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High-dynamic-range Colour Appearance Data to Verify CAM16-UCS

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Abstract

The purpose of this study is to accumulate colour appearance data under high dynamic luminance range. Two experiments were conducted based on different types of stimuli, colour patches and colour images. The colour patch experiment was conducted to match corresponding data between colors on a display and the real scene viewed under high dynamic range viewing conditions. Ten observers assessed 13 stimuli under 6 illuminance levels ranged from 15, 100, 1000, 3160, 10000 to 32000 lux. Observers adjusted the color patches on a display screen to match the color samples of the real scene against of a neutral background (The reflectivity was 35%). The visual results showed a clear trend, an increase of illuminance level raised vividness perception (both increases in lightness and colorfulness). However, CAM16-UCS did not give accurate prediction to the visual results, especially in the lightness direction. The model was then refined to achieve satisfactory performance and to truthfully reflect the visual phenomena. By modifying the lightness induction factor in calculating lightness according to adaptive luminance, the predictions of the model and the visual results had a good agreement in the direction of colour shift. The colour image experiment was carried out using 3 images assessed by 10 observers to test the CAM16-UCS on image generation. The results showed the modified model based on patches do not perform well and a further modification was made to come out a modified CAM16-UCS for images.

Introduction

A colour appearance model is capable of predicting colour appearance under different viewing environment [1]. CIECAM16 is the latest CIE colour appearance model recommended by CIE [1,2]. The output attributes from CIECAM16 includes lightness (J), brightness (Q), chroma (C), colourfulness (M), hue angle (h) and hue composition (H), where J and C are the 'relative' colour appearance perceptions always scaled against a reference white. Q and M are the 'absolute' colour appearance perceptions strongly varying with the illumination levels. CAM16-UCS [2] is the uniform colour space of CIECAM16 to predict accurate colour differences. Its output attributes are lightness (J'), colourfulness (M') and hue angle (h'), which were the modifications of CIECAM16 J and M. Note J', M' and h' were the best combination of attributes to give most accurate colour difference predictions [3].

The present research is an extension of earlier work [4] to collect corresponding data of colour patches between colours on a display and the real scene viewed under high dynamic range environment. In the earlier experiment, the unequal background colours were adopted, i.e., a light grey and a black background for viewing real scene and display colours, respectively. It was realized that the difference between the two backgrounds was too much contrast for observers to perform a satisfactory colour matching. In the present experiment, the experimental conditions were the same as the earlier experiment except the same neutral background was used for both fields against a reference white for each luminance level. The results of colour patch matching experiment were used to revise the CAM16-UCS model, and the model was tested using colour images. The results showed that the model based on patches could not achieve good results for colour images. Further modifications were then made to the CAM16-UCS model in high dynamic range luminance conditions.

Colour Patch Experiment

Viewing devices

Three light illumination boxes (IBs) were employed to construct a high dynamic experimental condition. Different IBs were set at distinct illuminations. They were named as IB1, IB2 and IB3, for which IB1 is adjustable, within a range of 15 to 32000 lx. IB2 and IB3 were set at 10 lx and 200000 lx, respectively. Observers viewed three IBs at the same time. All of them had a Correlation Colour Temperature (CCT) close to 6000K (fixed) and had well controlled Duv (≤0.0022) under different illuminance.

Figure 1 shows the viewing environment. In the experiment, the colour samples be matched were placed in IB1, and two X-Rite Macbeth ColorChecker Charts (MCCCs) were placed in IB2 and IB3, respectively. Note that MCCC colours were used in IB2 and IB3 rather than a uniform bright background to avoid too strong glare to reach observer's eyes. Observers viewed the physical sample and display colours in the foveal vision one at a time. The two MCCCs were also viewed in their peripheral vision, resulting a high-dynamic range environment. In the experiment, IB1 was set at 6 illuminance levels: 15, 100, 1000, 3160, 10000 and 32000 lx.

