorter and latency was longer in the 0.5 cd/m^2 dot condition than in the other conditions. ME was higher in the 0.5 cd/m^2 dot condition than in the other conditions. These results indicate that vection was the weakest in the 0.5 cd/m^2 dot condition. On the other hand, between the other conditions,

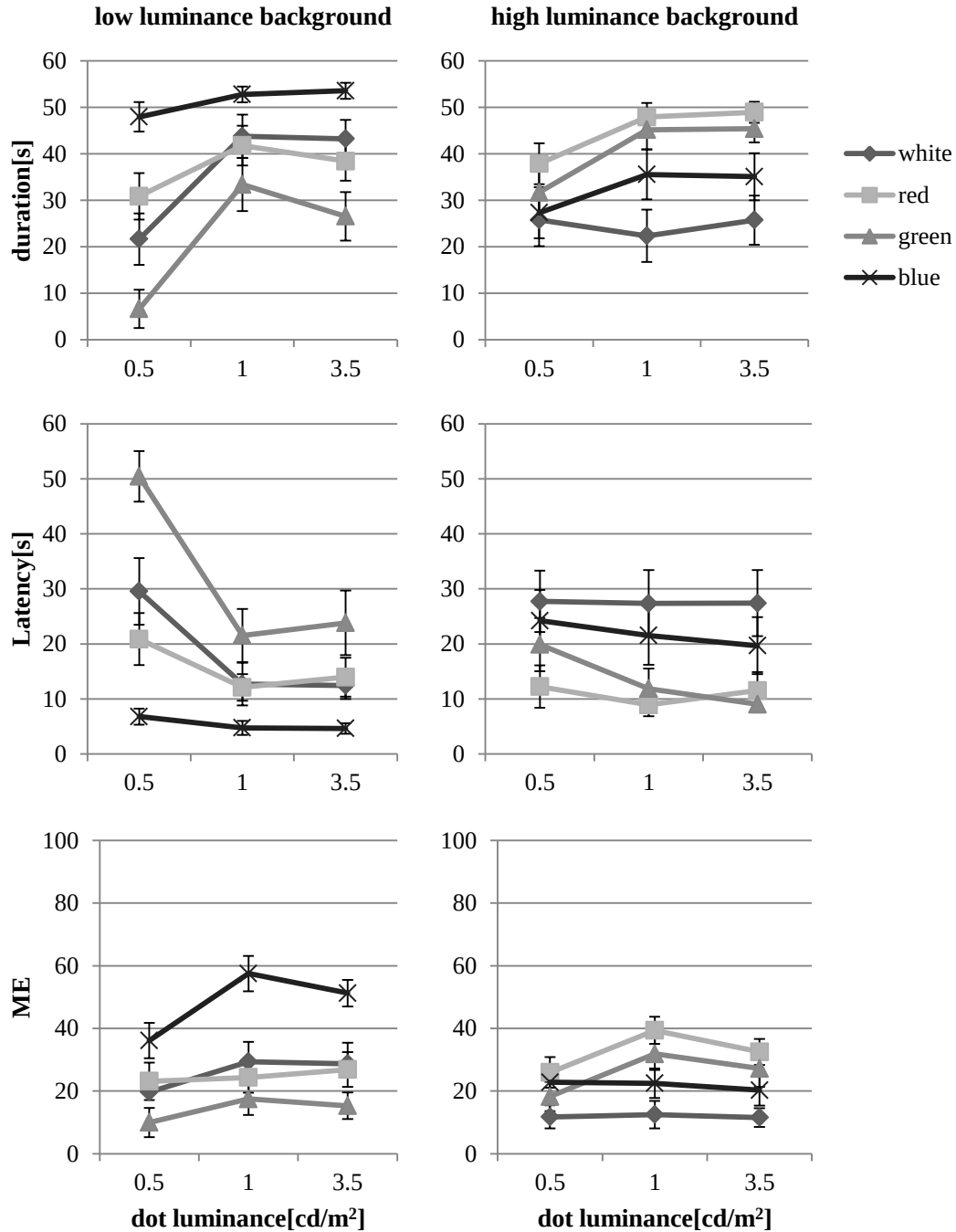


Figure 2. Mean vection duration, latency and ME value for each condition. Error bars indicate SE

there was no difference in vection indexes, suggesting that the effect of luminance was saturated in the 1-cd/m² condition. Note that the decrease in vection in the 0.5 cd/m² condition was more manifested in the low luminance background condition than in the high one.

3.2. Stimulus Color and Vection

In the low luminance condition, duration was longer and latency was shorter for blue dots than for the other dots (Figure 2). ME was also higher for blue dots than for the other dots. These results indicate that vection was the strongest for the blue dots condition than for the other dots in the low luminance background condition, which is consistent with Seya et al. (2015) who reported that chromatic stimulus, especially red dots, induced strong vection. On the other hand, in the high luminance background condition, duration was longer and latency was shorter for red dots than with the other dots. ME was higher for red dots than the other dots. These results indicate that vection was the strongest with the red stimulus condition than the other color conditions in high luminance background conditions. This finding

is not consistent with Seya et al. (2015)'s finding. Note that Seno et al. (2010) reported that red stimulus induced weak vection than other color stimulus, which is not consistent with the present results. The reason why the present findings were different from those in previous studies is not clear from the present study. Further studies should be needed for this point.

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OPTIMAL COLOR TEMPERATURE OF BAKERY PHOTOGRAPHY FOR ADVERTISING

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The main purpose of the production of bakery photography for advertising is to have a beautiful bakery photo that can be used to promote the image or stimulate the demand for purchasing that bakery. Lighting is one of the key elements that makes the bakery photo more beautiful and more appetizing. The color temperature affects the appearance of the photo. Therefore, this research aims to study the color temperature which is suitable for the production of bakery photography for advertising. In this experiment, the light patterns will be controlled to avoid the direct light shone to the bakery. The light will be exposed from the back or oblique of the bakery with the Reflex so that the light will be soft. The color temperature ranges in 10 levels, from 3000K to 6500K. The result of the study is expected that each bakery category may be suitable for different color temperature. For example, the suitable color temperature for cookie will be around 3200K to 4000K, cake will be around 5500K to 6500K. Moreover, each bakery category may be suitable for more than one color temperature.

Road luminance at tunnel and underpass entrance for safe driving of elderly people

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ABSTRACT

To provide elderly people with proper lighting at the entrance of tunnels and underpasses for a safe driving an experiment was conducted to investigate how much illuminance should be increased for elderly people by using cataract experiencing goggles that simulated elderly eyes and by experimenting in a simulated environment for driving situation. It was found about 7 times of the tunnel lighting at the entrance suitable for young people would be proper for elderly people.

Keywords: Elderly people, Safe car driving, Tunnel lighting, Underpass lighting, Parking lot lighting, Cataract, Luminance threshold

1. INTRODUCTION

Tunnels, underpasses, and parking lots in a building are normally illuminated dimly compared to the outdoor. This situation imposes a serious problem to elderly people who drive a car because of their cataract eyes, which they get normally when they become older. The cataract crystalline lens becomes frosted which reduces the incoming light and scatters the light coming from the environment in the eye¹⁾. The scattered light makes the entire visual field foggy and impairs the detectability of objects to see. The phenomenon particularly occurs at the entrance of tunnels, underpasses, and parking lots. It is urgent at the present aging society to provide elderly people with a safe and pleasant environment. The present paper tried to find out how much illuminance level needs to be elevated in such situations for elderly people compared to young people. An apparatus was built to simulate a tunnel or an underpass, or a parking lot and the detectability of a test patch was measured with cataract experiencing goggles and without the goggles.

2. METHOD

Figure 1 shows the apparatus, which was composed of two rooms, a subject room of 560 cm long and a test room of 300 cm long. The height was 200 cm and the width 340 cm. There was an opening W between the two rooms to simulate a tunnel entrance. The height was 140 cm and the width 52 cm. In the test room a test stimulus T was placed at the distance 120 cm from the entrance W and at the subject eye level of 110 cm. A subject sitting on a chair observed the test stimulus binocularly at the distance 3 m or 5.5 m from the stimulus, namely 180 cm or 430 cm from the entrance W.

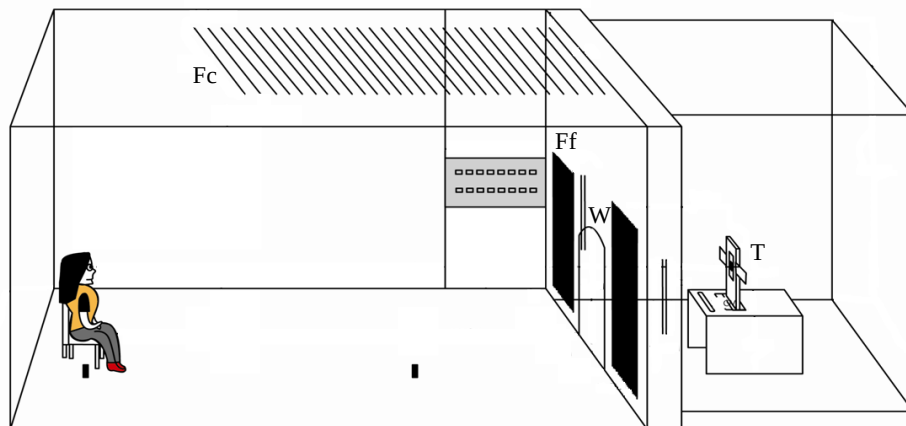


Figure 1. Experimental room.

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To simulate environment light in the outdoor 40 fluorescent lamps Ff of 40 W and the daylight type were installed on the front wall, 20 lamps at the left and the right of the entrance, respectively, and 29 lamps Fc at the ceiling. The arrays of the front lamps extended to 100 cm from the edge of the entrance, respectively and that on the ceiling extended to 300 cm from the front wall. When a subject sat at 5.5 m away from the test stimulus the nearest lamp to the subject was at 130 cm in a horizontal distance but at 3 m the last lamp located behind the subject at the distance 120 cm in a horizontal distance. Figure 2 is a photograph taken at the subject position, in which the dark opening at the center is the entrance W.



Figure 2. The front view of the subject. A dark area is the entrance W.

Five environment conditions were employed for both observing distances as shown in Fig. 3, where open circles indicate the lamps lit and filled circles lamps not lit. The upper lamp array in each condition indicates lamps at the ceiling, which were in fact arranged in the direction perpendicular to the paper surface. In both distances all the lamps were lit in the condition 5. The vertical plane illuminance E_v at the subject's eyes was listed in Table 1. The order of condition was arranged in the order of increasing illuminance. The bottom figure shows the lamps in the test room.

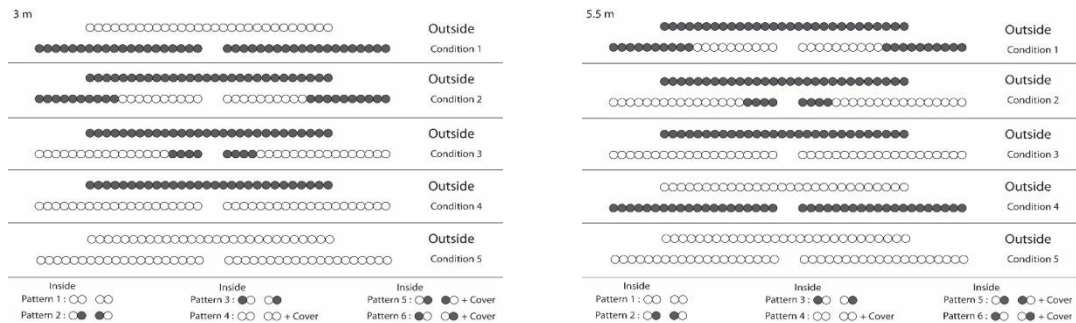


Figure 3. Illumination conditions at the subject room and test room.

The test stimulus T was composed of 17 patches of $1 \times 1 \text{ cm}^2$ each surrounded by a white paper of $L^* = 88.4$. The lightness L^* of the patches varied from 86.6 to 60.9. They gave the contrast from 0.051 to 0.644 with steps of about 0.037 which was calculated by $(L_b - L_o)/L_b$, where L_b is the background luminance and L_o the patch luminance. Patches were mounted on a hard paper along the horizontal direction and one of them was presented to subjects through a window of $4 \times 4 \text{ cm}^2$. The illuminance in the test room was adjustable and proper illuminance was set for respective environment conditions. The observing distances 5.5 m and 3 m, and the test patch size of $1 \times 1 \text{ cm}^2$ are equivalent to an obstacle in a tunnel entrance of the size $20 \times 20 \text{ cm}^2$ seen from 110 m and 60 m. It is considered that a car driver driving at the speed of 80 km/h can stop the car safely if he/she can detect the obstacle at 110 m.²⁾

The subject task was to obtain the threshold of luminance difference $L_b - L_o$ under one of the environment conditions with and without cataract experiencing goggles³⁾. The goggles simulate cataract eyes that start to cause some inconvenience in daily life. Four Thai university students and one young staff of the university participated in the experiment. They repeated measurement for five times for each condition at different sessions.

Table 1. Illuminance of subject room in lx and log lx.

3 m		
Condition	Ev (lx)	log Ev
1	2536	3.40
2	3209	3.51
3	4475	3.65
4	5371	3.73
5	8415	3.93
5.5 m		
Condition	Ev (lx)	log Ev
1	707	2.85
2	1096	3.04
3	1573	3.20
4	1797	3.25
5	3503	3.54

3. RESULTS AND DISCUSSION

In Fig. 4 the results of 5.5 m are shown for the subjects NS and CP. Illuminance in the subject room is taken along the abscissa by logarithmic unit in lx and the luminance difference threshold along the ordinate in cd/m^2 . Open circles connected by dotted lines were obtained without goggles and filled circles connected by solid lines with goggles. Short vertical bars indicate the standard deviation of five

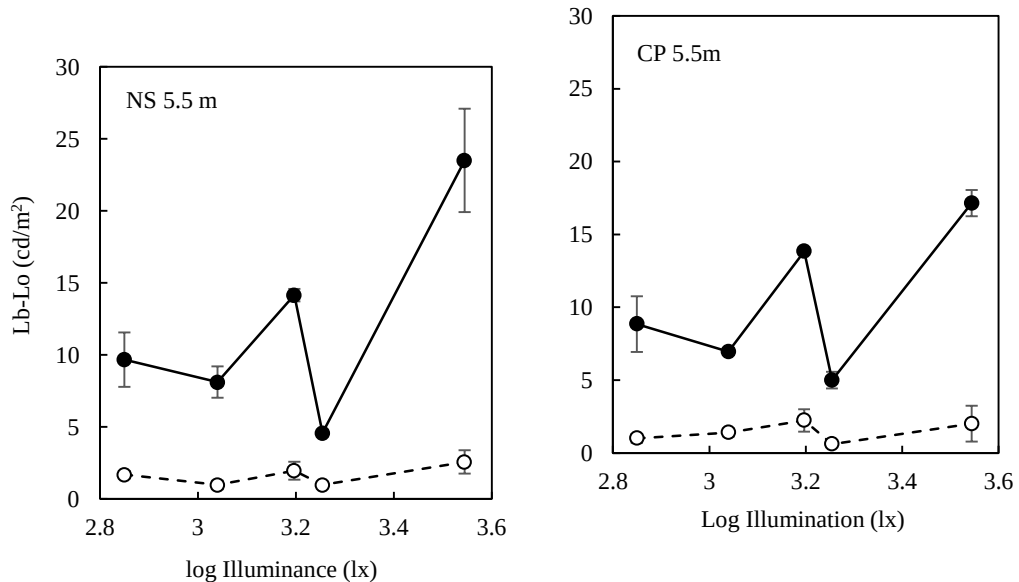


Figure 4. Results of subject NS and CP at 5.5 viewing distance.

repetitions. The two subjects showed similar trends. Larger thresholds were needed with goggles than the naked eyes without goggles showing the undesired influence of the environment light. The threshold increased for higher environment illumination. It is noted, however, the threshold dropped at the 4th condition in spite of the increase of the illuminance. The illuminance was given by only the ceiling lamps and the angle from the visual axis to the lamps θ increased for lamps nearer to the subject reducing the effective environment light, which gave lower threshold. In fact the concept of the equivalent veiling luminance Leq was introduced by Holladay⁴⁾ to quantify the effect of the environment light to the eyes,

namely, $Leq = k \times Ev / \theta^2$, where Ev is the vertical plane illuminance and k is a constant 10. The angle θ was very large at the 4th condition and the equivalent veiling luminance became small to reduce the effect of the environment light for the difference threshold.

Means of the difference threshold of 5 subjects are shown in Fig. 5 for both viewing distances, 3 m and 5.5 m. Vertical bars show the standard deviation among 5 subjects. It must be noted that the 1st condition in 3 m case some of the ceiling lamps located behind subjects and the vertical plane illuminance became smallest and. Under this condition test patches with lower contract were not available and the

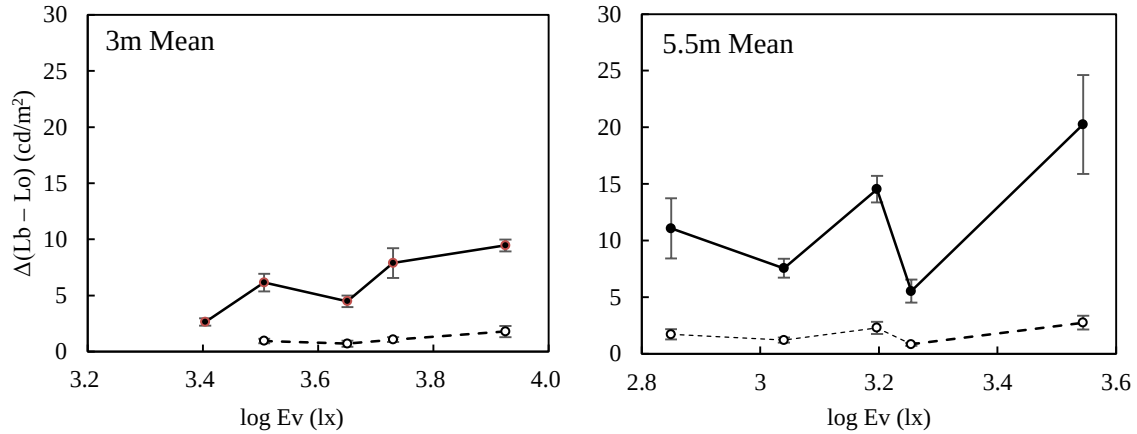


Figure 5. Mean results of 3 m and 5 m.

thresholds were not obtainable.

To see how much threshold should be elevated with the goggles the ratio of two thresholds, G/N was taken as plotted in Fig. 6. The ratio did not change for illumination condition and the average was 6.86 and 6.85 in 3 m and 5.5 m, respectively. We need to increase the road luminance about 7 times of the lighting designed for young people at the entrance of tunnel and underpass to assure safe driving by elderly people.

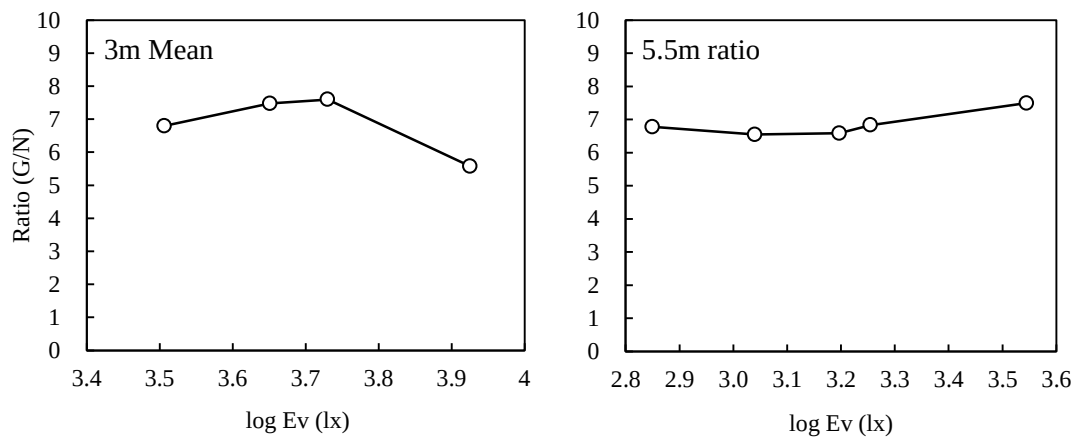


Figure 6. Ratio results of 3 m and 5 m.

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Effects of Colored Filters on Thai's Skin Tones

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ABSTRACT

This study aims to investigate the influence of colored filters on changes of Thais' skin tones and healthy skin perception when the colored filters were used in the photography. The photographs were taken in a studio, using 5500 K daylight lamp and under colored filters. The colored filters consisted of peach, pink, orange, yellow, green, and blue in front of the studio light. Three different skin tone models, including light brown, moderate brown, and dark brown were participated. No coloring cosmetics were used on the models' skin in order not to alter their original skin tones. The controlled variables were lens types, apertures, image sizes, a space between the models and background, and the light temperatures. Thirty students in the field of photography from Rajamangala University of Technology Thanyaburi (RMUTT) were asked to conduct the psychophysical experiment as the subjects. The study has found that the skin tones changed differently according to filter colors used in the photography. Warm color filters tended to create a dull effect on the skin. Orange filter helped the models' skin looked rosy the most. In addition, colored filter did not have a significant effect on the smoothness of the skin.