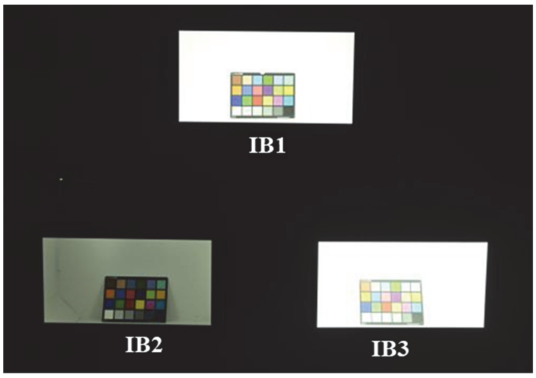


Figure 1. The HDR apparatus used in Colour Patch Experiment

an Apple Pro Display XDR with a resolution of 2560x1440 pixels and a peak luminance set at 550 cd/m² was used, the choice of this resolution over the native resolution was made with the objective of improving application performance and responsiveness, while still ensuring a suitable image size. However, it was worth noting that the high dynamic range feature of this monitor was not fully exploited due to the absence of compatible HDR source files. The display was tested before the experiment. In the uniformity test, the screen was divided into nine areas, and the mean colour difference was 0.47 ΔE^*_{ab}, (SD = 0.14). In the additivity test, each channel was divided into 18 colours, and the colour difference against the mean was 0.23 ΔE^*_{ab}, (SD = 0.15). Furthermore, the display was characterized using a Gain-Offset-Gamma (GOG) model [5]. By using 24 colours form X-Rite Macbeth ColorChecker Chart (MCCC) to test the GOG model, the mean accuracy was 0.63 ΔE^*_{ab}, (SD = 0.52). After the experiment, the 24 colours were measured again to test the GOG model, and the mean accuracy was 0.55 ΔE^*_{ab}, (SD = 0.51). Before and after the experiment, the colour difference of the display was 0.26 ΔE^*_{ab}, (SD = 0.17). This performance was considered to be satisfactory.

Stimulus

The Thirteen colour samples used in the previous experiment were used, including 5 achromatic colours and 8 chromatic colours which were selected from the NCS Album. Figures 3(a) and 3(b) show the sample distributions in CIELAB a*b* and L*C*ab planes, respectively. It can be seen that these were selected to give a reasonable coverage of colour gamut in CIELAB space.

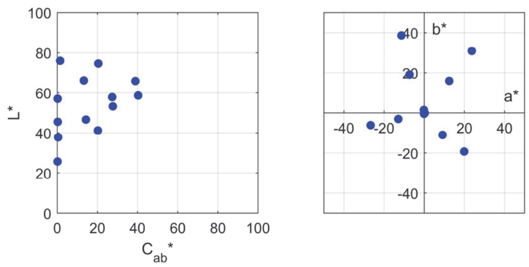


*Figure 2. The thirteen colour samples selected form NCS album plotted in L*C$_{ab}$* plane (left) and a*b* plane (right)*

Observers

In total, 10 observers participated in the experiment, including 6 females and 4 males. Their ages were ranged from 22 to 28 years old, with an average of 25 years old (standard deviation is 2.3). Each observer in the experiment passed the Ishihara colour vision test. All of the observers had received a training before the experiment to ensure they familiarized the techniques to produce cross media colour matches in HDR environment.

Procedure

The experiment was conducted in a dark room. Before the experiment, each observer was given the instruction of the experiment (See appendix 1). Observers were asking to learn that different colours are roughly in which region of the CIELAB colour space and to know how to adjust colours by using L*C*h. Then, a short training was given to familiarize with the colour control using keyboard. For chromatic colours, observers were instructed to make adjustments using L*, C*$_{ab}$, h_{ab}. There were 12 keys, 6 for rough adjustment, 6 for fine adjustment. For achromatic colours, observers only need to adjust at L* scale. In particular, there were 4 buttons for them to fine tuning a* and b*, if they need to.

The experiment was divided into 2 sessions. Each session included 3 illuminance levels, which were random for different observers. For each level, observers took a 2-minute adaptation. Each illuminance levels took about 25 minutes. Thus, the whole experiment took about 25 hours (10 observers × 6 illuminance levels × 25 minutes).

Figure 3 shows the experimental environment. The display was placed directly in front of the IBs and ensured that it did not obscure the color samples or color charts in any IBs. The eyes of observers were flush with the color sample placed in IB1 at a distance of 2 meters. The display had a slight elevation angle, which was designed to be perpendicular to the observer's sight. At the same time, the display color block size was slightly smaller than the actual color sample size, which was to ensure that in the eyes of the observer, the two were the same size.

Figure 3. Schematic diagram for colour patch experiment

After experiment, the matching results were recorded in RGB values and these were measured using the Konica-Minolta CS2000 tele-spectroradiometer. The colour samples in the IB1 are measured in the same way at the same position, recording their spectral data. All the results were reported as XYZ values for CIE 1964 standard colorimetric observer.

Results for colour patch experiment

Inter-observer variation

The inter-observer variation was used to judge whether the matching results of different observers tend to be consistent. In this case, the mean of colour difference from the mean (MCDM) in CAM16-UCS colour space was used as given in equation (1).

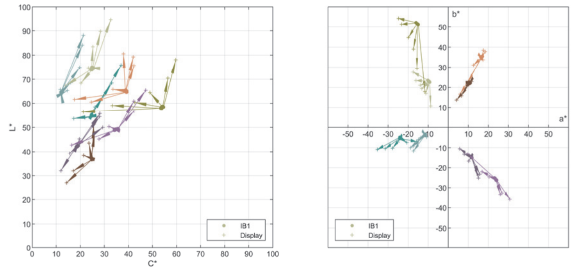
$$\Delta E = \sqrt{\Delta J'^2 + \Delta a'^2 + \Delta b'^2} \tag{1}$$

The results showed a mean variation was 4.58 ΔE, The 10 observers' data fluctuated between 3.54 and 6.18 ΔE, with a standard deviation of 0.8 unit, which showed results is stable. It was also found that the MCDM values were smaller in the middle range (1000 and 3160 lx) (about 3.27 ΔE) than those close to two ends (4.49-6.68 ΔE). This means observers perform less consistently under too dark or too bright conditions. Finally, the results also showed that observers matching achromatic colours (mean of 2.94 ΔE) more consistently than matching chromatic colours (mean of 5.60 ΔE).

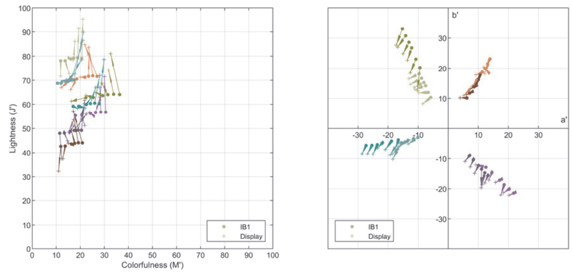
CAM16-UCS model's performance

The TSR was used to measure each test sample in IB1 (real scene) and the matched results on display. The two groups of XYZ values formed corresponding colour dataset. Both datasets were transformed to CAM16-UCS colour coordinates and CIELAB colour coordinates. During the conversion process, two distinct environmental conditions were applied. For the object color of the real scene, a white point of approximately 6000K was employed due to the stable color temperature of the lightbox, and the L_w changed with the illuminance. Conversely, for the display's color, the white point of the display itself was utilized, with L_w set at 550 cd/m².

Figure 4 shows the corresponding colour datasets plotted in a) CIELAB colour coordinates, and b) CAM16-UCS colour coordinates, respectively. Note that the corresponding colours are defined as two colours to have same colour appearance under two sets of viewing conditions (display vs. real sample in IB1). Each vector in Figure 5 represents the colour shift between a pair of corresponding colours. For a perfect UCS, the two points in a vector should be overlapped. For CIELAB, it can be seen each test sample of real scene at all levels to be just one point, but those of visual results on the display systematically varied in colorfulness direction according to illuminance levels. This was known as ‘Hunt’ effect [6], an increase of light intensity on an increase of chroma perception. Obviously, CIELAB failed to predict this effect, i.e., the real scene colours were invariant. On the contrary, CAM16-UCS performed well to show the general trend from both corresponding datasets. In general, both spaces showed good agreement of two sets of data in hue angle.



(a)



(b)

*Figure 4. The results plotted in (a) CIELAB L*C* plane (left) and a*b* plane (right); (b) CIECAM16-UCS J’M’ plane (left) and a’b’ plane(right)*

Another way to analyze the data is to report CAM16-UCS colour difference between each corresponding colour pair. Table 1 and Figure 5 show the mean of total, lightness, colourfulness and hue differences at each level. It can be seen that the largest colour discrepancies were in lightness difference. This was worse at higher illumination. Only when illumination was at 100 lx and 1000 lx, the J’ of measured results and visual results were closer. This was related to the fact that most of the data used to establish CAM16-UCS space are under low illumination. However, this did not apply to higher dynamic range environments.

Table 1: Mean colour difference between display results and real samples results in IB1 in CAM16-USC under different illuminance

Illumination (lx)	ΔE	$\Delta J'$	$\Delta M'$	$\Delta H'$
15	6.35	5.11	1.68	1.69
100	4.32	3.22	1.48	1.32
1000	2.95	1.74	1.21	1.30
3160	8.00	7.32	1.58	1.53
10000	12.11	11.74	1.38	1.78
32000	15.31	14.95	1.90	1.95
Mean	8.17	7.35	1.54	1.60