Keywords: cosmetic filter, colored filter, skin tone, Thai skin tone, photography

1. INTRODUCTION

Nowadays, the cosmetic market is growing rapidly. In Thailand, the cosmetic market continually expands year on year because people are concerned about their health and focused on how to make themselves look good despite the economic situations¹. It is said that cosmetic products have become one of the basic human needs. It has predicted that ASEAN cosmetic market would have risen from 130 billion baht to 140 billion baht when the ASEAN community is initiated. Products from Thailand hold a 40-percent market share². This issue, hence, is one of the Thai government's policies: to push Thailand becoming the center of cosmetic manufacturing and expecting Thailand, in the future, has an opportunity to be the cosmetic manufacturing base.

One of the important factors to draw customers' attention is how to make photography for the cosmetic advertisements attractive through commercials, advertisement posters, online media, or the Internet³. In the cosmetic marketing, an advertisement is required to catch a customer's attention and give said customer a good feeling—beauty and good health. So, the colored filters which is a lighting techniques in the photography is used to make products more attractive. Skin tones of the cosmetic models play an important role to express beautiful and healthy. The beautiful and healthy skin tone should be radiant, rosy, and smooth⁴.

However, sometimes models might not always possess beautiful or healthy skin tone, but it can be fixed by using cosmetic filters or colored filters⁵ to add diffusion to the studio light and help the models skin look healthier. People have different skin tones; therefore, this study aims to investigate in the effects of colored filters on Thai's skin tones.

2. MATERIALS AND METHOD

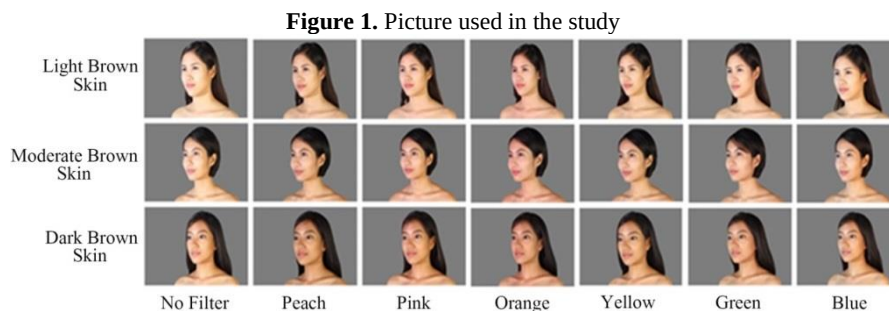
Six colored filters including peach, pink, orange, yellow, green, and blue were used in the experiment. There were three different models that possessed light brown, moderate brown, and dark brown skin tone without coloring cosmetic on models' skin in order to maintain their original skin tones. The photographs were taken in a studio, using a DSLR camera with AF 50 mm. f1/8 lens. The color temperature of the two lamps was 5500 K. The close-up shots were taken with the main light in front of and fill light on the side of the models. The photographs were taken with no-filter shot and other six colored filters placed in front of the main light. Each model was taken seven photographs per skin tone. The controlled variables were lens type, aperture, image size, space between the models and background, and the light temperature.

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The questionnaire was used to collect data; questions were divided into two parts: the skin tone perception after using the colored filters and the perception of healthy skin with colored filters in the photography. The first question was which color matched the models' skin tone the most. Then the participants were asked to choose the best match to the Munsell color chip. Nine Munsell color chips were applied to this task consisting of 7.5YR7/6, 5YR7/6, 2.5YR7/6, 7.5YR6/6, 5YR6/6, 2.5YR6/6, 7.5YR6/8, 5YR6/8, and 2.5YR6/8. All color chips were horizontally placed on a moderate gray paper to have the participants matching the color chips with each model's skin tones with and without colored filters. The second question was how the models' skin looked (dull, radiant, pale, rosy, rough or smooth). The semantic differentials method was conducted in this experiment.

Thirty students in the field of photography of RMUTT were asked to participate in the experiment. The experimental room's light was controlled to illuminate 500 lux, which was the standard office illuminance according to Chartered Institution of Building Service Engineering (CIBSE) ⁶. The digital photographs were shown on a screen that has previously calibrated by the X-Rite i1Basic Pro2 for the perceptual accuracy. The space between the monitor and the participants was 60 centimeters. The experiment was that, firstly, the subjects had to look at one photo at a time and picked the matched color chip from the Munsell Book of Color without time limitation. The photos were shown randomly in each group of skin tones. Each photo was disappeared and replaced by gray background in order to have the participants be prepared for the next photo. After that, the subjects were asked to relax their eyes for fifteen minutes before continuing the second part. Secondly, for the perception of healthy skin with the colored filter used in the photography; there was no time limitation for the answer. The pictures were randomly shown in each skin tone group. After the first group of skin colors, the participants were asked to relax their eyes for another fifteen minutes before doing the experiment on the next group.

To analyze the collected data about the perception of skin tones, Munsell color codes were converted into $L^*a^*b^*$ value and the result in mode. To analyze the perception of healthy skin, the median are applied with established criteria as follows; 1-2 points = dull/rough/pale, 3-4 points = fairly radiant/fairly smooth/fairly rosy, and 5-6 points = radiant/smooth/rosy.

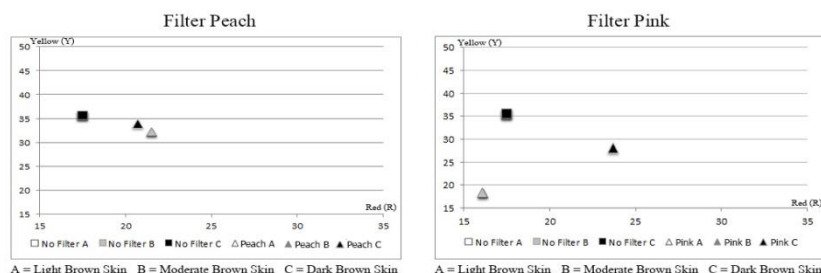


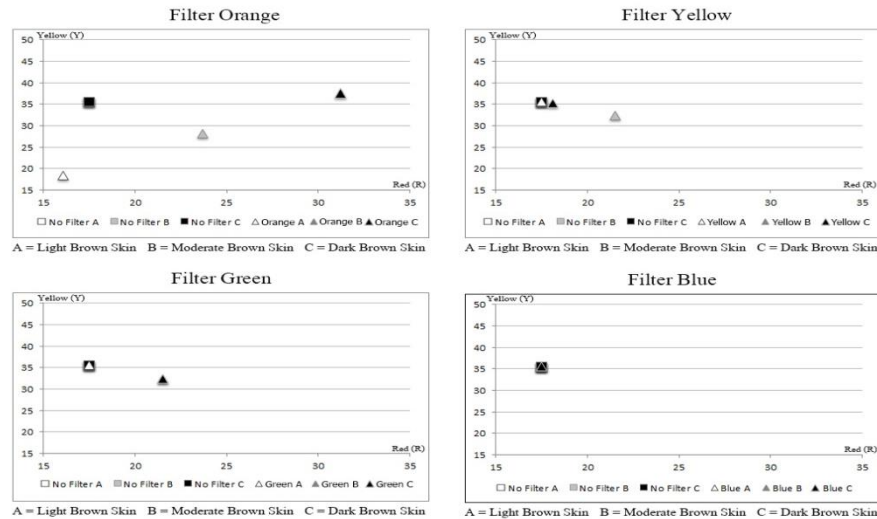
3. RESULTS AND DISCUSSION

3.1. The perception of skin tone with colored filters used in photography.

The study has found the perception of skin tones with colored filters used in photography as shown in Figure 2.

Figure 2. The perception of skin tone with colored filters used in photography





The skin tone perception with the colored filters in the photography's results, after converted Munsell's color code to $L^*a^*b^*$, were shown in the Figure 2. The study has found that almost of the subjects perceived three skin tones with no colored filters as reddish yellow and the mode value was $L^*72.2$ $a^*17.5$ $b^*35.6$. The subjects perceived light brown and moderate brown skin tone with peach filter as reddish yellow with the increasing of redness and the mode value was $L^*72.4$ $a^*21.5$ $b^*32.3$ while the dark brown skin tone was seen as $L^*63.6$ $a^*20.7$ $b^*33.9$. As for the pink filter, both light brown and moderate brown skin tones were perceived as reddish yellow with the increasing of redness and the mode value was $L^*72.4$ $a^*16.1$ $b^*18.3$ while the dark brown skin tone was perceived as $L^*62.3$ $a^*23.7$ $b^*28.2$. The participants had different views on the three skin tones in the orange filter. The light brown skin tone was seen as reddish yellow with the increasing of redness and the mode value was $L^*72.4$ $a^*16.1$ $b^*18.3$. The moderate brown was seen at $L^*62.3$ $a^*23.7$ $b^*28.2$ while the dark brown was perceived at $L^*63.0$ $a^*31.2$ $b^*37.6$. The subjects viewed yellow filters on the light brown skin tone as reddish yellow with the increasing of redness and the mode value was $L^*72.7$ $a^*17.5$ and $b^*35.6$ while the moderate brown skin tone was seen as $L^*72.4$ $a^*21.2$ $b^*32.3$, and the dark brown skin tone was seen as $L^*62.9$ $a^*18.1$ $b^*35.2$. In the green filter, the light brown was seen as reddish yellow with the increasing of redness and the mode value was $L^*72.7$ $a^*17.5$ $b^*35.6$ while the moderate and dark brown were perceived as $L^*72.4$ $a^*21.5$ $b^*32.3$. The subjects perceived all three skin tones in the blue filter as $L^*72.7$ $a^*17.5$ $b^*35.6$. The reason that the skin tones were perceived as reddish yellow was the red combination in the color filter. It might be because the qualification of filter that allowed its own color to transmit through it and blocked the other differently at the same time⁷. Therefore, it allowed red to go through and blocked the different color such as blue and green⁸. As a result, the photos tended to look redder. The same reason occurred with blue filter was that it did not allow the red color to go through itself. Therefore, the models' skin tones did not look redder.

3.2. The perception of healthy skin with cosmetic used in the photography

The study has found the perception of healthy skin with cosmetic used in the photography as shown in the following tables.

3.2.1. The perception of dull/radiant skin is shown in Table 1

Table 1. The scores of colored filters used in the photography (Dull/Radiant)

Cosmetic Filter	$\bar{x}$ (Dull/Radiant)					
	Light Brown Skin	Meaning	Moderate Brown Skin	Meaning	Dark Brown Skin	Meaning
No Filter	5.12	radiant	4.63	radiant	4.29	fairly radiant
Peach	4.01	fairly radiant	3.03	fairly radiant	2.32	dull
Pink	3.67	fairly radiant	2.5	fairly radiant	2.36	dull
Orange	3.08	fairly radiant	2.37	dull	2.06	dull
Yellow	3.64	fairly radiant	3.22	fairly radiant	3.34	fairly radiant
Green	4.37	fairly radiant	3.39	fairly radiant	3.76	fairly radiant
Blue	4.59	radiant	3.92	fairly radiant	3.8	fairly radiant

The study has found that, using six provided colored filters in the photography did not help all skin tones look radiant, but they created dull effect to all skin tones, especially orange filter. It was because using orange filter made the skin looked red, which was a warm color that indicated heat⁹. When it was being compared with skin tones, it looked dull in the subjects' opinion. On the contrary, blue filter created radiant effect on the models' skin as equal as no filter usage. It probably was because blue was a cool color that indicated freshness and relaxation⁹. When it was compared with skin tones, it did not create dull effect in the participants' opinion. However, dull means intense or not bright, and radiant means bright¹⁰. In the photography, under exposure value can create a darker photo and over exposure value can create a bright photo¹¹.

3.2.2. The perception of pale/rosy skin is shown in Table 2

Table 2. The scores of colored filters used in the photography (Pale/Rosy)

Cosmetic Filter	$\bar{x}$ (Pale/Rosy)					
	Light Brown Skin	Meaning	Moderate Brown Skin	Meaning	Dark Brown Skin	Meaning
No Filter	2.22	Pale	2.44	Pale	3.07	fairly rosy
Peach	3.89	fairly rosy	3.71	fairly rosy	3.81	fairly rosy
Pink	3.99	fairly rosy	4.08	fairly rosy	4.04	fairly rosy
Orange	4.32	fairly rosy	4.62	Rosy	4.23	fairly rosy
Yellow	3.6	fairly rosy	3.44	fairly rosy	3.61	fairly rosy
Green	3.59	fairly rosy	3.48	fairly rosy	3.62	fairly rosy
Blue	3.06	fairly rosy	3.21	fairly rosy	3.66	fairly rosy

The study has found that using six provided colored filters helped the models' skin tones looked rosy, especially orange filter. It might be because the interpretation of 'rosy' in the participants' opinion meant 'pinkish skin'¹². Pink is created with proportions of red and white or red tone color. Orange filter has a tint of red that helps the skin to look redder; therefore, the used filter in the photography is interpreted as rosy skin tone.

3.2.3. The perception of rough/smooth skin is shown in Table 3

Table 3. The scores of colored filters used in the photography (Rough/Smooth)

Cosmetic Filter	$\bar{x}$ (Rough/ Smooth)					
	Light Brown Skin	Meaning	Moderate Brown Skin	Meaning	Dark Brown Skin	Meaning
No Filter	4.11	fairly smooth	3.89	fairly smooth	4.12	fairly smooth
Peach	4.19	fairly smooth	3.38	fairly smooth	3.66	fairly smooth
Pink	4.02	fairly smooth	3.42	fairly smooth	3.74	fairly smooth
Orange	3.77	fairly smooth	3.32	fairly smooth	3.76	fairly smooth
Yellow	3.93	fairly smooth	3.56	fairly smooth	4.03	fairly smooth
Green	4.48	fairly smooth	3.53	fairly smooth	4.08	fairly smooth
Blue	4.23	fairly smooth	3.72	fairly smooth	3.91	fairly smooth

The study has found that, six colored filters did not provide a rough or smooth effect on the skin. It might be because, in the experiment, the colored filter changed the color of light that did not affect the skin surface. The quality of light is necessary in the photography. Hard light is suitable for showing roughness of the subject surface, while soft light is suitable for creating a smooth effect on the subject surface¹³.

4. CONCLUSION

1. The perception of the skin tone changed according to the color of the filters. Changes were varied to the intensity of the filters.
2. The warm colored filters created dull effect on the skin. If more radiant effect was needed, camera aperture should be increased.
3. The orange filter helped the models' skin looked rosy the most.
4. The colored filters did not provide smooth effect on the skin, but soft light could be substituted.

ACKNOWLEDGMENTS

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The Blur Level of Crime Images in Newspaper for Understanding the Content and Reducing the Violence: Case Study of Dailynews Newspaper

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ABSTRACT

Newspaper is one of media that plays an important role to spread the information to the people in particular we do not have broadcasting. In Thailand, crime news is frequently presented as the headline news in the popular newspapers. It said to be that Thai people preferred to read crime news to other news. Sriluck (1995) reported that the circulation of the newspaper depend on a number of crime news. Because crime news is required to appear on the newspaper, the journalisms are required to concern about journalism ethics, morality and human right. One of the techniques to protect the human right and reduce the violent feeling is a blurring technique. Regularly, newspaper editors use this technique to make an image unclear. The critical point is how to make an image cloudy but it is still to give reader clear information. This study, hence, focused to investigate the effect of a level of blurring in the crime image on the understanding of the content. Three crime images were selected from the Dailynews newspaper as three categories consisting of accident, murder, and suicide images. We call those images “the original picture”. Each picture was blurred for eleven levels using the Gaussian and Tiles blurring techniques. One hundred samples were asked to compare the blurred image to the original ones in the term of the degree of violent and content understanding. From the result, we found that no significant difference between blurred images and original images in all categories. From our result, we concluded that there are no effect of blurring level on the content understanding and violence in the crime images. Moreover, the more blurring level is required to apply in the future research.

Keywords: Crime Images

1. INTRODUCTION

Currently, crime is one the most important news published in the newspaper, especially the publication of crime images in order to simultaneously create more readers and sales revenue. Therefore, the presentation of the naked and horrible crime images in the newspaper, which are inappropriate, affects the perception of the public.

According to the regulations of the professional journalism ethics 1998, the practices are as follows: In presenting the news or any images, the human dignity of a person in the news must not be violated, especially the rights of child, woman and disadvantaged must be strictly protected. The news should not aggravate the suffering or tragedy happened to that child, woman and disadvantaged in any way. Moreover,

the newspaper must not present an ugly, obscene or horrible images without carefully considering the public sentiment.

2. METHOD

The objective of this research was to study the blur level of crime images in the front page of the newspaper that were horrible and ugly. The crime images were divided into 3 categories: the accident, the suicide and the murder.

The methods of the study were the following:

1. Using the same blur method used in the Dailynews newspaper, the crime images—all three categories—were diminished the horror of the images into 11 blur levels.
2. Data Collection: showed these 3 images that were diminished the horror of the images into 11 blur levels and one original image to 100 samples who live in Pathumthani province to assess the level of the understanding of the content and the horror image. Then the results were analyzed.



Figure 1 : The original crime images of the accident, the suicide and the murder.

3. RESULT AND DISCUSSION

The study found that the samples understood the content of the accident image in some levels. For the appropriateness of the blur level for the crime image showed the horror at the acceptable level.

For the suicide image, most samples' level of understanding of the content was in the moderate level. For the appropriateness of the blur level, the images still showed some horrors; however, it was in the acceptable level.

For the murder image, the samples partly understood the content. For the appropriateness of the blur level, the original image was inappropriate and still conveyed the horrors. For the images that were diminished the horrors, they were in the moderate level and was in the acceptable levels.

The study found that the samples' understanding of the content was in the moderate level and the appropriateness of the crime image was in the moderate acceptable level. However, when considering the average of the evaluation from the samples, the best image from the respondents was the image in Level 1 (Gaussian Blur = 4, Tiles = 0).

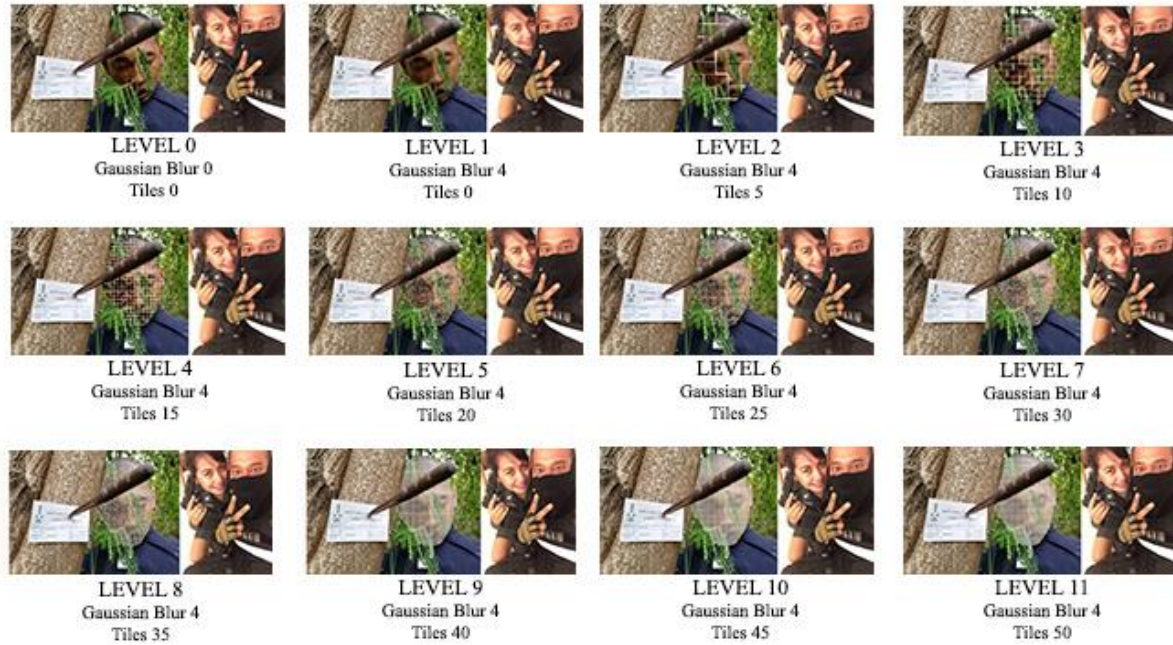


Figure 2 : The blur level of crime images.

Table 1 : The level of samples' understanding the content of crime images

LEVEL	The accident image			The suicide image			The murder image		
	$\bar{X}$	S.D.	results	$\bar{X}$	S.D.	results	$\bar{X}$	S.D.	results
Level 0	2.33	.667	moderate	2.17	.682	moderate	2.42	.606	Very good
Level 1	2.35	.609	Very good	2.22	.645	moderate	2.39	.634	Very good
Level 2	2.28	.552	moderate	2.05	.796	moderate	2.21	.624	moderate
Level 3	2.07	.728	moderate	2.12	.742	moderate	2.11	.709	moderate
Level 4	2.11	.723	moderate	2.05	.770	moderate	2.21	.715	moderate
Level 5	2.17	.604	moderate	2.19	.692	moderate	2.16	.677	moderate
Level 6	2.07	.714	moderate	2.10	.704	moderate	2.27	.601	moderate
Level 7	2.06	.722	moderate	2.12	.624	moderate	2.21	.640	moderate
Level 8	2.12	.671	moderate	2.22	.645	moderate	2.29	.608	moderate
Level 9	2.11	.695	moderate	2.15	.687	moderate	2.11	.709	moderate
Level 10	2.14	.682	moderate	2.19	.677	moderate	2.27	.633	moderate
Level 11	2.19	.677	moderate	2.15	.702	moderate	2.26	.630	moderate

Table 2 : The appropriateness of the blur level for crime images.

LEVEL	The accident image			The suicide image			The murder image		
	$\bar{X}$	S.D.	results	$\bar{X}$	S.D.	results	$\bar{X}$	S.D.	results
Level 0	1.95	.809	moderate	1.51	.628	inappropriate	1.66	.807	inappropriate
Level 1	1.90	.798	moderate	1.72	.668	moderate	1.80	.620	moderate
Level 2	1.80	.682	moderate	1.59	.653	Inappropriate	1.75	.575	moderate
Level 3	1.76	.712	moderate	1.64	.644	inappropriate	1.69	.647	moderate
Level 4	1.91	.653	moderate	1.83	.697	moderate	1.93	.769	moderate
Level 5	2.02	.586	moderate	1.95	.672	moderate	1.87	.706	moderate
Level 6	1.97	.745	moderate	1.96	.665	moderate	2.03	.643	moderate
Level 7	1.94	.763	moderate	1.90	.704	moderate	2.11	.695	moderate
Level 8	2.09	.698	moderate	1.96	.634	moderate	2.26	.705	moderate
Level 9	2.12	.769	moderate	2.00	.739	moderate	2.29	.729	moderate
Level 10	2.17	.667	moderate	2.08	.774	moderate	2.19	.720	moderate
Level 11	2.17	.682	moderate	2.10	.759	moderate	2.18	.642	moderate

4. CONCLUSIONS

For the crime images of accident, suicide and murder in 11 blur levels, the study found that the sample's understanding of the content was in the same level as the original image. The opinion about the violence of the images was no different from the original image. Therefore, the Gaussian and Tile filter from the Photoshop program had no effect on the understanding of the content and reducing the horror of the image.

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Boundary of acceptable blue color in Thai traffic sign for elderly

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ABSTRACT

Recently, blue traffic sign was officially introduced as a mandatory sign in Thailand where the elderly population increasing. Since the elderly have difficulty seeing blue color, we investigated the elderly vision on blue color in traffic sign. This research aimed to locate the region of blue color which is suitable for the young and the elderly. The subjects were divided into two groups: a group of young subjects aged between 18-23 years old, and a group of young subjects wearing a cataract experiencing goggle to simulate the elderly vision. Ten mandatory signs were used in this experiment. The background color of these mandatory signs was modified from the original blue color and varied to other 51 colors around this point. In each judgement, one mandatory sign was randomly selected from the set of 18 mandatory signs. The background color of the selected sign was filled with a color which was randomly selected from 52 colors. For the first task, subject was asked to judge whether the stimuli was a blue mandatory sign or not. And the second task, subject was asked to categorize the background color based on eleven basic color terms. Our results exhibited that the boundary of the acceptable blue color in mandatory sign for the elderly was larger than the boundary of the acceptable blue color for the young.

Keywords: Elderly vision, traffic sign, memory color

1. INTRODUCTION

Blue color has been generally used in traffic sign for a long time in Europe or USA. It was used as a background color for traveler service information sign (in US), mandatory sign (in Sweden) or regulatory sign (in UK). Recently in Thailand, the blue traffic sign was officially introduced as a mandatory sign which is a white figure or symbol on a blue background as shown in Figure 1. Besides, the elderly population in Thailand is expectedly growing to be larger than 15% by 2025.¹ It is well known that the color perception of the elderly is quite different from color perception of the young. The elderly seem to perceive color with less saturation and have difficulty seeing blue color.² We, therefore, studied the elderly vision on blue color in traffic sign. This research investigated how different the young and the elderly see the blue traffic sign and aimed to locate the region of blue color which is optimal for both the young and the elderly vision.



Figure 1. Examples of mandatory sign in Thailand.

2. METHODOLOGY

2.1 Apparatus

The dimensions of the experimental room were 180×360×200 cm (W×L×H). This room was covered by a black curtain. An LED monitor (EIZO ColorEdge CX271) was placed inside the experimental room. The subject sat on a chair which was placed 285 cm far from the monitor.

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2.2 Subjects

Two groups of the subject were participated in this experiment. Named as “young”, the first group was 30 subjects age between 18-35 years old. The second group was called “elderly”. They were the same 30 “young” subjects who were asked to wear the cataract experiencing goggle during the experiment. The cataract experiencing goggle was developed by Obama et al.³ It was made from 58% transmittance filter, 14% of haze values filter and yellow filter in order to simulate the elderly vision. All subjects had normal or corrected to normal visual acuity. All of them were screened for normal color vision with Ishihara Test.

2.3 Stimuli and Experimental Conditions

Fifty two background colors were used in this experiment. CIE xy chromaticity of these 52 colors were shown in Figure 2. However, the luminance of each color was not equal and was determined by brightness matching experiment. We measured the luminance level of each background color where its brightness was matched to brightness of a reference blue color ($Y_{xy} = 16.6 \text{ cd/m}^2, 0.141, 0.063$).

The stimuli—52 test patch—had different 52 background colors. The symbol of each test patch was randomly selected from 18 mandatory signs. In the dark room, a stimuli were presented on an LED monitor covered by a black mask with 2 degree circle aperture to prevent background light from the monitor.

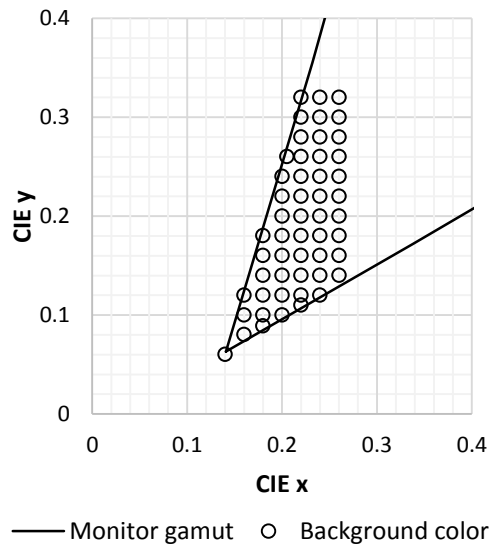


Figure 2. CIE xy chromaticity of 52 background colors used in this experiment.

2.4 Experimental Procedure

Before starting experiment, a real blue mandatory sign was presented to subjects so that they see the original blue color used in mandatory sign. Then, the subject was asked to sit inside the experimental room for two minutes before starting experiment. The experiment started by presenting a test patch. There were two tasks for each subject. Subject completed each task in separated sessions. For the first task, subject was asked to judge whether the test patch was a blue mandatory sign or not. The subject gave their answer by pressing “Yes” or “No” button on a keypad. For the second task, they were asked to categorize the background color based on 11 basic color term defined by Berlin and Kay.⁴ When the subjects finished each judgement, a blank screen was presented until subject was ready for next judgement. They had to press a “Next” button for starting the next judgment. The experimental procedure was repeated until all 52 test patch were presented.

3. RESULTS AND DISCUSSIONS

Results of the first task were plotted on CIE xy chromaticity diagram as shown in Figure 3. Each point represented average result obtained from 30 subjects. The solid line represented monitor gamut. Solid circle, half-filled circle, blank circle and blank triangle represented percentage of “Yes” responses at higher than 75%, 50-75%, 25-50% and lower than 25% respectively.

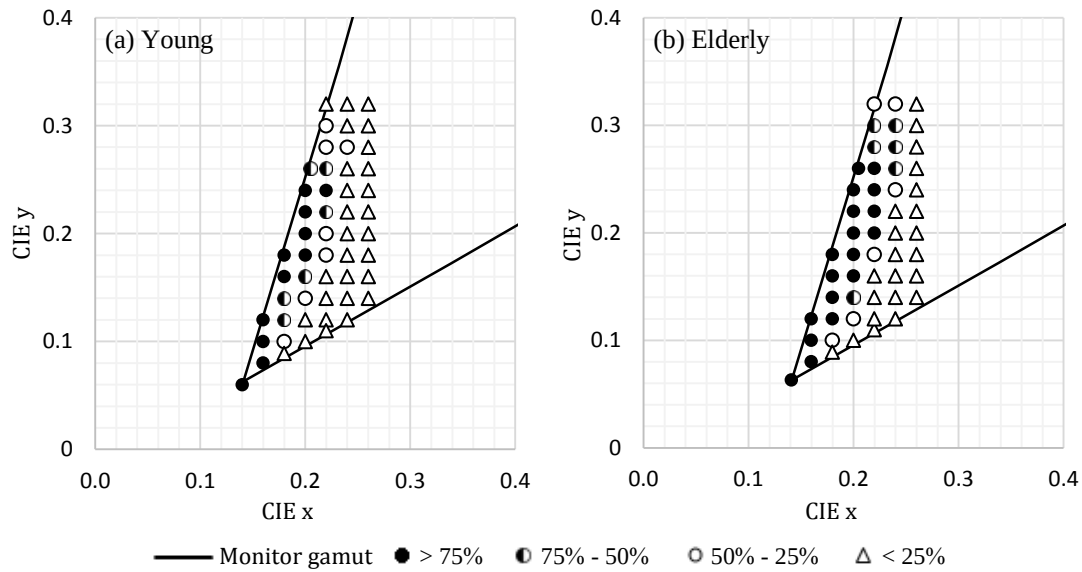


Figure 3. Percentage of acceptance of blue mandatory sign

Figure 3a showed the results obtained from the “young”. There were only 17 background colors which more than 50% of the “young” accepted as blue color on mandatory sign. In contrast to the “young”, 24 background colors were accepted as blue colors on mandatory sign by the “elderly” as shown in Figure 3b. At first, we hypothesized that the boundary of acceptable blue on mandatory sign for the “young” should be larger than boundary for the “elderly” since the “elderly” have difficulty on blue perception. However, our results disagreed with the first hypothesis. The results exhibited that the “elderly” seemed to perceive some green or purple as blue.

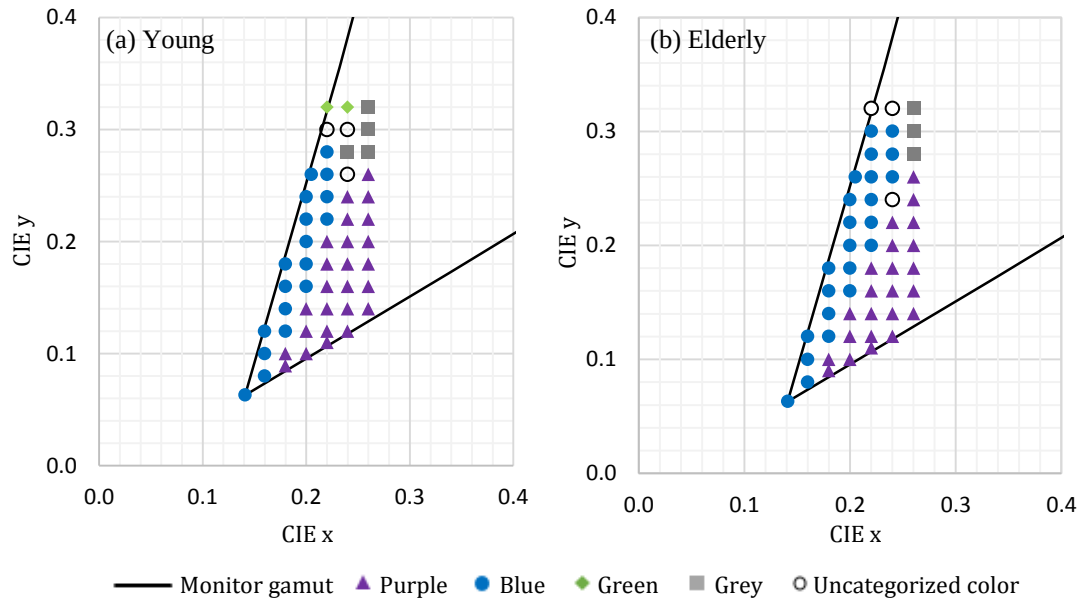


Figure 4. Results of category color naming

To confirm our results, we asked subject to conduct the category color naming based on 11 basic colors defined by Berlin and Kay. The results of category color naming were shown in Figure 4. Each background color was categorized as the color term which got more than 50% judgement. Triangle, circle, diamond and square represented the background color as purple, blue, green and gray respectively. The blank circle represented the uncategorized color which, from 11 basic color term, got less than 50% response. The result of category color naming agreed with the result from the first task. It confirmed that boundary of blue perception of the “elderly” was larger than the boundary of the “young”. We also asked some subjects to describe the difference of color perception between viewing stimuli with naked eye and

cataract experiencing goggle. They reported that some greenish or purplish color look almost identical to blue when they viewed through cataract experiencing goggle. Therefore, they categorized those greenish or purplish colors as blue. Unlike viewing with cataract experiencing goggle, they can properly discriminate between blue and those greenish or purplish colors. This result was consistent with previous research that some elderly people failed to discriminate between the combination of blue and green color due to the yellowing of their crystalline lens.⁵

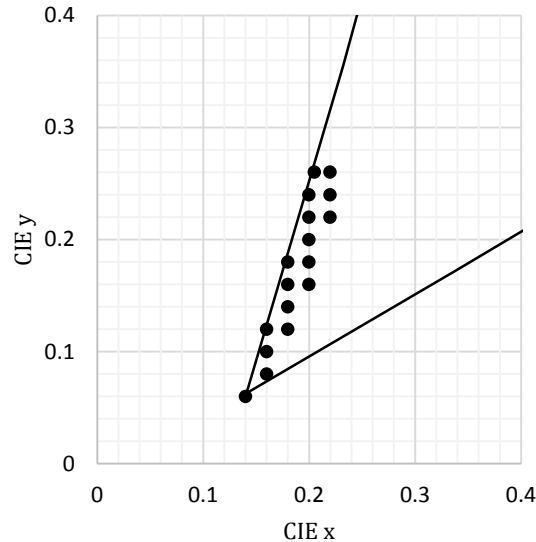


Figure 5. Acceptable blue color for both the young and the elderly

To specify the acceptable blue color for both the “*young*” and the “*elderly*”, two criteria were set. Firstly, we selected the background colors which more than 50% of both the “*young*” and the “*elderly*” responded as blue in the mandatory sign. Secondly, from 11 basic color term, the background color which both the “*young*” and the “*elderly*” categorized as blue color was selected. The acceptable blue color which passed these two criteria were shown in Figure 5. These colors were suitable for background color in blue mandatory sign. However, we found the limitations of our work since the LED monitor cannot presented other colors located outside monitor gamut. Therefore, some of out-of-gamut colors located near blue region were also necessary to investigate in the future.

4. CONCLUSION

Our results indicated that the elderly did not have difficulty viewing the blue mandatory sign. However, they may perceive some greenish and purplish color as blue. Therefore, the boundary of the acceptable blue color in mandatory sign for the “*elderly*” is larger than the boundary of the acceptable blue color for the “*young*”.

ACKNOWLEDGMENTS

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The Investigation of Color Image Context and Configuration Affecting Perceptually Uniform of Color Evaluation Based on CIE Color Spaces – Using Natural Scenery Images as Tested Samples

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ABSTRACT

In recent years, most researches focused on developing mathematical methods to calculate principle color component value and color difference of tested images, but without any explicit description regarding their characteristics, classifications, and compositions. However, CIE recommended color spaces can be applied to predict which spectral power distributions perceived as the same color which is not particularly perceptually uniform. A preliminary study was conducted to evaluate the precision of calculation of principle component color between CIE color spaces via using natural scenery color images as test samples. A group of 51 natural scenery color images with similar context and configuration were selected. An image analysis tool, ColorSpace Convertor, was developed to analyze ΔE between two sets of tested color images. The experimental results indicated that there were existed significant variations of the principle color component values of those images between CIEL*a*b* and CIEL*u*v* color spaces. The largest color difference about 38 in terms of CIEL*a*b* unit occurred between evaluated results has been found. It is suggested that the color images with similar context and configuration did not reach perceptually uniform between CIE recommended color spaces.

Keywords: Color Image, Image Context, Image Configuration, Color Space, Perceptually Uniform, Color Evaluation, Color Difference

1. INTRODUCTION

Color theory was originally formulated in terms of three "primary" or "primitive" colors - red, yellow and blue (RYB) - because these colors were believed capable of mixing all other colors. Color perception is best described in terms of a different set of primary colors - red, green and blue violet (RGB) - modeled through the additive mixture of three monochromatic lights. A viewer's perception of the object's color depends not only on the spectrum of the light emitting from its surface, but also on a host of contextual cues, so that color differences between objects can be discerned mostly independent of the lighting spectrum, viewing angle, etc. The tendency to describe color effects categorically are due to contrasts on three relative attributes, such as lightness, saturation, and hue, which define all colors.

Landscape paintings were deemed somewhat deficient and lacking in truth as photography "produced lifelike images much more efficiently and reliably". Artists are inspired to pursue the means of creative expression, rather than compete with photography to emulate reality. In order to express the perceptions of nature, rather than create exact representations. A scenery is developed into an art form which is very subjectivity in the conception of the image that photography eliminated. On this basis the quantitative description of color mixture or colorimetry developed in the early 20th century, along with a series of increasingly sophisticated models of color space and color perception.

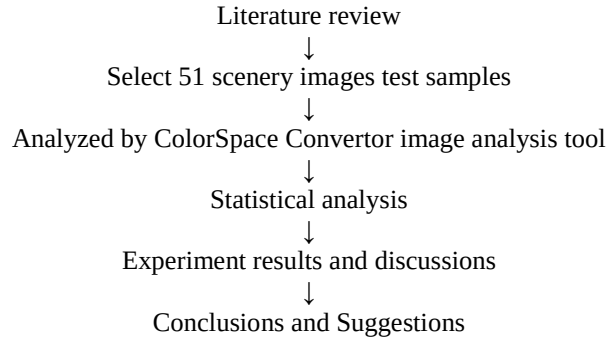
CIE recommended color spaces can be applied to predict which spectral power distributions perceived as the same color, but among them are not particularly perceptually uniform to each other. CIELAB and CIELUV are adopted simultaneously by the CIE when no clear consensus could be formed behind only one or the other of these two color spaces. The purpose of the preliminary study intends to evaluate perceptual uniformity between CIELAB and CIELUV color spaces using natural scenery color images with similar context and configuration as test samples.

2. METHOD

2.1 Experiment Devices

Experiments were carried out, recorded and analyzed. A personal computer with Window 7, ColorSpace Converter image converter tool, 51 scenery images test samples, Farnsworth-Munsell 100 Hue, and Microsoft Office PowerPoint & Excel, are used to conduct the experiments.

2.2 Experiment Workflow



2.3 Experiment Data Analysis

ColorSpace Converter image analysis tool is adopted to analyze and record 51 scenery images test samples for each of 1st component color and 2nd component color. ΔE is calculated between color spaces and top 5 ΔE values are selected for further analyzed. After plotted selected ΔE values on both a^*b^* plane and u^*v^* plane, the comparisons of the precision of calculation of principle component color between CIELAB and CIELUV color spaces, by lightness, chroma, and hue, are examined by their covariance (CV %) and correlation coefficient (r).

3. RESULTS AND DISCUSSIONS

3.1 Tested Image Samples Analyzed by CIELAB Color Space

Due to each of first component color and second component color of 51 scenery image varied from each other. Therefore, ColorSpace Converter is used to analyzed and recorded color values of each images via CIE a^*b^* color plane. Distribution of 1st component color values are plotted on Fig. 1, and 2nd component color values are plotted on Fig. 2.

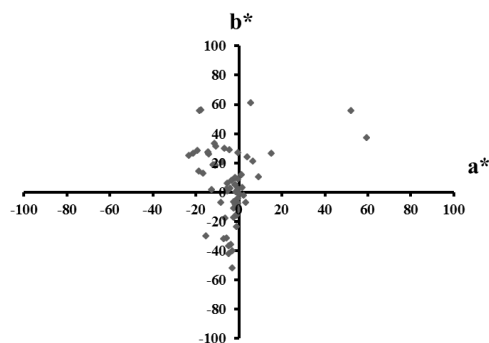


Figure 1. Distributions of 1st component color of test images via CIE a^*b^* plane.

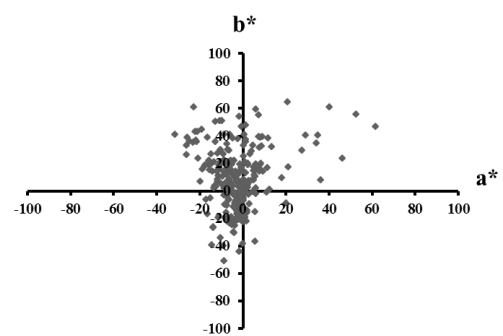


Figure 2. Distributions of 2nd component color of test images via CIE a^*b^* plane.

3.2 Tested Image Samples Analyzed by CIELUV Color Space

Same analysis repeated again via CIELUV color space. ColorSpace Converter is used to analyzed and recorded color values of each images via CIE u^*v^* color plane. Distribution of 1st component color values are plotted on Fig. 3, and 2nd component color values are plotted on Fig. 4.

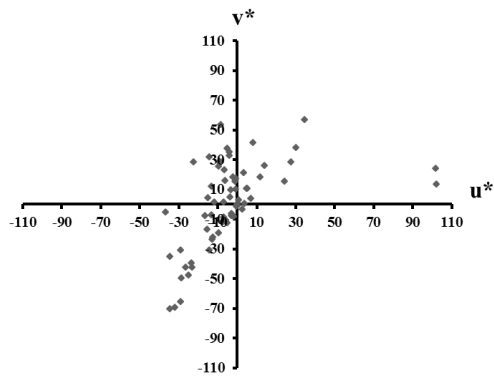


Figure 3. Distributions of 1st component color of test images via CIEu*v* plane.

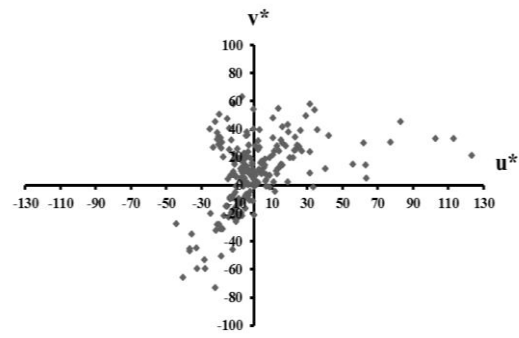


Figure 4. Distributions of 2nd component color of test images via CIEu*v* plane.

3.3 The Effect of Principle Component Color via Different Color Spaces

3.3.1 Analysis of Variance of 1st Component Color between Color Spaces

Color difference formula is used to calculate ΔE between two color spaces. Top ΔE values with largest variance are selected, shown on Table 1. Maximum ΔE value is 38.45089, minimum ΔE is 0.364345, and averaged ΔE value is 9.54223.

Table 1. Top 5 ΔE values of selected 1st component color

Sample(S)	ΔE
S1(ab01) (uv01)	32.83
S15(ab02) (uv02)	28.11
S19(ab01) (uv01)	30.57
S20(ab02) (uv02)	38.45
S51(ab03) (uv02)	28.96

3.3.2 Analysis of Variance of 2nd Component Color between Color Spaces

ΔE calculation repeated on 2nd component color between two color spaces, shown on Table 2. Maximum ΔE value is 47.69352, minimum ΔE is 0, and averaged ΔE value is 11.56131.

Table 2. Top 5 ΔE values of selected 2nd component color

Sample(S)	ΔE
S1(ab03) (uv02)	47.69
S1 (ab05) (uv05)	40.94
S12(ab05) (uv05)	36.40
S16(ab03) (uv02)	43.62
S50(ab07) (uv05)	44.09

3.3.3 Discriminate Analysis of Principle Component Color

From above Figures and Table, among 51 tested images covering all colors, there are found between two color planes that there is no significant difference in lightness, but in hue. Shown on

Fig. 5, 6 and 7. For example, 1st component color in sample 19 is closed to blue, which is found the same result from both color spaces with no significant difference in lightness and hue.

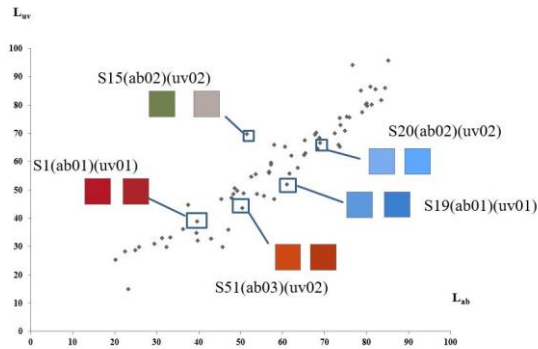


Figure 5. Lightness difference of 1st component color of test images between color spaces, $r = 0.95$, $CV(\%) = 12$

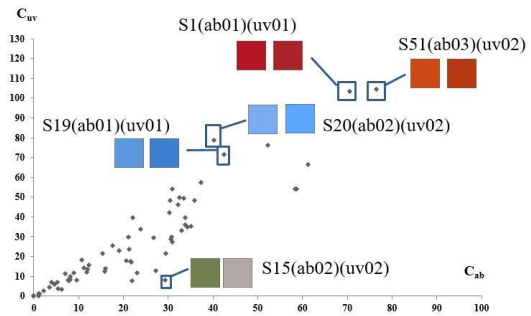


Figure 6. Chroma difference of 1st component color of test images between color spaces, $r = 0.92$, $CV(\%) = 50$

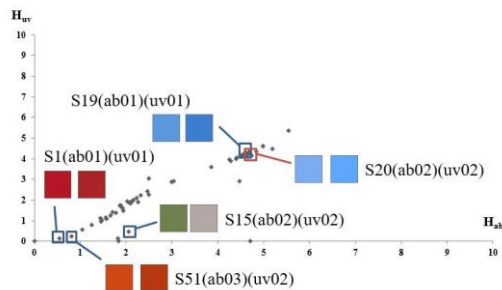


Figure 7. Hue difference of 1st component color of test images between color spaces, $r = 0.91$, $CV(\%) = 34$

4. CONCLUSIONS

1. Among 51 tested images covering all colors, there are found between two color spaces, CIE $L^*a^*b^*$ and CIE $L^*u^*v^*$, that there is no significant ΔE difference in 1st component color, but slightly different in 2nd component color.
2. A significant finding is in sample 15. The 1st component color is different between CIE $L^*a^*b^*$ and CIE $L^*u^*v^*$ color spaces, but correlation coefficient (r) is 0.90. Covariance, $CV(\%)$, found medium high in hue and chroma, medium low in lightness. It is indicated that it is not related to principle component color analysis method used in the study, but no clear consensus between color appearance models in each of two color spaces.
3. Another finding shown that the analysis of 2nd component color between CIE $L^*a^*b^*$ and CIE $L^*u^*v^*$ are highly correlated in all colors with averaged r , above 0.9. Covariance, $CV(\%)$, found medium high in hue, chroma, and lightness. It is indicated that there is better agreement between two color spaces in 2nd component color analysis.

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A brief comparison of three color systems

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ABSTRACT

Color system is an important part of the research on the color and the designers. From the structure characteristics and the use of function of angle contrast in color science community is known as the three major color system, “Ostwald”, “Munsell”, “PCCS” are analyzed in the paper. In order to help designers in various fields to choose color system suitable each takes what he needs.

Keywords: Color system, Ostwald, Munsell, PCCS

1. COLOR SYSTEM

1.1. The System of the Color

It has long been noted that the experience of everyday life, the color change is gradually carried out. Early in the 13th century researcher has put forward all the color changes in the composition of the continuity of a system so that the various relationships between the colors tend principled. It was not until the early 17th century, people started to have this idea into practice. Some color theory, the continuity of the organization change various colors into a complete system, called color system. Like Agnes Houston said, the color is three-dimensional.¹

In 1666, Newton's experiments demonstrated through the dispersion by dispersing sunlight obtained colorful shade, opened a prelude to explore color theory. Mid-19th century, with the development of physiology, people understand that because the human eye is stimulated by the shade of the color can be perceived. Since then, many color scientists, artists and even scientists, are the theoretical basis of this knowledge, try the color system of research. With the increasing variety of colorants, the range of color expression is also rapidly expanding research on color theory from the limitations to the expansion of the practice and published various models of color systems.

1.2. Color Solid

In large and complex color system, it is necessary to establish an effective color order. Factors affecting the color are diverse, planar structure can only represent a maximum of two factors change, and change a number of factors must rely on the performance of three-dimensional structure. In order to facilitate more intuitive to observe changes in color, the color came into being three-dimensional. It is a three-dimensional model of all visible colors by their hue, lightness and purity composed systematic. Designers can accurately and quickly determine the attribute relationship between them by different colors in the three-dimensional model of the location.²

Establish a uniform color three-dimensional, for the management and use of color have an irreplaceable role. But this color standards, there are many inevitable shortcomings. First, the existing production chromatography pigment produced by the technical limitations, it is impossible to print out all of the colors; Second, the printed colors cannot maintain long-term does not change color, the color data display will be affected hardware, which standardized the use of color to bring some difficulties. Chromatography currently used color system is not required to design activities and so delicate rich colors. Sense of color feel naked eye color and color models under different light conditions, the difference is there.

1.3. Color Wheel

After in-depth study of the laws of color, some researchers will be arranged in a certain order color circular ring, which is the color wheel. Color hue ring is three-dimensional cross-section, which helps to easily identify the hue relationship between colors. Eaton and Newton hue ring hue ring is an early two simple yet scientific color representation.

Newton hue circle of red, yellow, and blue right in an equilateral triangle of three top corner. Orange, green, purple three colors located concentric inverted equilateral triangle of three other top corner. Eaton hue ring is manifested in the complementary relationship between colors. Eaton himself has described this

complementary color pairs: two such color combinations into singular pair, they are mutually antagonistic, but also need each other, and when they approached each other can contribute to the biggest bright; but when will they reconcile like water and fire as eliminate each other, become a dark gray.³

2. THREE COLOR SYSTEMS

In order to design more easily choose the color, variety of colors must be lined up according to certain rules. There are a lot of color scientists and institutions long-term commitment to the development of the history of the color system, the results of the more famous German "Ostwald" color system, the United States, "Munsell" color system, the Japanese "PCCS" color system.

2.1. "Ostwald" Color System

German chemist Ostwald dye made great contributions to the field of chemistry, had won the 1909 Nobel Prize. He made this color system in the first half of the 20th century iconic mixed color of law in 1917. Albricht believes black absorbs all light, white reflected all the light, solid colors reflecting specific wavelengths of light. The different proportions of solid color, white, black painted separately on a rotating disc into a fan, then high-speed rotation, a sense of color due to the characteristics of the human eye and visual stimulation alternating each color to obtain a variety of color is the color wheel press area ratio after the mixing effect. Pigment as uniformly as possible and then copy the resulting rotation mixed color, and finally to prepare a color made from color. Continuously changing colors mark between austenite three-dimensional color by adjusting the color disc is solid, the proportion of black and white between obtained.

Albricht from the color visual perception of four original hue - red, yellow, blue, green and departure, between two equal mixture to give a total of 8 main color, then insert two equal separation between each of the two main color, composition 24 color hue ring constituting the color wheel. Wherein the hue of each color can be used containing white numbers + volume + volume containing black to represent, for example, representatives of the 8th 8ga color color (red), g containing white volume, a volume containing black. On the division of lightness, divided into eight levels --a, c, e, g, i, l, n, p, a representative of the brightest pure white, p represents the most pure dark black. In lightness scale vertical center axis hue triangle formation, and thus one side of the shaft as a triangle. Side of the triangle vertices have pure color, the apex of pure white, pure black at the apex, the middle of the ash cloud colors. Color coordinates within the triangle is a common feature of the relationship between color method of color mixing system. Colors proportional relationship is satisfied: solid color + white + black = 100%. Each color in sequence are assembled together to form a thin intermediate rough ends of the turbinate color solid.⁴

In this three-dimensional color, some color have the same characteristic elements are arranged in a regular geometric shape location can be connected on. In this color system at regular intervals, several selected color specification, color theory can be made to reconcile. This ratio of the number of scales using color selection with the traditional approach is strict German color system. Ostwald color system is completely "equal to reconcile order" color theory he advocated specific implementation visually. Although many artists of this seemingly excessive syncretism rigid veiled, but it is precisely because the system is easy to reconcile the rational choice of the color, it is still widely supported by the community. But Ostwald hue circle, etc. do not have intermittent visual, detailed and color uniformity of expression is not enough. So now there is no authoritative body to represent and use it as a color standard. Even in Germany, but also as an industry specification system indicating the country's reconstruction after its resulting DIN color.

2.2. "Munsell" Color System

Munsell color system is representative of chromogenic color system, it will be visible to the human eye color by hue, lightness, purity of the three elements of certain changes in the interval, and this made into a continuously changing color system. It pioneered by American painter, color scientist, art educator Munsell in 1905. As early as 1915 the United States published "Munsell Color Atlas", in 1929 and 1943 respectively, and by the US National Bureau of Standards and the Optical Society of America published a revised twice "Munsell Color Atlas", which is now Munsell color system.

Munsell color man on three visual attributes were standardized, and as a principle to build a three-dimensional color, showing the continuity of change uniform colors. The vertical axis is the three-dimensional color brightness, hue around the circumference, the radiation from the vertical axis extending from the center of purity. His unique language selection for the three color attribute naming: a conventional "Hue" on behalf of hue, art term "Value" shows the brightness, color intensity represents the "Chroma" describe purity. Any color can be used hue / lightness / Purity (H / V / G) values to represent, such as "5R / 4/14" Seji representatives purity lightness value of 4 is 5. Red No. 14.

On the Munsell color wheel, the original hue of red (R), yellow (Y), green (G), and blue (B), purple (P) 5 species. Twenty-two after mixing equal amounts, constituting 10 hue, five new hue generated for: yellow-red (YR), green and yellow (GY), blue-green (BG), purplish blue (PB), purple (RP). To make the gradient is more delicate, each hue subdivided out of 10 rating. Each five major color hue and intermediate level set at 5, each hue are separated 2.5, 5, 7.5, 10 four grades, so a total of 40 actual color is often used. On the division of lightness, black as 0 and white is 10, then 10 aliquots between black and white as Segmentation. In reality does not exist over black and white, the lightness of the color patch with an interval of 1 to 9, or at intervals of 0.5 to 0.5 to 9.5. Dividing the purity, the purity of the achromatic color is 0, the purity of a color with the same lightness scale of achromatic color standard, is gradually increased from 1 to 10.⁵ Munsell color system based on the psychological point of view, based on the visual perception of color characteristics developed. It is widely used in color representation and management, as well as a standard tool to define color relationships and to evaluate the effect of color, shape color recording.

2.3. "PCCS (Japan Color Research Institute)" Color System

Japan Institute of Color Color System (Practical Color Coordinate System) was published in 1964 in Japan, in Japan as well as a color color design education system and relevant market research tool widely used. It is a unique variant of chromogenic color system. At that time a large number of the latest achievements of the PCCS color research into them, the international community is well known color. The system has 24 hue, lightness value of a total of nine levels from white to black is 1.5 to 9.5, the highest purity of each hue are 10, all solid distance from the axis of achromatic color are equal.⁶

PCCS hue circle each hue purity visually visually distinct. The most solid all have their different hue lightness. Yellow lightness with the highest, followed by red and yellow on both sides of greenish yellow, and so on, the farther away from the yellow lower brightness with a complementary colors yellow violet darkest brightness, which is the nature of them true color shade match. But this color when viewed at the property itself often affected by the actual situation. For example, dark yellow and bright purple on the brightness is not much difference. Given this situation, PCCS color system introduced the "tone" of the concept, it cannot be expressed in a single representation of such a clear visual impression of color, color is actually a comprehensive concept of lightness and purity by the lightness and purity. PCCS simple and practical structure where it is compared to the greatest advantage of the first two color system.

The basic concept of the color system not only correctly constructed relations scale color three properties, and surface changes hue with shades of color divided in three-dimensional color, thereby successfully using both color tone and hue of a description full color continuity changes. Almost all representative color can be designed by different combinations and variations of hue and tone. Thus, PCCS color system is also called "Hue Tone System".

3. EPILOGUE

An ideal color system, it should have at least two functions: (1) accurate calibration of all colors visible to the human eye; (2) in accordance with its order to select a set of harmonic color. Including the above three included, still do not have a color system can meet these two requirements. Systems in a variety of colors to show off their coexistence with their own theories and advantages, which adds to the user according to their own requirements choose the appropriate color system difficult. Now, the experts including printing, image processing, color education, including in the areas of R & D efforts in the respective color system. This is a true color scientists should do.

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An analysis of the contemporary design style of super realism printing

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ABSTRACT

As the most influential one of the artistic style, Ultra realism style has a great influence on fashion printing pattern design, which means to explore super realism style with unique advantages on spirit and form is necessary. This paper attempts to get deep analysis of the background of super realism style, the design thought of super realism printing style, the visual characteristics of super realism printing style, the performance method of super realism printing style, sort out the creation characteristics and methods, and inspire future print in fashion design and creative thinking.

Keywords: Ultra realistic art style, printing design, thinking, characteristics, performance methods

1. INTRODUCTION

The super realism art style originated in the 20's of last century, although it has been 90 years from now, its design connotation, style is still influencing the contemporary fashion designers and their works. In recent years, design uses more and more widely by the designer of printing, especially the super realism printing design style is much favored by the fashion circle. Many designers and fashion brands with its unique ultra realistic design thinking and methods, combining with advanced computer synthesis technology and high-tech digital printing technology, creating highly visual appealed and impact printing pattern, prevailing in the forefront of catwalk, which not only enrich the fashion visual effect, but also greatly manifest designer's design philosophy. This paper attempts to get deep analysis of the background of super realism style, the design thought of super realism printing style, the visual characteristics of super realism printing style, the performance method of super realism printing style, sort out the creation characteristics and methods, and inspire future print in fashion design and creative thinking.

2. SUPER REALISM ART STYLE

As one of the important thoughts of modern art in twentieth Century, the ultra realism is not only a cultural movement, but also a thought movement which has had a profound influence on the spiritual outlook of the modern western people and their way of life. After World War I, a group of French youths started to spread the whole France. The experience of the First World War has made them to see the absurdity and destruction of the war to the modern civilization, thus they began to doubt the traditional values of rationality as the core. The old ideas, culture and morality loses their meanings, a new idea is needed to replace them. As what they try to explore the road, the super realism is born in such a historical context. Super realism sprint and analysis the opposites of ideal philosophy, to express the poet and the artist's consciousness and fantasy, practice the designer's ideas and inspiration. Super realism affects the aesthetic thought among the whole twentieth Century." super realism ", just as its name implies, is a kind of anti-aesthetics genre which is opposite to the "realism". It is built on the basis of Dadaistic.

In 1916, Super realism was originally proposed by French Modernist poet Guillaume Apollinaire, and formal definitions of beginning is Breton's manifestoes of surrealism published in 1924. He pointed out: "super realism, nouns, positive, pure spirit of unconscious action, the use of this unconscious action, verbal or written, to express the true function of thinking.¹ The instructions issued by the mind, without any control of reason, are not subject to any aesthetic or moral prejudice." The core of super realism is based on the Freud's psychological analysis theory. Arnason, the professor of American art history, once said: "without Freudian theory, it would be impossible to produce super realism. Freund's theory is soul of super realism." Freud's theory of psychoanalysis reveals that so-called unconscious subconscious which deeply sleeps in the heart of people, not being touched by people's consciousness, but determines the meaning of people's behavior. Super realism see it as the theoretical foundation, "super realism is working on exploring human prior, striving for breakthrough in accord with logic and the realistic view, trying to conform the practical ideas and instincts, subconscious and dreams experience, to show a kind of absolute or transcendent real situation." From this we can deeply feel the respect which super realism shows to Freud's academic.

Super realism has a quite profound influence on visual art of painting. After the artists in nineteenth Century inherit romanticism, symbolism, Dada and other factors, they began to explore the irrational real self-expression, and gradually form a super realism style. This style has two kinds of visual expression method, one is the reality super realism, by super realism, dismember, or deformation, to change the natural objects and scenes, to create an unconscious and irrational control of the image, to create an illusion and dream work. Such as Dali and Margaret, their works of art shows surprisingly ambiguous structure, to subvert the audiences' habits, to accept irrational, absurd, magical and difficult explained reality. The other is abstract super realism, which is influenced by Semiotics, Dadaism, futurism, such as Miró and Ma Song, to pursuit the unconsciousness and chance during the painting process. The image symbols purely dominated by psychological appears on the painting, which results in the abstract images full of illusion and life forms.

3. ANTI-TRADITIONAL UNCONSCIOUSNESS-THE DESIGN THINKING OF THE SUPER REALISTIC PRINTING STYLE

Design thinking is the thinking process that through the form and style of design implementation process to implement the rationality, meaning, mind, and spirit, embodied in a design concept, use the way of thinking and innovation means to reach the ultimate goal. In the design and creation process, influenced by ideas of super realism, fashion print designers pursue with abstract and realistic art language to create a dream like world, more acceptable than other genres, has greatly enriched and extended printing designers' design view and unique style. Visual images with the strong sense of the anti-logic, beyond time and space, bizarre sense, can stimulate the curiosity of the audience, to impress them. And the impact of curiosity and vision is the best catalyst in the field of fashion, printing designers form the super realistic style of design thinking during a long-term research and exploration process to the super realistic style. Super realism printing designers claims to get rid of traditional forms of thinking completely, nonconformist, seek to "perverse" "breakthrough", to pursuit the absolute freedom to create, to represent the most pure, the most vivid art form, to use the visual illusion of the subconscious and dreams for visual elements as artistic conception, to take incidentally discovery or almost non-existent matters as the creative subject, let almost "impossible" in the picture to become "may". This is a new way of thinking to print in fashion designers, when we face with a design theme; we always bound ourselves by traditional thinking or habits, let us lost in the original position of the beginning of creation. We should jump out of the established conventions and re positioning own theme content and way when we express the theme.

Super realism fantasy and absurdity give the designer a good nutrient, so that our works takes on an entirely new look from the nature of the problem. This is the innovation of fashion design, from the anti-traditional way of thinking to develop new visual field of view. Such as the British punk fashion designer Vivienne Westwood is anti-traditional representative, she use anti-traditional thinking, breaking the traditional women's pursuit of the noble and elegant design style, use super realistic creative design to create a strong shocking visual prints. Such as men's general banknote printing "mercenary" suit, which reflects people's excessive pursuit of wealth in today's society, as shown in Fig. 1(a). And as she uses the queen image, the British flag, graffiti painting and other techniques to the composition of a puzzling pattern in the fashion, which fully performs her persistence to the rebellious spirit of the punk. The famous Japanese designer ISSEY MIYAKE, in view of the non-conformist, interpret the traditional and classical realistic painting works to the unexpected, and take amazing prints paranoid and rebellion of metaphorical imagery through the fashion design, as shown in Fig. 1(b). As super realism movement organizers said that, they determined to let the world half puzzled, another half is at a state of shock.



Figure 1. Super realism fantasy and absurdity

Surrealism also believes that the rational and logical thinking has been poisoned; only unconscious and subconscious is pure spirit without outside interference. Unconscious and subconscious reflects the people's hearts "secret self", it is the real process of mental activities, and the objective world and the rational world is nothing but the "shadow", the unconscious is the substance and essence, thus is the source of creative design. It is the people's doubts and negative expression of rebellious spirit of reality; it is the pursuit of the subconscious in the minds of the real, to explore beyond reality. Such as Kenzo 2015

men's. It uses point and line as basic elements, to create incredible graphics, and use ink techniques to express unique language of symbols, metaphor that the thought issued instructions are not controlled by sense. To explain those that cannot see or is difficult to explain, reveals the truth of human connotation of unreal awareness, as shown in Fig.1(c)

4. FANTASY AND ABSURDITY-THE VISUAL FEATURES OF THE ULTRA REALISTIC PRINTING STYLE

"Every matter implies a point exist though the thought, where living or death, real or unreal, past or future, communication or silence, high or low is no longer in the face of opposition appear in the hearts."² "The beginning of the super realism are based on the reversed and specific spirit, although they advocated the expression which is subconscious straightforward and dreams of natural, among the communication of information they implies various of metaphor, implication and visual association, stand out in a prominent picture while maintained some sort of the latter mystery. The goal of the super realism is not to present a contradiction, but to enter a state beyond reality. This kind of visual effect beyond reality and imagination not only make fashion design become more interesting, artistic appeal, visual impact, the most important thing is to enlighten the consumer's infinite thinking. Such as the British designer Holly Fulton design fashion prints like the mirror world of psychedelic, printing in vertigo shrouded and strong order sense, interleave the graphics maze seems to be meaningless, keep the protean and chaotic design to the right point, giving a person some kind of unsuppressed excitement, as if the exposure to laboratory like greenhouse, waiting for a time travel through contemporary to future, as shown in Fig. 2(a). According to Freud, the essence of the dream is "a dream is a coming true of a wish, it can be considered as the continuation of a sober state of mind activity", super realism printing designers are looking forward to perform this mental activity, and more eager to depict that fantasy beauty inside the sub consciousness. They express their poetic emotion thoroughly, in order to create surrealist images of the dream.



Figure 2. The ultra realistic printing style

Absurdity has long been pursuit by ultra realism as sense of action and art aspiration. Absurdity is bewilderment when human face relatively freedom, is ultimate panic while human suddenly realize the abyss of little consciousness inner self. Li Zehou said: "there is no God and the law of the people's sense of the absurd, not to import a logical, abstract, rational, but walks to the experience, experience, emotion and soul."³ The subconscious reflects the embarrassment among children and adult period; people in this state tend to become weird, naive and very naughty. Surreal printing designers use the absurdity of "black humor" to compare the absurdity of "abnormal relationship". It breaks the restrictions of time and space, dislocates the existence of traditional matters in our real life, in order to break the original order to cause strong conflict, resulting in the expression of a brand new form, even absurd visual images. Such as Kenzo totem eye series, it uses fantastic imaginations to express indifference, cruelty, absurdity, self-contradictory and such dark side and weakness of human nature, which make people see the funny through pain of anger, see the absurd through ridiculous weirdness. No matter the white eye or the black eye, its mysterious visual effect reaches our heart straightly. Combined with fresh color, the eye largely distributed a strange irony playful, what an exciting alternative fashion, as shown in Fig. 2(b).

5. REORGANIZATION-THE PERFORMANCE OF THE SUPER REALISM PRINTING STYLE

The super realism turns the impossible to be possible, performs the form of irrational anti logic. Printing designers use nontraditional perspective, look for different picture elements, or use special shooting techniques such as multiple exposure, dynamic image control, suspended filming, reversed shooting as a means of modeling, or use the computer system to reorganization and recreate such image, based on the needed fashion theme style, combining specific details with distortion, ellipsis and metaphor methods, creating a realm between reality and fantasy, specific and abstract which is such a super realism realm.

The new image created by the use of super realism collage, restructuring and other means, will be unquestionably making fashion designer's creation distinctive. They use the familiar image, through decomposition or combinations two or several unrelated things to produce a particular graph, create a strange picture, express the theme of the new meaning by the metaphor of inner linkage. Surreal picture

can bring a sense of absurdity and mystery to the fashion design, which is the most popular and respected trend in the contemporary fashion. Ukrainian designer Masha Reva is concerned about personality change development process among all kinds of social relations, and she believes that human is a part of nature, and the confrontation between nature and artificial matters is an interesting theme analysis. She uses the photographic montage method to decompose, combine, overlap and blend the real image, producing a figure with metaphor, creating a kind of rich poetic visual transfer method in printing design. As she put the magic forest, beautiful flowers, dazzling diamonds, classical portraits and others to become her deep imprint of subconscious as well as the most important "reality" to constitute her perfect world inside herself. These different context elements are scattering and restructuring in unconscious thinking, showing up "abnormally" in her works, just like staying in a beautiful dream, a fairy tale world, leaving unreal and intoxicating feelings. Saturated pink and maroon, quiet quaint dark green embellished in the spirit of the fairy tale world, bursting out the exuberant vitality and wonderful child interest. It shows the history documentary as well as the very creative mind of the picture, not only gives strong super realism metaphor meaning, but also leaves the magnificent beauty of the super realism beyond time and space, as shown in Fig. 3(a).



Figure 3. The super realism printing style

Another super realism Greek fashion printing designer, Mary katrantzou, has been working on the printing pattern design and technology development. She is famous for her three-dimensional sense, complex and deep literary temperament prints. The theme printing of each season are treated though the splicing and recombinant, breaks traditional visual images and the ratio to stimulate audiences' attention, makes her fashion designs stand out fastly to convey information. The design elements of Mary katrantzou are everywhere, interesting letters, stamps, stop sign symbols, old-fashioned typewriters, whirlpool grid, classical architectures, garden flower shops, spoon racks, watch, telephone, armorial bearings, the rose patterns, logo uniforms. All things in our life can be moved into her printing Kingdom. She uses the symbol through the visual language of cultural value to abstract from the source of creation to create. In the strong perspective digital printing, adding three-dimensional garment structure matched with, totally mix the two dimensional and three-dimensional to create a new interpretation of the aesthetic language. No matter with unity or uniqueness, it is the symbol of view. These elements mix luxury vocabularies, become the basis of delicate lace, embroidery, appliqué and brocade. They not only hold the individual and professional representation, at the same time, they have a symbolic value. Each one brings a direct visual impact, which is their expression about ideas, beliefs and actions in their own language. Both crossing stitching designs and art color contrast are originating from the life but higher than life; Realistic patterns and complex structure of clothing, leave you fall into the visual vortex of super realism, as shown in Fig. 3(b).

6. CONCLUSION

As one of the most influential artistic style, Super realism style has a great influence on fashion fabric printing pattern design. It is a traditional media, closely linked with painting art pattern in its development process, and easily influenced by artistic ideological trend. Super realism's interpretation and expression to the modern times, provides a great reference for contemporary prints designers creative design, gives an important inspiration, encourages designers to break through the traditional, innovative and enterprising, connects the most direct image cognition onto the poster design, enriches the cultural connotation of printing pattern design. The artist's persistent of the subconscious, dream, illusion in their work expresses the novel legend of the personality and gloomy social background and so on, all of them are triggering the printing design designers of the repeated research and depth reflection. In addition, the rich and change of the theme, also allow the design space of the theme and service objects to change a lot. In short, the distortion of the surreal theme does not make people feel comfortable, but it gives us a challenge, let us to see the world from our instinct view rather than rational view.

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Color Design and Product Innovation of the Car Seat

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ABSTRACT

Color design usually plays a very important role in the appearance design of the product. In the design work of the car interior seat, color and texture design gets more and more attentions from the automotive factories. In this paper, through examples of color and texture design application in car seat design, it explores how to grasp the color application and make the whole color matching to achieve the innovation effect during the new product development of car interior seat.

Keywords: Car seat, texture, color design, color matching, product innovation

1. INTRODUCTION

In modern society, the car has become an indispensable part of our life. It becomes a fashion consumer goods with providing convenient transportation to the people and extending the people's living space. As an important part of the vehicle color design, the color design of the car seat already has evolved into an important way of giving the product a fashion personality, highlighting the brand culture and the car concept.

2. THE SIGNIFICANCE AND FUNCTION OF COLOR IN PRODUCT DESIGN

The famous color expert Anchor Hocking said that "the color can directly affect the mental state and mental activities of human being, which is the lifeblood of products sales and production."¹ Foreign scientific experiments prove that: in the first 20 seconds, the observation of the object for people's visual organ, 80% of which is color sense, form accounted for 20%; after 2 minutes, the sense of the color accounted for 60%, the form feeling accounted for 40%; after 5 minutes, sense of color and form feeling each accounted for 50%, and the state will continue.² The color with playing the role of head start, can affect people's visual experience before the form.

Color design and application always exist in the product design. The product transmit the information and express a certain meaning through the color; at the same time, color can stimulate people's emotions through visual perception, trigger people's thinking and psychological activities, transfer deep information, create a different aesthetic feeling and atmosphere. Color is also the very important external character of the product. The use of color will directly affect the product quality, sales and consumer appeal to people. The ingenious application of color often can enhance the appeal of the product image, strengthen memory recognition, influence the consumer's psychology, improve the added value and market competitiveness of the products.

3. THE DESIGN THINKING OF THE ENTIRETY COLOR DESIGN FOR THE CAR SEAT

In order to do a good design work for the car seat, we usually consider from the following aspects:

1) Firstly we must consider the seat color design in a broad environment of the vehicle design style and overall effect of interior-exterior color application. The aim is to ensure the coordination of color application, consistency of the value orientation and the design concept of part and overall.

2) Market investigation and research is the key step before the product design. Through different market information such as the brand culture of target vehicle model, interior seat style of formerly vehicle model, the seat feature of the major competitor car model, etc., it will provide some data base and reference to the new car seat design and development. For different models such as the economical family car, sporty SUV, business MPV and high-end cars, etc., the color application in the seat design is also not the same, as shown in Fig. 1. Different consumer groups and cultures also have different demands of car seat color. Therefore, making full analysis of the research work, we can more accurately choose the appropriate color to express the design purpose and the value orientation.

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3) Combining the fashion color trends, we choose the mass-tone and ornament accent of the car seat; meanwhile need to consider to choose the texture of material. The fashion color has strong characteristics of times. Its application has prospective for the product design, which can improve the higher recognition probability of the product for customer in a certain extent.



Figure 1. The color application of different vehicle models

The types of car models can be roughly divided into economical family cars, sports SUV, business MPV and high-end cars. We make a deep research on the positions and modeling features of these cars. Through the consumer groups analysis of different models, and the understanding of the model itself which conveys the design concept, we design the color application scheme for the car seats. Economical family cars (usually including A0 and A class): The consumer groups of such models are mostly the young people who just build or prepare to build a new family. They have the pursuit economical and practical, and also pay more attention to the driving of getting home feeling. So, the seat color design emphasizes the sweet and comfortable, pure and nature. Its characteristic is the high-saturated, warm hue, weak contrast. This mild color tone can lead consumers to experience the real family sense of belonging, build our own emotional connections with the family, as shown in Fig. 2. The consumer groups of sport SUV models are mostly the young people with first step into the society. They have the fashion personality, and pursuit the freedom. The mass-tone of the seat usually is the dark-toned, such as black, dark gray, at the same time, matching with high-saturated high purity bright-colored color as ornament, which can reflect the sporty and the visual impact. The high contrast colors are always applied in this kind of color matching system, as shown in Fig. 3. The MPV models usually are used for providing service to the enterprise or business people. In order to let them effectively alleviate the fatigue of work when staying in the car, the design concept of this kind of seat is given priority to the natural relaxed colors, like the series of beige and gray colors, as shown in Fig. 4. The consumer groups of the high-end car are mainly the middle-aged people. Based on their better economic condition, they pay more attention to the experience of the quality and details. The target colors of the seat mainly are the composed and elegant dark, cool colors. Through the color match of low brightness and high purity to reflect the low profile and high grade, the similar colors are commonly used in the color-matching system, as shown in Fig. 5.



Figure 2. The seat color application of the Economical family cars



Figure 3. The seat color application of the SUV models



Figure 4. The seat color application of the MPV models

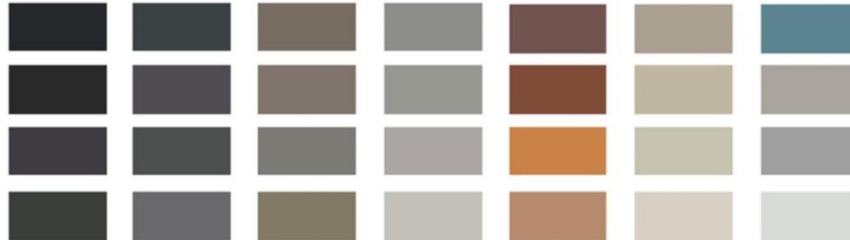


Figure 5. The seat color application of the high-end car models.

4. THE MATCH DESIGN OF THE COLOR, MATERIAL AND MODEL

Whether in the textile clothing, packaging materials, metal products, transport vehicles, consumer goods and other fields, the expression of color is presented on a certain material and shape. The same color, applied different materials and shapes, its visual effect is also not the same for people.

1) The carrier material types of the car seat color

Generally, color design of the car seat mainly shows in the seat trim. The main function of the trim is providing the safe, durable, comfortable, beautiful and enjoyable surface cladding. As usual, according to the material of the trim, it can divide into two kinds: leather trim (genuine leather, PVC and PU) and fabric trim (including woven, knitting, and nonwoven). Presently, the mainly conventional collocations of the materials are: full fabric, full leather and fabric with leather, as shown in Fig. 6.



Figure 6. The material collocation of the conventional car seat trim

In these materials, the color matching design of the fabrics are more flexible; for leather, the flexibility of the color changes is relatively low due to the characteristics of material itself. The color collocation of the fabrics is relatively convenient, mainly through the yarn with different color hues, contrasts and glossiness collocations to reflect. Also using some special processing, such as embossing, printing, high frequency welding process with fabric and PVC, all of them can give a new color texture design effect of the fabric. Examples of application are shown in Fig. 7.



Figure 7. The special processing application in the car seat trim

2) Profile design of the car seat

About the profile design of car seat, the main focus is on the different areas division of the seat, different surface shape design and the materials application of the corresponding area.



Figure 8. The profile design and color application of the car seat

In accordance with the requirements of design consistency, profile design of car seats also need to meet the requirements of the whole vehicle design concept. These requirements are mainly embodied in the seat, backrest part and the head part design. For the models of different market positioning, such as economical cars, high-end cars, MPV and SUV models, the seat profile, area division, sewing effect are different. In addition, the color match of sewing thread and the effect of different stitches also influence the color design of the whole seat. Concrete application examples are shown in Fig. 8.

5. CONCLUSION

The innovation design of car seat product is the important step of the whole vehicle interior design work. Along with the increasing consumption and level requirements of the car, especially in today, advocating personalized and private custom, the model design and color collocation of the car seat more and more show their unique roles and influence. In a good design of car seat product, the profile design directly shaped the basic architecture, and successful color design and material collocation added a bit connotation, temperament and personality. Automotive seat designers must fully consider all the factors in the interior space, like the mass-tone, ornament accent, material, texture, light-and-shade drawing, gloss, and contrast, etc. A perfect collocation of the seat model, color and material, can provide an interior space with rich visual appeal and give consideration to quality, safety, comfort, personality; and also can provide automotive products with greater market competitiveness.

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Static if Qing Chi, moving like ripples - The traditional blue & white colors & modern decor of blue & white

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ABSTRACT

Blue and white pattern from China's blue and white porcelain as inspiration, is not only the traditional symbol, but also evolved from the Chinese and Western cultural connotation. She is fresh and smart, flowery, fashion's most fascinated China wind, the classic elements is never ending.

She was so quiet resembles to clear pool, so beautiful resembles to the ripples. Blue and white porcelain has its different characters in different times, the modern blue and white is the inheritance and development of the traditional blue and white art. Summed up the change of generations of blue and white with the traditional blue and white decoration, and expounds the unique cultural value of the blue and white decoration and rich connotation, and puts forward some opinion about modern blue and white decoration and development.

Keywords: quiet resembles to clear pool, resembles to the ripples, blue and white change, traditional blue and white, modern blue and white, decoration, development.

1. THE BLUE & WHITE COMPLEX

Blue and white pattern with blue and white Chinese porcelain as the inspiration, is not only the traditional symbols, also evolved different cultural connotations of Chinese and Western. Her fresh and clever, happy, smiling, fashion is the most obsessed with Chinese style, which is the never-ending classic elements. If she still Qing Chi, moving like ripples, turned into a variety of patterns tell the story behind the unique home space to lay a deep imprint. Blue and white Qing-Rou elegant, which is simple and generous, giving a fresh and bright, dignified and solemn feeling, is the first of the four traditional porcelains of Jingdezhen, which is known as the "world treasure." Blue and white porcelain, as a Chinese traditional culture treasure, has been able to enduringly popular, because it has a variety of decorative techniques and unique style of traditional Chinese culture. 2008 Spring Festival Jay's a "blue and white", soft melody tactful, elegant and refined, sing intoxicated, very touching, so many people fascinated imagination. Beijing Olympics series of blue and white dress, the blue and white which liked by people to the extreme, "blue and white" such as hurricanes involved ordinary human auditory, visual or tactile, set off a "blue heat" wave at home and abroad.

2. THE BLUE & WHITE OUTLINED

Prepared by the Chinese Ceramic Society, "history of Chinese ceramics," a book that: " 'blue' refers to the application of cobalt material on porcelain painting, then the transparent glaze, firing at a high temperature, showing a pattern of blue glaze under color of porcelain. " From the definition of the concept of point of view, the traditional blue and white is practical for the primary purpose of blue and white porcelain, dishes, plates, etc., time is about blue and white porcelain from maturity until the new China was founded during this long period. Modern blue and white porcelain is based on reflecting the ornamental art as the main purpose for about time after the founding of new China to the time span now. From a functional point of view, the blue and white can be broadly divided into three categories: household porcelain, antique porcelain, art porcelain. Stress the usefulness of the traditional blue and white, consider the aesthetic and practical, based on the most rigorous shapes pursue neat, perfectly plump shape. Modern blue and white ceramic form is played down the practical function, pay attention to reflect its artistic appreciation. From the decorative carrier perspective, modern blue and white decorative ceramic carrier in addition to the traditional form of refined generalization, but also into the modern ceramic components to further expand the space for modern blue and white décor. This article from the decoration carrier, decorative themes, blue and white decorative techniques, etc., summed up the modern and the traditional blue and white blue and white decor changes, an overview of the blue and white

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decorative unique value and rich cultural connotations, presents modern blue and white decorative color development and innovation View.

3. CHANGES IN THE DECORATIVE CARRIER

Traditional blue and white use function of decorative carrier is very obvious, the early in Ming Dynasty, the necessities of life will be available to make porcelain, such as tableware, wine, tea, furnishings and enjoy the goods, etc., so as the mainstream decorative blue and white on the use of natural among them. Focus on production and sales in the traditional blue and white era of the preferred carrier must be round device with regular shape and large output, a circle is because the body casting convenient, and draw on the regular shape of the same theme can be without too many changes to draw, that is, a folk artist one's whole life could only draw 3-4 themes without undue changes to meet market needs. So, from the traditional blue and white decorative vector, the traditional type of ceramics such as pomegranate respect, creel cans, bottle gourd, garlic bottles type styles are based on natural forms, to generalize from deformation. Meanwhile, the Chinese pay attention to the type of traditional ceramics complete perfection modeling method, therefore, the traditional ceramic type mostly neat, rigorous pursuit of the perfect shape, full, and the formation of a coherent type harmony, echoing up and down, left and right pairs of each other relationship.

But in today's economy and society, spiritual civilization, when demand for the rapid development of high culture, people obviously need more kinds of modeling approach to heritage freehand blue and white decoration, and therefore, the carrier in the form of change has become one of modern blue and white decorative features. Therefore, modern blue and white decorative ceramic carrier has gradually dilute of practical functions, instead focus more on art appreciation and reflects its author emotions, expression of ideas, philosophy. The author believes that modern blue and white decorative vector can be divided into four types: First, the traditional ceramic type of heritage, such as a large number of porcelain, still the main practical function, but in the decorative themes and decorative techniques inject new elements. Second, the improvement of traditional pottery, such as the traditional bottle gourd shape, proportion, radian improved after adjustment, become reflects a novel form of modern blue and white decoration carrier. Third, integration into the modern pottery culture, modern aesthetic interpretation of the concept of innovation in the decorative carrier, will soon break through in the traditional ceramic ware type, the break through of the decorative carrier to guide the modern blue and white decorative themes, decorative techniques, decorative color innovation. Fourth, the new decorative carrier expansion, not just blue and white have been used for household porcelain, antique porcelain, art porcelain decoration, small jewelry, mosaics, frescoes with large blue and white tiles and mosaic pieces, home decoration and so on, can be seen everywhere in the footsteps of the blue and white porcelain, Tianjin "porcelain house" well-known, far and near, which completely Ming blue and white porcelain and debris from buildings, described as East meets West, the concept of there is a heavy sense of history and modern fashion style, like wandering around in the ancient blue and white porcelain ocean, giving dreamy feeling, as if back to the Ming and Qing Dynasties, ear but sounded mildly blurred Jay "Blue and White" untold retro feeling, Changbu Wan classical tunes, also witnessed the new blue and white decorative expand, and left behind an endless source of fascination and incalculable wealth.

4. THE CHANGE OF DECORATIVE THEMES

Traditional blue and white decorative themes are to express good luck, good wishes for the theme. Wherein the animal pattern of dragons, phoenix, unicorn, lion, tigers and leopards, cranes, deer, fish, duck, magpie and other auspicious animals; plant decoration in Lotus Scroll, Interlocking Peony, floral, Switzerland fruit, flowers and broken branches, pine, bamboo, plum, and the like. "Children-playing pattern" is divided into two, one is the "conscience" and "innocence" thought to influence, Another is to the people for the "many sons multi Fu" thought of advocating off, such as "even Takako" and "five sons Corrections," and other decorative themes. In addition, by the influence of literati landscape painting decoration, in which there are often people fishing, firewood, farming, reading as dotting purposes, with "Heaven," aesthetic realm. Other lines such as gossip, eight guitar pattern, Eight lines and various abstract signs patterns, fonts, and other traditional blue and white decorative themes are then reflected in social culture, to show the spiritual content of a particular era. With the passage of time and the times in the new social environment, the traditional blue and white decorative ornamentation in excellent form and themes in a modern blue and white decoration still be in use. But in traditional societies, blue and white decorative ornamentation in the form of people are concerned about the implication of limited aspects, while ignoring the choice of the form. In the social consciousness, a different culture, modern, decorated in blue and white traditional culture process loss or dilution, the creators have a different selection criteria in form and content. Thus, in the traditional blue and white modern decorative theme in use, not

the blind pursuit of a prototype of imitation, but an absorption, transformation, and thus have a heritage, beyond and further increase the significance of creating awareness and aesthetic embodies the modern concept of.

Although modern blue and white décor theme is still the traditional classification methods to classify subjects, such as figures, flowers, landscapes, but the pattern and content of its manifestations has already broken through the traditional decorative themes numerous restrictions, changed the traditional ceramic decoration "type there must be decorated, will be auspicious ornaments "concept in favor of more emphasis on formal beauty and the pursuit of spiritual connotation.

5. THE CHANGES OF DECORATIVE TECHNIQUES

Different blue and white decorative vector also brought blue and white decorative techniques innovation. Drawn on the round device modeling blue and white patterns, usually with the wrist raised draw blank, thus requiring bold but cautious, intended to pen first, a sense of rhythm so drawn patterns reflect the speed of the line also fluent and imaginative, Artistically vivid. Therefore, it requires producers mastered drawing techniques, grasp the relationship between the material and of water, so that the amount of water and feed pen containing body thickness, and the speed of the flexible use of brush speed, brush avoid stagnation, repeat with Tim color, so that the material have to go underwater, relaxed, you can collect more, no accumulation of thick materials. Thus, in a sense, is blue and white decorative circle drawn on higher skill requirements. Today, the blue and white of the carrier is no longer confined regular round device, with parquet, a porcelain decorative and so is our common carrier plane constituted such a carrier with its flexible plane for the blue and white decor provides creative freedom platform, technical requirements are relatively smaller than the round shape is, this change in favor of today's artists more fully with the blue and white to express their inner world.

From the perspective of ceramic decoration, whether traditional or modern blue and white decorative decor, all pay attention to the principle of balanced decoration, which must ensure the complete composition, but because of the different aesthetic concepts, the traditional blue and white decorative composition mostly second party continuous pattern, was banded distributed in the porcelain surface, and multiple use of string lines to separate the main body decoration and the small print decorative pattern; modern decorative blue and white are more common discrete point, the individual pattern are integrated in the form of free composition, make it a complete decoration graphics, and rarely useful string lines to separate the decorative pattern.

In comparison, the traditional blue and white performance techniques to reflect the primary purpose of the profound techniques and skill, pay attention to perfect composition and ink charm, co-moderation, reserved style. The modern blue and white personalized attention, dare to break the conventional form of the composition, the bold exploration in the traditional performance techniques on find and create the beauty of blue and white materials and process operation, try not to repeat, and seeking new ideas.

6. THE DEVELOPMENT OF BLUE & WHITE DECORATION

Blue and White is an ancient ceramic decorative arts, she loaded with Chinese history and culture heritage into modern times, as long as the environment in the new era of fusion, the essence of Western art, with the times, be creative, will have a more broad space for development. For the development of blue and white decoration, her practical significance is also the same performance, as a historical relic from her generation has been a long time, but because of her matter in the practical function or pure aesthetic function has to make today's people get "function to enjoy" role, therefore, we do not have doubts why the blue and white decoration can experience the history trauma tradition for hundreds of years now, don't worry and in the new environment also can continue to move forward, as long as people still able to recognize her features blue and white will continue to "live", she is the development trend of the times, in line with the law of historical development. And the overall social environment, the development of blue and white with a solid foundation, as Professor Tian Hong Xi in "through the Millennium," a book said, mainly in the following two points: First, the human sense of return to nature: today's society, the rapid development of science and technology, on the one hand, advances in technology make human life more convenient, rapid increase of productivity levels, however with the continuous encroachment of large machinery production, people's living environment has become a world of reinforced concrete, At this time, it is found that only a handful of blue and white decoration in a few pens of fruits, animals and landscapes and figures is contemporary experienced complex everyday things in the hope of natural landscape, a broad mind of a pursuit of reproduction. Second, the new understanding of the significance of manual labor: since the industrial revolution in Europe, the whole world into the endless machine production model of urbanization in the production of modern lifestyle makes hands and brain gradually

lost the opportunity to create, for this situation, part of the pursuit of individuality, a man who is in the pursuit of nature begins to produce a feeling of disgust, so they began dating back to ancient history and civilization manually create return. Thus, in recent years, enthusiasm for handmade products is growing, and the blue and white this pure manual way of expression naturally once again has her unique and extensive appreciation of the crowd.

In summary, although the modern blue and white with the traditional blue and white has a non cutting and abandoned blood relationship, but if you want to make it in today's society continues to demonstrate its vitality must be innovative. Modern Blue and White is the traditional blue and white decorative heritage, improvement, innovation, development, fully in line with the development of the law of general things, especially the x-decorative carrier breakthrough, led the modern blue and white decorative themes, decorative techniques, decorative colors innovation, to further expand modern blue and white decorated space. Of particular note is that the "blue and white" porcelain has been just a simple name, the history of heavy gave her much richer, it has become more of a highlight Chinese traditional culture carrier, charged with the responsibility for the spread of Chinese traditional culture. We have all-round, multi-angle of the blue and white decorative rediscover bold excavation and innovation, the "blue" this ancient porcelain decorative way to give a new element of the times, so that the "blue and white" always maintain its Chinese porcelain (China) in Quebec position crown. And decorated with blue and white as the pride of the nation, with its unique artistic impact on the world of traditional Chinese culture, admiration, and can spread in the environment of globalization, modern civilization, to create a huge economic, cultural, social and value.

7. MODERN BLUE & WHITE DECORATIVE COLORS CASE STUDY

7.1. As early as 1968, Valentino on oriental porcelain as inspiration to design a stunning world of blue and white blue and white dress. Blue and white pattern printing is a never-ending fashion classic elements, her charm has swept the international T station in 2013. Valentino blue and white dress (1968) (Fig. 1), blue and white complex: Complex blue: blue + emerald green color match, reverie.

7.2. Blue and white Chanel dress (1984) (Fig. 2) with a blue and white color + cedar green, oriental classical elements.

7.3. British brand Erdem (2013 early spring vacation series) (Figures 3, 4) blue and white complex: blue and white color + with bitter chocolate, fine.

7.4. Italian brand Roberto Cavalli (2013 early spring vacation series) (Fig. 5) blue and white complex: blue and white color + with bitter chocolate, fine.

7.5. Italian brand Roberto Cavalli (2013 early spring vacation series) (Fig. 6,7) Complex in blue: blue and white color with gray + glacier grey, calm and quiet.

7.6. Italian luxury brand Valentino (2013 Winter Series) (Fig. 8,12,13) blue and white complex: blue and white color + aromatherapy color with fashion combinations.

7.7. Italian luxury brand Valentino (2013 Winter Series) (Fig. 9) Complex in blue: blue and white color with color + lark, peaceful, elegant.

7.8. Italian luxury brand Valentino (2013 Winter Series) (Fig.10, 11) blue and white complex: blue and white color + Phantom with ink, traditional, refined.

BLUE DECORATION INTERIOR ((Fig.14 ~ 23)

7.9. Blue and white patterned wallpaper can deduce abstract sense, but also very story. But in any case, the first thing you can feel is still the kind of indelible Smart charm. (Figures 14, 15) blue and white complex: blue and white color + golden yellow with Asian luxury.

7.10. Sofas, chairs, bedding, curtains, all kinds of household fabric can carry this blue emotional expression. Soft cloth elements of the original tough blue and white pattern, blue and white decoration and gives the space more pure gorgeous.

(Fig.16 INTERIOR, FIG 17PRODUCT PILLOW FEVER PRINTING BLUE PILLOW, 18INTERIOR) blue and white complex: blue + silver color matching, clean, wise.

(Fig. 19INTERIOR) blue and white complex: blue and white color + sand color with a sense of history and vitality.

(Fig. 20INTERIOR) blue and white complex: blue and white color + blue mouse, will perform a luxury style tranquil and gentle atmosphere.

(Fig.21INTERIOR, 22INTERIOR) blue and white complex: blue and white colors + bright white , sunlight thrown a piece of white light, the interpretation of the British classical style.

(Fig.23INTERIOR) blue and white complex: + indigo color with natural simplicity.

7.11. Whether it is hanging on the wall of blue and white decorative hanging plate, or put on the table or countertop blue and white porcelain, the most simple decor bring the most natural calm classical oriental charm,Blue and white elements. (Fig.24 ~ 27)

(Fig.24 ORIENTAL DANNY) blue and white porcelain lamp and sit pier, feeling blue: blue and white colors + white with winter, dense fog Morning sense.

(Fig.25) Germany's top blue and white bone china tableware brand Meissen Blue Onion series, feeling blue: blue and white colors + winter white, mist in the morning feeling.

7.12. The South African artists Ruan Hoffmann designed blue and white tableware series (Fig.26~27)

(Fig.26) Complex of blue: blue and white color + rock chocolate, Innisfree sense of vitality.

(Fig.27) Complex of blue: blue and white colors + bright white, sunlight thrown a piece of white light, the interpretation of the British classical style.

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Fig. 1



Fig. 2



Fig. 3



Fig. 4



Fig. 5



Fig. 6



Fig. 7



Fig. 8



Fig. 9



Fig. 10



Fig. 11



Fig. 12



Fig. 13



Fig. 14



Fig. 15



Fig. 16



Fig. 17



Fig. 18



Fig. 19



Fig. 20



Fig. 21



Fig. 22



Fig. 23



Fig. 24



Fig. 25



Fig. 26



Fig. 27

Research on the teaching methods of science & technology theories for art post-graduate student's color education

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Abstract

New era of color education was begun by the introduction of science and technology. Thus, science and technology education became an indispensable part of color education. However, it is an awkward business to teach art major students science and technology knowledge, whose relevant base was weak. In view of that, three approaches, addition of experiment, from known to unknown, and flexible and effective evaluation method, were proposed. Students' interests are stimulated, followed by expansion new knowledge with the help of teacher, accompanied with effective evaluation. Good effect has been obtained from approaches in these years. Also, active exploration has been made for educational concept of blending of art and science & technology from approaches of Beijing Institution of Fashion Technology.

Keywords: color education; science & technology; practice; Knowledge development; assessment

The development of modern color education in our country, in terms of history, has experienced three periods from the beginning of twentieth century to now, which is the enlightenment period, the development period and the prosperous period. Color education enlightenment period was from the beginning of the 20th century to the 1970s, adopted the color teaching system established in Japan at the beginning of the 20th century. In this system which based on decorative color and color pattern, imitation and reproduction of the object were emphasized; color knowledge was obtained from the traditional case.

Color education development period, from the end of the 20th century 80's to the 20th century, during this period with the reform and opening up, color composition system was introduced from Hong Kong and Japan, and Bauhaus' color education system was began. The system was founded by Johannes Eaton Professor advocated from the perspective of scientific study of color and established a rigorous theoretical basis for color course, conducted students by kinds of color teaching methods. And students may generally be able to know the color creation principle.

It is a boom in the education of color from the end of the 20th century. Art colleges and universities in China conform to the color diverse needs of the history, market and society, and color education become an independence professional discipline.

In 2002, a post-graduate student's major named domestic color design art design was opened in Beijing Institute of Fashion Technology. China's first systematic color education system and curriculum structure were established. Because the color design is a new profession, which has the

typical cross discipline nature in the contemporary art design, it involves many disciplines domain, which belong to the fusion of art, science and technology. Teaching methods need to abandon the past, which teachers with comprehensive practice decay to the student, changed to modern education system.

In order to meet the "Arts and engineering integration" of Beijing Institute of Fashion Technology, we have opened the "color physics and chemistry research" course, which has the characteristics of cross subject, since the establishment of color design. This course covers the color of the physics, chemistry and physiology of four chapters, mainly taught by professional teachers majored in engineering. Under the guidance of scientific and systematic theory, art students were guided to fully understand the nature of color.

"How to teach" is the first question to a science teacher. The teacher has to teach the physical, chemical and biological lessons to arts students who have no science basic. At this stage, students who had a certain color practice need more deeply, systematic color science knowledge. But students' own thinking mode, knowledge structure and foundation are different from those majored in engineering. If just in accordance with the teaching mode of engineering students who obtain knowledge from rational thinking and derivation, the students of arts would be very blunt and obscure. If just in accordance with the old "color composition" mode of teaching, arts students would not accept it and only think it is a repetition. Therefore, how to guide students in a better way is a major issue in the course of "color physics and chemistry research".

According to the teaching practice in recent years, some effective methods were discussed in this paper.

INCREASE THE PRACTICAL LESSONS, ENHANCE STUDENTS' PERCEPTION OF COLOR

The predecessors of Beijing Institute of Fashion Technology were Beijing Institute of Textile Science & Technology and the Beijing Institute of Chemical Fiber, respectively. In 1987, it was approved by the State Council that named BIFT. There are five schools, two departments, and three sections. Disciplines are complete and have good foundation. In the teaching process, engineering and arts professional equipment were built an experiment platform. To enhance the understanding of color, students obtain the corresponding perceptual knowledge through their own practice.

For example, when red, yellow and blue beams were mixed on a white screen and formed white spot, students always were amazed. They immediately felt the power of science and technology and exclaimed "this is the legend of the additive color mixture". In the explanation of the light source color, prism and grating and other equipment in the physics laboratory can help students observed natural decomposition phenomenon of sunlight and artificial light lamp.

Through these optical phenomena, students directly understand to natural light and artificial light, monochromatic light and complex light and their relations. In addition, with the help of standard light source box in the light chemical engineering (textile chemistry and dyeing and finishing) professional laboratory, students observed with color changes of an object under different light source. They could be more intuitive understand "color by light", "metamerics" and other optical phenomena.

Anyway, color professional practice platform provided powerful hardware support for students' practical activities; students could more fully contact with color science instrument, and recognize that color is indeed scientific. At the same time, students' interest was greatly stimulated by rich and

colorful color practice. And the color of the relevant professional knowledge was explained to the students.

EXPAND UNKNOWN KNOWLEDGE ON THE KNOWN

Due to the limitation of the education system and the thinking, division of domestic engineering and arts has always been quite distinct from each other. Engineering students accept the science and engineering education for a long time. Their basis of mathematics, physics, chemistry and other basic knowledge of science and technology are more comprehensive. When learning new subject knowledge, students can obtain a new field of knowledge by appropriate logical analysis or mathematical deduction. Compared with engineering students, art students have a good creativity. They often pay more attention to personal experience. But in physics, chemistry and physiology as the representative of science and engineering their foundation is very weak. Most students' understanding of science knowledge is stuck at the level of common sense. Students often cannot directly accept the relevant knowledge, and easy to feel discouraged. According to teaching experience in recent years, art students can effectively accept new knowledge from their existing color knowledge basis.

For example, in the teaching of color physiology knowledge, the common sense of human eyes basic structure is a starting point. Knowledge was expanded according to accepted the concept “cell is a basic unit of organisms, and different cells have different functions and structures”. Retinal photoreceptor cell layer and ganglion cell layer were conducted. Knowledge expended from photoreceptor cell layer to cone cells and rod cell. Therefore, visual light and shade adaptation was introduced on them. Cone cells are subdivided into red, green, and blue cone cells. A person with three normal kinds of cells is a trichromat. Any cell damage will lead to the second color (color blindness). The tricolor theory of Young-Helmholtz was guided out in the unconscious. Human visual pathway model and transmission of color neural signal were stretched from the ganglion cell layer. Thus, students were able to sum up Hering color opponent theory and dialectical unification between the trichromatic theory and color opponent theory by themselves.

After aspects of the previous practice, students had felt the charm of science and their learning enthusiasm was greatly mobilized. So they could follow the teacher gradually improve teaching pace step by step and were inducted a new color theory height in the oblivious.

ADOPT A FLEXIBLE AND EFFECTIVE ASSESSMENT METHOD

The "color physics and chemistry research" course was designed to guide art students to master the scientific method of color studying. As a post-graduate course the assessment of students' learning performance is also an important content. In recent years, students were not required to recite and repeat those professional terms and complete the examination paper. The courses require students to complete two jobs.

First job asked students write an article on the color system on the basis of documents. In the article, the origin and development in the history of the color system must be explained clearly.

It was most important that analysis of the color system by the color opponent theory and the trichromatic theory, clarify relations and differences with others. Second job asked them calibrate an object's color using the NCS color system under the different light. The second job was an expansion and an application of the first work. There were less limited conditions.

For example, a student used canon KISS X-6 camera and Nikon D90 camera to take pictures of the same colored object with same shooting conditions, illumination D65, aperture F/5, exposure time 1 / 200 seconds, ISO200. Then, the student used NCS to calibrate the camera screens color by NCS hue ring and color triangle positioning. The two cameras displayed color differences in the hue, blackness and chroma were contrast. Their color reduction problems were researched. The other student studied color difference of a well-known brand wallpaper in the D65 light source (in the northern hemisphere North Window daylight), A light source (typically incandescent lamps) and CWF light source (fluorescent lamp). The color sense and its impact on consumer behavior were discussed. These were proposed by student's hobbies and interests. The jobs were originated in color, under the guidance of scientific theory to analyze and study.

Through these two jobs, students can take the initiative to apply the knowledge of science to provide practice, to achieve a combination of theory and practice. Because most students were the first time to have relevant practice, teachers need to guide and lead. After several times communications and modifications, students felt the joy of harvest by contrasting the first draft with the final.

CONCLUSION

In recent years, advantages in teachers and equipment of art and engineering majors were combined. Communication among art, engineering and other disciplines of was constructed. Arts students were guided to the scientific path and had more complete and thorough knowledge of color structure.

Color Analysis of Hot Film “Monkey King Hero Is Back”

Luo Yuting, Cui Wei

ABSTRACT

As a 3D Domestic cartoons with a considerable box office, “Monkey King Hero Is Back” is Under debate, is called a rare conscience. The author makes analysis and commentary to film through making analysis of the people in the film and scene atmosphere of color analysis.

Keyword: Monkey King Hero Is Back, Color, Role, Scene

The hot film “Monkey King Hero Is Back” tells the story of “Monkey King” which is pressured in the “Five Finger Mountain” below, meet the Tang Seng in the childhood, fight the demon king together, recover early heart and courage, in the end, to be the hero returns. After the completion of the film is faced with insufficient funds, no money to promote the dilemma. Would rather have no money to promote the production of money is also to make the audience greatly moved, Huge "water" spontaneous publicity of this "conscience making". Then, as the first domestic recognized not only for the children in the production of animated films, is really like rumors so well?

CHARACTER DESIGN

Character design in the film, whether it is a leading role or supporting role, even if it is only a few shots of the role of soy sauce, also do very attentively. Such as the chart 01, the author makes a color extraction and analysis of the role in the film.



chart 01

Monkey King in the film is a loser in fact, although the broken hill out, but the seals are still. He can't go back to the mountain of flowers and fruit, also can't fight the Lich king, So, this is a monkey which is Vicissitudes of life, melancholy, longing for freedom and with no power. He no longer have

golden flexibly piercing eye, with no "Golden cudgel", Can't a somersault for One hundred and eight thousand miles. So, at this time the monkey was very pale, red nose, faded old yellow jersey. The whole color is in the medium-low blackness, medium-low chromaticness, and in high lightness, although dominated by warm tones, feels cold and loneliness, At the same time, then the risk is more "Desperate Editor", it's a sentient, frail monkey. When unlock the seal, Monkey King covered with passionate, tragic heroism color. "Flaming molten rock body, golden monkey to the golden cudgel, Yuyu clarification Wanli, it is a moment to explode all the audience for a full 90 minutes to look forward." [1] People's Daily truthfully describe the king in the film. Black and red armour, Red cloak, Golden cudgel and the colorful paint on the face, In the light of the fire burst out of the power to win, Warm colors with high saturation let to seal the win with Mahatma color.

The Lich King of HunDun, Is the author believes that the most vivid and appropriate role in the film. HunDun is one of the four ferocious ancients, But in different ancient books, are different. It's the giant dog in <Zuo Zhuan>; in <ShanHaiJing> record for a bird called "Di Jiang", with no face; The Lich King of HunDun in the film, should be changed by <Zi BuYu She Wang> written by Yuan Mei: "There is king snick in Chu, looks like 'Di Jiang', with no eyes, ears, claws and nose, but have mouth. Shape is square, when it pass through all the vegetation was dead." [2] In the film, it is a reptiles just with a huge mouth. About its color, it is dark Purple Gray. IN "Journey to the West" explain "Hun Dun" that "At the beginning of the word, it is dark, there is nothing in the word, so it is called HunDun." [3] In the film, use this color for Hun Dun, first to fit the dark property, second, in Chinese Color System, say "Evil purple fight the red", An secondary color purple metaphor evil, pure color red metaphor justice, as the lich king, purperty is best. "Hun Dun" as a human is also good. At first, Facial adopted Chinese traditional elements of facial makeup, the young man's role wearing a Scholar hat. Be worth what carry is, both face and clothing, All use black and white color. The lich king is set with Taoist culture, On the color Settings, Black and white and dichromatic is Taoism color system — Two Forms color, with bluish violet, The role of the lich king evil has a connotation. But in the film, for the life history of the lich king is not clear, only on the expression of the role itself, is not enough strong.

Cute little monk "Jiang Liuer" is the predecessor of Tang Monk. In "Journey to the West" river monkrevenge [3] is the origin of the name to the young monk. In "Monkey King Hero Is Back", Jiang Liuer's slowly grow long hair makes the movie looks very delicate. Different from the traditional Tang Monk, he is Energetic, enthusiastic, and cheerful. Shallow color of skin, little round face with two cooking starch red, like a round doodle peaches, with Buddha Blue coat and maroon pants, blue of medium-low blackness and puce of high blackness match slow blackness skin, color assortment is polite and youth, The audience presents a little monk image of the youthful vitality.

About the pig, Color of skin is slightly higher than "Jiang Liuer" (05°) and "Monkey King" (10°) in blackness, it's 20°, color of skin in the body of the pig is 70° in blackness, At the same time, color of the pig's skin is amber shift than the others, it's Y70R, the integral color assortment is the warm color attune, display a greedy timid, but simple and honest warm image.

As the role of supporting and even only a few lens, in the film are all very vivid characterization. My Guardian is only a group of lovely marmots, and they can directing the way by biting a branch, Won the audience's widespread high praise. the warm color attune are warm and lovely; Rubuzahl adopted high chromaticness of red and green, contrasting colors, with very strong visual impact, has a murderous visual feeling; Female Rubuzahl as the wife of shop-owner, dressed in a pinkish purple dress, skin color is similar with the pig, such a setting, presents an enchanting smart little villain image;

The Jiang Liuer's mother of lens is not much, but about her garment, the blue jacquard fabric, with magenta color sleeve and skirt, show the elegant demeanour of traditional Chinese women.

White dragon's image is in place, even amazing. blue cast match a little yellow, Belong to the complementary color collocation, with great eye-catching (color matching contrast chart 1). About the appearance, as chart 2, is four claw dragon, it is the dragon during the Ming dynasty, White dragon's image is very great, with momentum, but the author thinks that, about the color matching, even though it was so cool, but it is too blue, it is the blue dragon or ice dragon, not looks like the white dragon.



Chart 2 white dragon

THE SCENE ATMOSPHERE

The film color tone is fresh and bright. The author Summed up the color scheme in the film through color extraction of the scene and conclude, as chart 3.



Chart 3

The main line of the story is that, "Jiang Liuer" unlock the seal, adventure together with the Monkey King, than the Monkey King hero is back. The little monk is not only the key to unlock Wuzhishan seal, but also the key that the monkey find himself. The tone of the film is full of hope and vision, fresh and tender feeling. About the color, is also fresh, full of vitality and hope. As chart 4, from the hue, belong to the pure fresh and natural blue-green tone, match pink mauve tone, this two tones match together, conform to the plot of the film. From the color triangle of NCS: Mainly distributed in area 1 and area 3, belong to the pastel color with senior grey color collocation. About the chromaticness, it is from 20° to 50°, is medium-low chromaticness, this color is soft; About the blackness, in

between 0.5 to 40°, is medium-low blackness. This color is brisk, apply colors to a drawing a kind of relaxed and happy atmosphere.

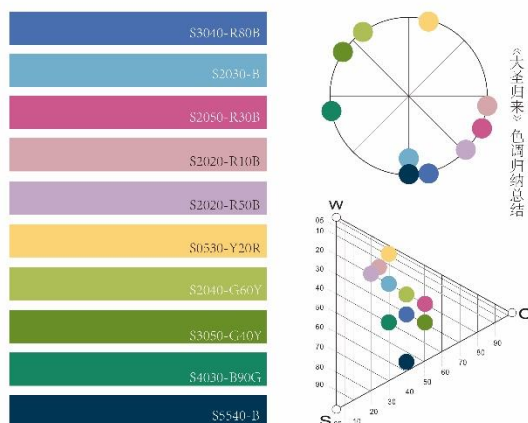


Chart 4

CONCLUSION

From character to scene, the film is excellent of color and design, it is the Chinese animation but not just for the children. But there is no denying the fact that the film has some defects, Such as some roles' origin, the continuity of the story, integrity of the ending...As the film's director said, the plot is the film's shortcomings. The film is said to be officially released about 30%/. This related to production funds, and many other reasons. Let's look forward to the second to have a greater leap forward on this basis, let Chinese animation go to the world.

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On the Relationship of Style-Line and Fabric Colors of Female Clothing

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ABSTRACT

Style-line costume is the mainstream clothing in the current times. Its graphic model is intrinsically supported by stereoscopic structure. Especially for female clothing, it is more necessary to show elegant silhouette of female body shape through formative structure. The charm of costume designing rests at the novelty of ideas and modeling, uniqueness, and beauty of style line. These are also the aesthetic pursuit of consumers. However, from the current market products of female clothing, some designers do not attach importance to the design and presentation of style line, their technique usually not skilled and taste to be upgraded. I think the main reason is their lack of knowledge of multiple application methods for dart transfer of female clothing as well as the negligence of the importance of color for structuring style line. In this paper, the author tries to provide an analysis of the interaction of color and style line according to author's experience in designing practice.

Keywords: body-molding clothing; complex fabric; style line; dart transfer; color explicitness

With the improvement of living standards, people's daily wear has shifted from meeting the function of natural environment to pursuing social function. The mainstream of modern clothing is to become close to human figure. Stereoscopic modeling clothing formed by curves is termed as body-molding clothing. The dominant idea about the modeling design of woman body-molding Clothing (hereinafter referred to as "suit-dress") has also diverted from utility to appreciation, in the pursuit of visual effect of dress. It shows elegance and feminine beauty of women through the perfect fusion of point, line, surface, stereoscopic structure, colors, patterns, material textures and other elements. The lines in modeling design of women suit-dress are not to stick to one pattern with both vertical and horizontal one as well as curved and straight one, which can be divided into three categories generally. The first category is the contour line, also known as silhouette lines, namely the line of clothing outline shape, which is made up of the shoulder seams, armhole line, side seam, coattail or skirt lines. The second one is style line which refers to modeling of stereoscopic structure of women's dress, including the breast level line, waist dart line, waist line, back porch line and line formed by tailoring and sewing process, which plays an important role in the silhouette of a costume. The third one is the visual line, referring to the lines formed by stripe fabric design. In this paper, author attempts to analyze and explore the interaction between color and style line according to his own experience in designing practice of women's dress design.

1. THE STYLE LINE OF WOMEN'S DRESS AND ITS APPLICATION

Clothing style line refers to any seam but shoulder seams, armhole line and side seam which plays a decisive role in clothing modeling and style. The design of style line depends on two aspects: one is wrapping the body, suitable and easy for people's physical activity; the other is fully displaying of masculine beauty of male or feminine beauty of female, both of which are associated with the differences in body between male and female and aesthetic psychology in human inheritance. Among them, compared with male's body, female's body is mainly characterized by prominent breast, waist shrink, buttocks outward and so on which makes the entire body of women form a complex surface with several different curve rates. Thus, in terms of the design, women's dress puts more emphasis on the role of dart. It makes the fabrics stereoscopic to meet the demand of complex surfaces of female's body through the processing of darts such as chest, back porch, waist dart. The style line of women's dress includes dart and dividing line crossing from one point of a part to the other point.

1.1 The dart and dividing line of modeling of women's dress

Dart is an indispensable means of modeling of women's dress, which is presented to people in the form of line, and an important structural line in women's dress modeling. Oriental women's dress is represented by cheongsam which shows the upright breast, round shoulder, slender waist and plump buttocks through breast dart, back porch dart and waist dart. The dart line, namely, underarm and waist dart, of cheongsam has also become a classic structure line of women's dress modeling. The dart processing of western

women's dress is most represented by clothes with princess line structure. It connects the breast dart, back porch dart and waist dart to coattail or skirt lines, then treats them as dividing lines and stitches them together. The incorporation of different fabric eases in different places can also change the silhouette and style of the dress. For example, adding the wide skirt lines can form a A-skirt. Therefore, princess line has become the basic structure line of women's dress popular worldwide with its flexible operability and scientific rigor.

1.2 The application of the change of style line of women's dress

From the comparison of dart design of cheongsam and structural change of princess line, it can be seen that in the evolution process of modern women's dress the primary cause of the various silhouettes and styles of western women's dress lies in the change and expansion of style lines, such as S-type, 8-type, H-type, A-type, X-type, Y-type and so on. The application of style line of women's dress mainly comes from dart transfer, in which the breast dart plays a unique role. The application of breast is to make the high spot of breast as the base point and let the breast dart turn 360 degrees, or change its direction, form and length, or remove dart and connect waist and buttocks to form dividing line; or change the quantity of dart and dividing line; or incorporate wide fabric ease in proper place to form folds, tuck, pleating and draping, etc. in order to innovate the style line of women's dress constantly as well as to improve people's aesthetic taste.

Tips for the application of the change of style line of women's dress:

(1) The method used may vary, but the principle is the same. "Principle" is the purpose of the application of the change of style line of women's dress: use the exquisite smooth lines to build the graceful curved body of female. By dart transfer or diversion, the position, symmetry, direction and form of the structuring can be defined. Various style lines all target at enhancing the beauty of dress and meet the social aesthetic psychology.

(2) Avoid complications. With the popularity of socialization of clothing production and computer technologies such as CAD, the change of style line of women's dress is much more simple and practicable. The unique modeling originality of designer lets people appreciate the novelty and diversity of the style line of women's dress. However, not all the innovative structural lines are elegant and smooth, and some even give people the feeling of gilding the lily. For instance, the volume of thoracic province is divided into two parts, one being transferred to armhole and connected with waist dart spreading to coattail and becoming princess line, and the other becoming horizontal princess line in the form of underarm dart. Though the structural line is very unique, it diverts people's attention on main structural line, which reduces the sense of beauty of the clothing and increases the workload and cost of dress making at the same time.

2. RELATIONSHIP BETWEEN THE STYLE LINE AND FABRIC COLOR OF FEMALE CLOTHING

To further utilize of style line to enhance the overall beauty of clothing in female dress making, the choice of fabric color is also the key. How to make style line get its best performance by using color characteristics and diverse match color methods such as embellishment, arrangement, separation, unity and contrast. I have the following thoughts:

2.1 Make the best of color explicitness to show the style line

In the constitution system of clothing color study, the importance of color to style line has not get enough attention. The style design in the market often ignores the effect of visual identity definition of color on the style line, tailoring process and decorating technique. For example, some color can make the style line clear at a glance; some cannot present it to people. Here, the author defines the effect of visual identity which color has on style line, tailoring process and decorating technique as color explicitness. The color of high definition of visuognosis tends to be more explicit, otherwise, it is a less explicit one. In the three color attributes, whatever the hue is, the color of high chroma and lightness belongs to strong explicitness. While, the color of low chroma and lightness tends to be the less explicit one. Among the three archromatic colors, namely, white, grey and black, the high-lightness white and light grey is more explicit, the medium-lightness mid grey is relatively explicit, and the low-lightness dark grey and black is less explicit. Reference is made to the schematic diagram of lightness and chroma of Munsell (color graph1-1, the stereoscopic schematic diagram of three color attributes of Japanese color (color graph1-2). In the design of women's dress, it is imperative select the proper fabric color according to the features and the color explicitness of the style line.

2.1.1 Classic style line and color of weak explicitness

The clothing silhouette formed by classic style line has been around for a long time, and the sense of beauty that it gives people has been widely accepted. As long as people see the silhouette of clothing, the style line will come into their minds, such as the straight figure and the tubaeform of princess line modeling. Such structuring line is very inclusive to fabric colors. In the selection of color of weak explicitness, the beauty of clothing can be improved by the use of other decorative techniques and the elusive characteristic of style line. For instance, the dart line cannot be seen clearly in the black cheongsam, but it is appropriate to use contrast match color and all kinds of decorative technique to highlight the ornamental effect and promote the dressing beauty in the position of collar, shoulder and chest (color graph 2-1 and 2-2).

2.1.2 Novel style line and the color of strong explicitness

The novel style line may change the direction of the style line and its normal position, and achieve asymmetrical design, or make use of dividing line to increase the ease of fabric and form folds, tuck, pleating and draping, which breaks the routine and the common structuring line. Therefore, to enhance the effect of visuognosis of this novel style line and fully display the novelty and beauty of the line and the stereoscopic effect of modeling, it is better to use the fabric of strong explicitness.

For example, contrast color pictures 2-3 and 2-4 are two sundress of cheongsam silhouette with the same structuring line. The breast dart is transferred below the waistline, while the waist darts shift slightly to the left and right respectively. As a result of strong explicitness of fabric color in color graph 2-3, the novel style line is able to attract people. However, the color graph 2-4 selects the black fabric with weak explicitness, which is difficult to see the style line clearly and display it except appreciating the silhouette and the decorative technique of the dress.

The modeling structure in color graph 2-5 and 2-6 increases the fabric ease and constructs pendulous stereoscopic effect, which builds a symmetrical pendulous modeling and asymmetrical pendulous modeling. If we choose the color of weak explicitness, the display of pendulous effect will be greatly affected.

Such as sundresses in color pictures 2-7, with the strong explicitness of ginger, it can be seen clearly that the breast dart has been transferred to the shoulder and diverted into their lines, one being the dart, the other two being dividing lines. Though the design of the lines is much different, the patterning making by computer is easy, and the arc-shaped line is formed by the main structuring line spreading to the shoulder and below the waistline. But if three structuring lines are arranged in the narrow shoulder, along with the sundress which has two darts from up to bottom, the beauty of the whole modeling will be affected because of the scattering of the structuring lines. In addition, the dart of shirt lines will classify the silhouette of this sundress into elliptical modeling, and the style line displayed by the fabric color is nothing but the foil of elliptical modeling.

2.2 Use of fabric stitching to show the style line

Use fabric with different colors or texture to splice, in order to show the style line. By fabric stitching, the fashionable elements are incorporated to display the clothing style. The illusion created by the expansion and contraction of color, it can build the tall, slim and plump body of female.

2.2.1 Vertical splicing

Such as the yellow dress in the color graph 2-8, by transferring the breast dart to the shoulder, using standard princess line to incise and concolorous lace stitching, the classic style lines can be displayed in a fashionable way.

Such as the trousers in the color graph 2-9, by the stitching of fabric with different colors, the breadth of loose pants will get stressed, and its taste will no longer be drab.

2.2.2 Horizontal splicing

Such as the dress with horizontal and interval match color in color graph 2-10, by means of interval stitching of dark and light color in the hemline of the dress, the length of the dress can be increased by creating the sense of distance, which has a role in increasing height visually.

2.2.3 Criss-cross splicing

Such as the multicolor jacket in color graph 2-11, the breast darts are dispersed into criss-cross cutting lines, which are artfully used in the color matching of fabric. The style lines make the color splicing come into being. Such dart transfer and color change enhances the aesthetic taste of clothing.

2.2.4 Diagonal splicing

Such as the braces skirt in color graph 2-12, underarm dart and waist dart are concealed by red lace fabric. The fabric stitching achieved by diagonal style line, which is a small idea, but the collocation of red and black gives people strong visual impact.

2.2.5 Curve splicing

Such as the cheongsam in color graph 2-13 which changes the design of traditional darts, and transfers the underarm dart on the right to the neck line that connects with waist dart and forms curved cutting line. Then it uses the white and black fabric to stitch, which constitutes contrast match colors, and shows the unusual style line of the cheongsam clearly.

2.2.6 Creative modeling splicing

It can be either concrete or abstract by using dart transfer to carry creative modeling design. Such splicing is the form of artistic presentation of clothing modeling which is superior to life. The famous surrealist work published by Saint Laurent in 1966 displayed the beauty of body by the artful use of stitching and color matching. For another example, the color graph 2-14 uses the dart transfer to incise and the fabric of different colors to stitch, which constitutes the shape of a butterfly and unique style line.

2.3 Use decorative technique to manifest style line skillfully

The explicitness of fabric color has a direct effect on the display form of style line. Generally speaking, fabric with weak color explicitness can serve the purpose of better presentation of style line, and improve the high value-added of clothing if it uses the decorative technique of clothing tailoring skillfully. The common decorative techniques are as follows.

2.3.1 Bias strip or clip welt

Bias strip or clip welt are the common decorative process used to beautify the edge and line. Some strips of cloth used are with the same color and fabric, but others are not. In order to display the style line, the different color or fabric is a better choice. Such as the black sleeveless dress in color graph 2-15, the breast dart is transferred to the collar and dispersed into two lines left and right. It is connected with the waist dart to both sides forming the dividing line. Such a novel and elegant style line is illegible on absolute black fabric. By means of color matching method of embellishment, and the use of black and red fabric in clip welt technology, the style line can be perfectly presented, which not only enhances the elegance and shaping effect of the overall clothing, but also enhances its quality, which can be used as a dress.

2.3.2 Embroidery

The embroider technique can be classified into silk embroidery, beaded embroidery, and sequined embroidery according to the materials used. In terms of the forms of embroidery, it includes machine embroidery and hand embroidery, with numerous stitches. The selection of proper embroidery technique and stitch plays an important role in dress modeling. Such as the color graph 2-16, which sets the waist dart of the dress as a fixed point, and designs a style line similar to Z. It divides the dress into two parts, upside and downside. In the middle of the hem, there is a pleat. Along the dividing line, with the use of same color method and the selection of silk thread close to the fabric color, two exquisite straight stitches are made by machine embroidery, which manifests the style line but is still classic.

Such as the style line of dress in color graph 2-17, which is the dividing line of the left semicircle merged by the transfer of breast dart and waist dart. The style line is beautified by sequins and embroidery by means of adding fabric ease through dividing line, and making it into live tuck.

2.3.3 Macrame

There are various kinds of macrame for decoration. Some are processed by machine, some by manual tailoring. When we choose the lace, we need take into account the explicitness of the color as well as the whole style suitable for the clothing. Such as the velvet sundress in color graph 2-18, the style line connects the underarm dart with the center front with arc, which forms the dividing line. By adding fabric ease, it will be made into tuck which will make the breast seem plump. Then, sewing lace with sequins to it, the gloss of the black sequins will sketch the style line and increase the sense of elegance of the dress.

2.3.4 Lace edge

Inlaid lace edge is the decorative techniques with the richest woman's charm. Such as the color-matching in color graph 2-19, the breast dart has been eliminated in the mosaic dividing line and the fabric stitching does not use the method of direct suture, but use the lace to connect, which makes the simple lines more

charmful. Meanwhile, with lace stitching, the separate color matching method has been applied, which makes the collocation of three low-saturation colors have a bright and lively effect.

In the clothing modeling design, as a silent language, color has an effect on the tailoring of clothing and the decorative techniques, which not only demonstrates the silhouette beauty of women's dress but also optimizes the charm of style line of women's dress. Instead, the style line can deepen the philosophy of color matching, inspire the innovation of color matching as well as expand the form of it. In conclusion, the style line of women's dress and the fabric color enhance each other's beauty and bring the best in each other.

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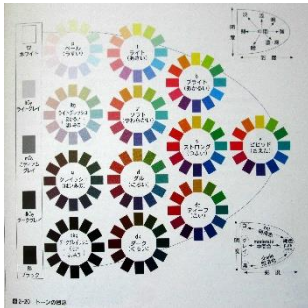


Fig. 1

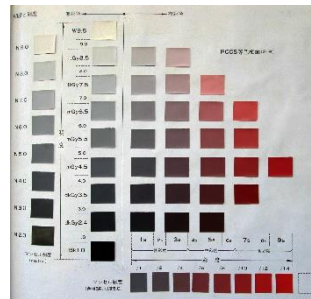


Fig. 2



Fig. 3



Fig. 4



Fig. 5



Fig. 6



Fig. 7



Fig. 8



Fig. 9



Fig. 10



Fig. 11



Fig. 12



Fig. 13



Fig. 14



Fig. 15



Fig. 16



Fig. 17



Fig. 18



Fig. 19



Fig. 20



Fig. 21

The Composition of the Space Color in Modern Urban Waterfront

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ABSTRACT

In addition to the effect of the decoration, color in the waterfront space also acts as a link. Urban waterfront space colors are composed of natural and artificial color, and two types of color components are inter-growth. The most important characteristic of urban waterfront is the existence of water, so the water color is the center of waterfront space color, which spreads to the periphery, the composition of the space color element is harmonious and unified.

Keywords: Waterfront, space color, composition

1. INTRODUCTION

Color has exceeded the unicity of the visual elements and becomes a part of culture. It also contains rich cultural spirits in modern urban environment. Identifying the suitable color theme and applying it appropriately in urban environment can not only manifest the overall beauty of the city, but also reflect its special magnetic personality. The waterfront is the organic components in urban environment, because of which the space color composition has its specialization. As for the waterfront's overall environment, only the space color is harmonious can it be the organic component element in urban environment. Therefore, the analysis and study of the composition of the space color in urban waterfront possess high theoretical and practical meanings.

As a special component in urban environment, the waterfront could be regarded as the water plant formed by urban water drainage. If defining the range of the urban waterfront from the aspect of the accessibility, the water space of 200-300m and the adjacent urban land area space both belong to the waterfront range. Through the analysis of the sample survey, it could be seen that the induced distance that the beautiful and comfortable waterside landscape environment made on the citizens is 1-2km, equal to the range of 15-30mins by foot. According to our national specific situation, some domestic scholars think the waterfront range could be defined as the first block from water line to road. While western scholars tend to claim that the waterfront is not just limited in material, for example, Ann Breen and Dick Rigby tend to emphasize the psychological concept of waterfront, which think it could be both identified as the waterfront as long as there is a relation with water space sensuously or itself is a part of the overall waterfront.

From the vertical color research idea, the article divides the waterfront color into following ranges: water space, hydrophilic space, waterfront road, waterfront street, waterfront concordant zone and urban internal function area. Such a main line represents the research direction that takes the riverway as the starting point and stretches to the urban inside. The detailed research range is showed in Fig.1.

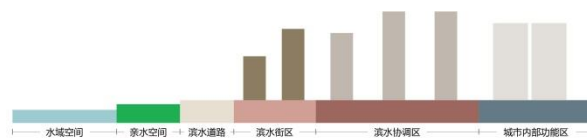


Figure 1

As the organic component of the urban environment, the composition of the space color in waterfront has distinct features. However, with the development of the modern city, many waterfront cities show many defects like the same ashen or random bright color. In order to promote the development of the urban waterfront, it is quite important to analyze the composition of the space color comprehensively. The urban environment color is made of natural color and artificial color, and waterfront is the same.

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2. WATERFRONT NATURAL COLOR

The natural color refers to the inherent color from the natural environment. They are objective existence to a greater extent. The waterfront is close to the city and has a large water space, which determines the natural color elements of waterfront could be generally divided into 5 categories: water space color, natural edge water color(soil, stone and etc.), plants color(tree, shrub, lawn, flower and etc.), sky color(season and time), climate color(rain, snow, frog and etc.).

2.1. Water Surface and Sky

The color of Waterfront waters is confined by environment, and its main color elements are water surface and sky, as shown in Fig.2 (a).

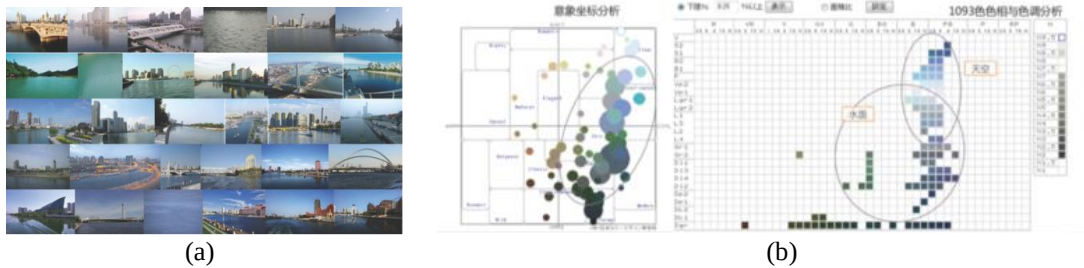


Figure 2

The article analyzes that the waterfront waters color mainly focuses on B-PB color segment and part of the G (green) color system through great quantity of sampling. In the axis, it could be seen that the sample of the waterfront waters color mainly distributes in the cold color area. Through making analysis on 1093 color hue and tones to sky and water surface, it could be seen that waters color image mainly concentrates in the modern and (cold) natural range, as shown in Fig.2 (b). The neutral color appeared in the axis is caused by the weather, such as the color of the cloud in the clear sky or the gray of different degrees in the hazy weather.

2.2. Soil

Because the soil in waterfront is near to the waters, the influence of the humidity leads to different positions' soil color brightness changes a lot, as shown in Fig.3 (a). The soil color mainly concentrates on the R-YR color system and the chroma is on the low side. The soil color image focuses in the classic and (warm) natural area, as shown in Fig.3 (b).

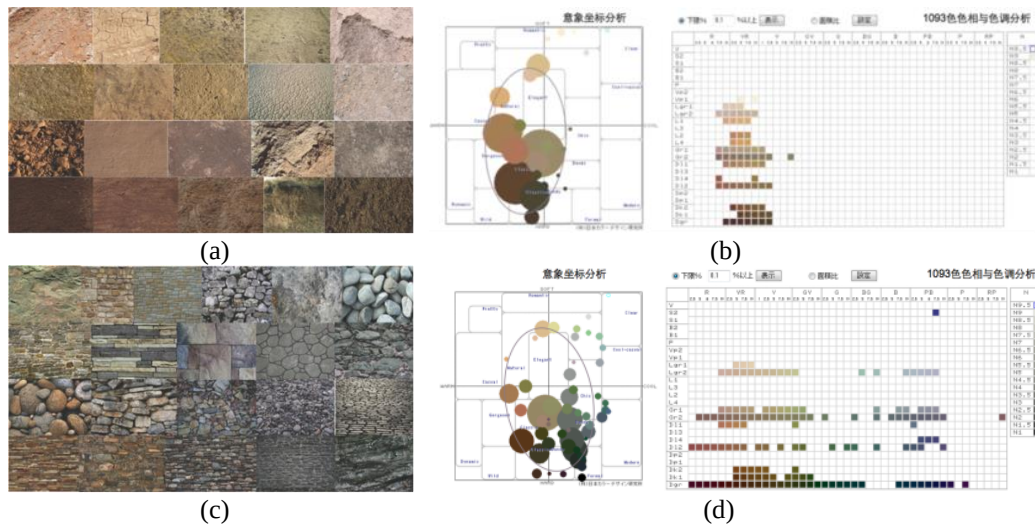


Figure 3

2.3. Stone

Though waterfront stone belongs to the range of the natural color, due to the artificial influence, its hue changes a lot, as shown in Fig.3 (c). Stone color is mainly in the range between the low chroma and low brightness. Through the analysis, it could be seen that except the P-RP (purple-red purple) color system, the stone color contains all other color systems, which mainly because of the rich color change of the stone itself. The color image of the stone focuses on the classic and steady one, as shown in Fig.3 (d).

2.4. Tree

There is almost no high chroma color and high bright color in the tree color. The trees' seasonal variation is very high, and because the waterfront is near the urban environment it must fully consider the trees' seasonal color in cities with four distinctive climates when selecting the time to plant the tree, as shown in Fig.4 (a). Tree color image focuses on the traditional and quality area. Tree color usually concentrates on the GY color system, and the partial emergence of the R-YR-Y color system is mainly influenced by the season and light, as shown in Fig.4 (b).

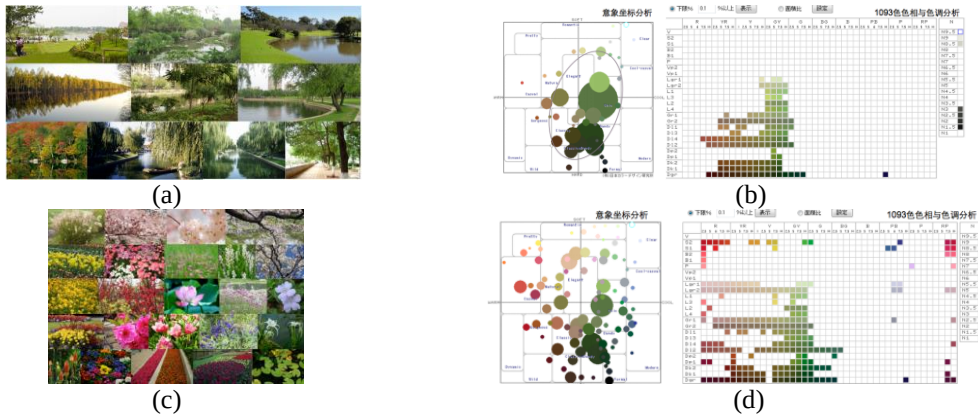


Figure 4

2.5. Flower

The flower color in waterfront almost contains all color systems. The flower color also shows high chroma color. Flower color is suitable as the dotted color for the waterfront color, as shown in Fig.4 (c). The flowers' seasonality could make influence on waterfront color image of different degrees according to its plant area, as shown in Fig.4 (d).

3. WATERFRONT ARTIFICIAL COLOR

3.1. Element of Artificial Color

The artificial color refers to the color influenced by the human beings' behaviors. If defining it from the application scope, the artificial color in waterfront is influenced by its special infrastructure, the materials and so on. The reasons could be generally divided into three categories: the artificial color in waters range (ship and bridge), the artificial color in shoreline range (wharf, embankment, footpath and crowd) and the artificial color in land area range (architecture, road, public facilities, outdoor advertising, cars and so on). I will mainly take the bridge and architecture color as the example to explain the constitution of the artificial color elements in waterfront.

The color in urban waterfront architecture is rich and changeable, which fully reflects its cities' characteristics. The color in waterfront high-rise buildings mainly focuses on the architecture material color and shows a tone of low chroma and high brightness. While the middle-rise and low-rise buildings' color prefer to be the high chroma and low brightness, as shown in Fig.5 (a).

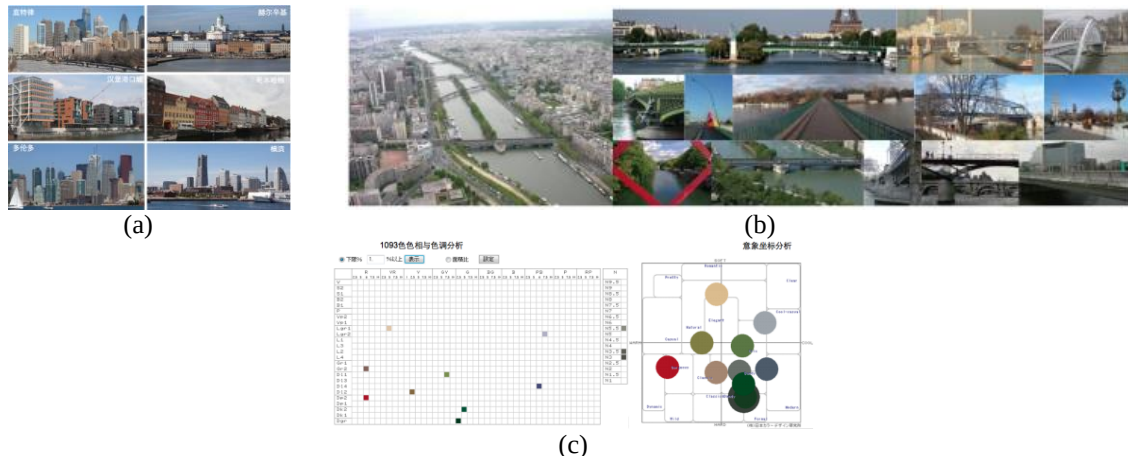


Figure 5

Taking Paris as the example, as shown in Fig.5 (b), and analyzing the hue from the collected bridge figures. From the following figure, it could be seen that as the dotted color of the waters space, the bridge color in Paris is rich in hue and the color of high chroma is dominant, as shown in Fig.5 (c).

3.2. Material and Artificial Color

It has to mention the material elements when talking about artificial color. Color does not exist separately. It must be attached to the concrete material surface. Material is the necessary elements in any kinds of design categories. Its special texture, function and color have the direct influence on the application objects' color and model. With the progress of the times and the development of the technique, the ability and level of people's acknowledge and use of the material have undergone the constant improvement. And people's need for the environment is also improving, which promotes the development and progress of the material. The richer the material categories are the more artificial color categories people could use.

Texture is the rough and smooth degree of the material surface. It has a great influence on the material and color. The texture of some material surface has the effect of heightening and weakening the color. For example, the brighter color is suitable for the material surface with pattern, and the shining material could highlight its color's expression effect. The color's expression effect could be more restrained in the uneven texture. And the rougher the material surface is, the lower its reflection will be. Therefore, the color in the rough material surface looks stronger than the color in the smooth material surface. The same color used in the materials of different textures will show the different effects, which could make people feel the change of the unity. When using the artificial color in the waterfront, if fully making use of the materials' characteristics, it could reduce the sense of polish, make the artificial color integrate into the environment better and make the color relationship more harmonious.

4. THE CO-DEPENDENCE OF NATURAL COLOR AND ARTIFICIAL COLOR IN WATERFRONT

The above contents mainly talk about the features of natural color and artificial color in modern waterfront. In a word, the natural color (except the flower color) centers on the YR-GY-PB (yellow red-green yellow-purple blue) color system and the chroma is high and most colors' brightness is low. The urban waterfront color should center on the YR-GY-PB and form radial zone color combination. If putting each area of the waterfront range in the monochrome color matching axis, the distribution is shown in Fig.6 (a). From the figure, it could be seen that the position natural color in waterfront holds tend to be the HARD and the COOL axis, and its color scope has intersection with hydrophilic space, waterfront street, waterfront concordant zone and urban inland.

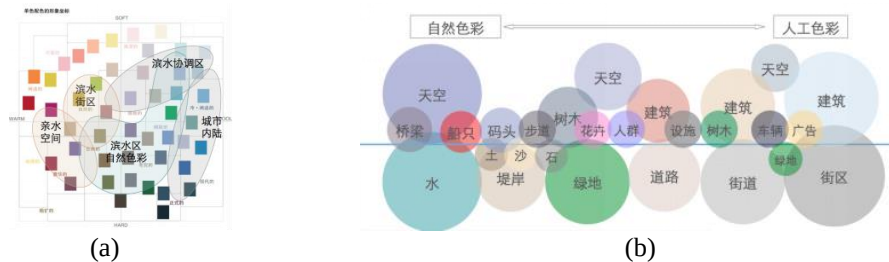


Figure 6

From the vertical distribution of the waterfront color, in the stretch process from waters to urban inside, it forms the color transition trend from focusing on natural color to artificial color, as shown in Fig.6 (b). In the waters space side, the natural color takes a larger proportion, so the artificial color is the dotted color of the natural color and is more suitable to use the color with high chroma. While in the urban space side, the proportion of artificial color is larger than the natural color after having been increased. The artificial color composes the environment basic color and the natural color becomes the dotted color of the artificial color. And then in the practical application situation, it should take control of the artificial color's chroma and hue application.

5. THE CONSTITUTION AND INTERRELATION OF URBAN WATERFRONT SPATIAL COLOR ELEMENTS

Natural color and artificial color, static color and dynamic color, these two pairs of scopes are not unchangeable in the urban waterfront color, and the interrelation between them is interdependent. First, the static color makes up the main components of the urban basic color because of the physical property stability of its carrier. While the dynamic color makes up the main components of the dotted colors. From the view of necessity and probability, the proportion the static color takes is always more than the

dynamic color. In the spatial combination of the urban waterfront, from the waters space to the urban internal functional area, the color is also gradually transferred from focusing on natural color to artificial color. Combining the two pairs of scopes -natural color and artificial color, static color and dynamic color with the spatial relation of waterfront, the conclusion is as follows:

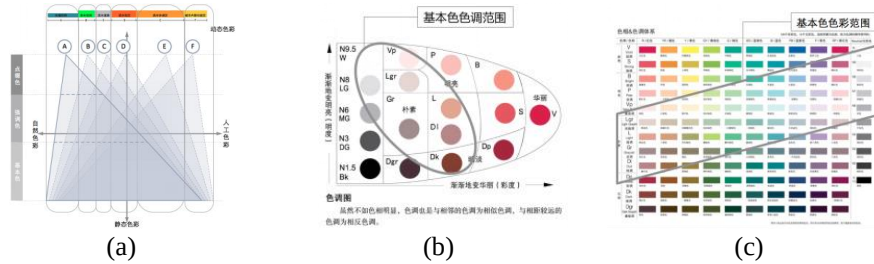


Figure 7

From Fig.7 (a), it could be seen that in different scopes the proportion each color element takes is different. Taking waters space A and urban internal space F as the example, no matter in which area, the proportion of basic color is always more than the dotted color. In the change from triangle A to F, the proportion natural color takes is gradually decreasing, while the artificial color is increasing. In the vertical direction, the static color is located in the hemline position of the triangle because of the physical stability of the color carrier. The dynamic color is located in the top of the triangle because of the randomness, and its proportion is less than the static color, so the correspondence is dotted color.

In the concrete use of the color, no matter the natural color and artificial color or the static color or dynamic color, the color with low chroma and high brightness is suitable as the basic color appeared largely in the city base map. Therefore, the basic color and the tones are shown in Fig.7 (b) and Fig.7 (c), respectively. The reason of this kind of design is to satisfy the users' psychological needs better of different cities. And the color with high chroma and low brightness is suitable as the dotted color to increase the characteristics and vitality of the city.

6. THE CHARACTERISTIC OF THE SPATIAL COLOR IN URBAN WATERFRONT

In the urban waterfront, along the specific direction of the river line or from the river upstream to the downstream, the change of the color is called lateral variation, as shown in Fig.7 (a). No matter the natural or the artificial factors, the coastline color is dominated by the functional area where it locates to a greater extent. Because of different function orientations, different areas have apparent characteristic difference in color. The vertical color's scope changes from the waters area to the urban internal space. In the vertical change the personalized performance of the color in the waterfront is more decided by the color of the street where it locates. Due to the stylish difference of the architecture and public facilities, different streets have the difference in color. Therefore, the characteristics of color are different in the horizontal and vertical performance, but the performance in the common features is much easier. No matter the horizontal or vertical direction, the basic color of the waterfront is coastal and is restrained between waters area and hydrophilic area. Therefore, the basic color is the color of water, sky and tree.

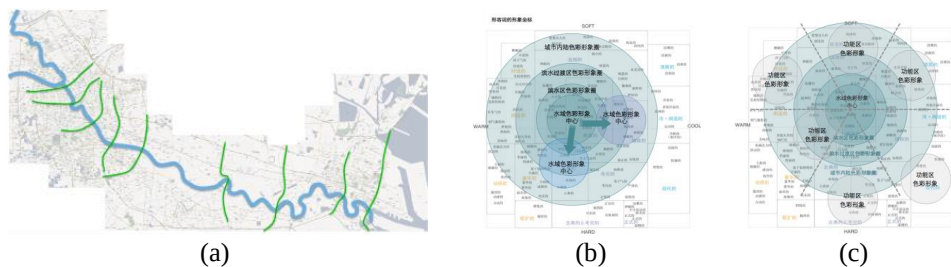


Figure 8

Dividing the Color image of waterfront according to the scope and putting it into the color image axis, its general scope is as shown in Fig.8 (b). The biggest features of urban waterfront are the existence of the waters. Therefore the waterfront color centers on the waters color image and diffuses outward. It is because of diffusion and radiation that the dominant position of waters color image has the greatest influence on waterfront color image. According to the Ripple Effect, due to the furthest distance from the waters, the color image located in the urban inland is affected the least. From above contents, it could be seen that the color change from waters color to the urban color belongs to the vertical change, which is caused by the change of the spatial relationship. So its stability is relatively strong. Therefore, when the

waters color image changes, the relative waterfront color image circle, waterfront transitional area color image circle and the urban inland color image circle will change along with it.

Then from the view of the urban internal functional areas, the color images' difference of each functional area also has influence on the color image of the waterfront transition zone as shown in Fig.8 (c). Therefore, the waters color zoning in river basin will also reflect the color image of its adjacent functional area or itself located functional area. Due to this kind of interaction, the waters color image in urban river basin and waterfront color image should be coordinated with the color image of its adjacent or itself located functional area.

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