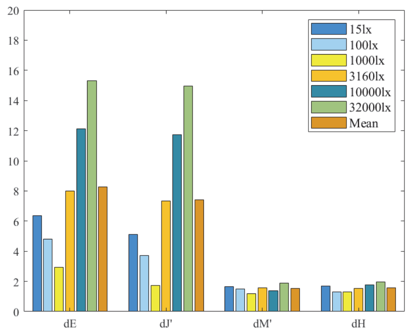


Figure 5. Mean colour difference between display results and real samples results in IB1 in CAM16-USC under different illuminance

Figure 6 shows the plot of corresponding colours in CAM16-UCS J’M’ plane, respectively. The Hunt effect is shown again for real scene colours, i.e., an increase of light intensity raises an increase colorfulness perception. This effect was consistent as that shown in Figure 6 (right). However, the trend of colour shift was very different from that of measure results of real samples in IB1 in Figure 6 (left), i.e., there was a large difference in lightness direction. Another effect can be found, i.e., an increase of light intensity results in an increase of lightness perception. This is related to the Stevens’ effect [7]. Overall, the pattern of colour shift reflects our visual experience well. An increase illuminance would increase the vividness perception of objects [8]. Note that vividness is a sensation of colour to indicate the degree of departure from a neutral black colour. It reflects our daily experience of the impact of the change of illumination level on object appearance, a stronger light intensity to make objects to appear brighter and more colourful.

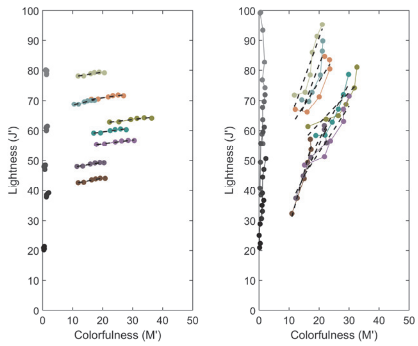


Figure 6. The CAM16-UCS prediction (left) and visual (right) results plotted in J’M’ plane

Discussions

Refinement of CAM16-UCS based on patches

It can be seen from the results that the model should be modified mainly in Lightness. Figure 7 shows the comparison between predicted J’ and visual J’ (left), predicted M’ and visual M’ (middle), and predicted data vividness and visual data vividness (right) in the CAM16-UCS colour coordinates. The formula for calculating vividness is given by equation (2). Ideally, if the model predictions were accurate, all data points should be close to the 45°-line, which M’ performed well. However, the results in different illuminance (shown in different colors) were linearly parallel to the 45° line in the comparison of J’ and vividness. Therefore, modifying J’ in equation (2) to ensure that the data points align as close as possible to the 45° line.

$$V\ (\text{vividness}) = \sqrt{J'^2 + M'^2} \quad (2)$$

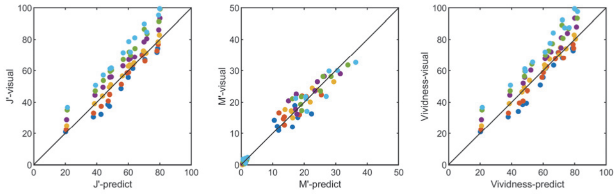


Figure 7. Comparison between predicted J' and visual J' (left), predicted M' and visual M' (middle), and predicted data vividness and visual data vividness (right) in the CAM16-UCS colour coordinates

By modifying the weight of J' (lightness) contribution to vividness, we aim to align the visual results and predicted results to minimize their disparity, thereby deriving a novel formula for vividness, as delineated in equations (3) and (4), in which parameter a is related to L_a (Luminance of test adapting field). Under the new formula, Figure 8 shows the revised comparison between J', M', and vividness, showing that almost all data points in the three figures are clustered near the 45° line. It was worth noting that under the new formula, the original M' (colorfulness) and h' (hue) were retained, and only J' modified.

$$\mathrm{V}' = \sqrt{\mathrm{F} \cdot \mathrm{J}'^2 + \mathrm{M}'^2} \quad (3)$$

$$F = 0.054 \cdot (\log La)^2 + 0.875 \quad (4)$$

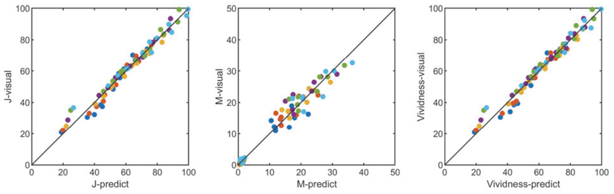


Figure 8. Comparison between predicted J' and visual J' (left), predicted M' and visual M' (middle), and predicted vividness and visual vividness (right) in the revised CAM16-UCS colour coordinates

The two sets of data were much closer after the correction. Prediction data has the same trend as visual data as shown in Figure 9. The error of predictions, especially in lightness direction is reduced.

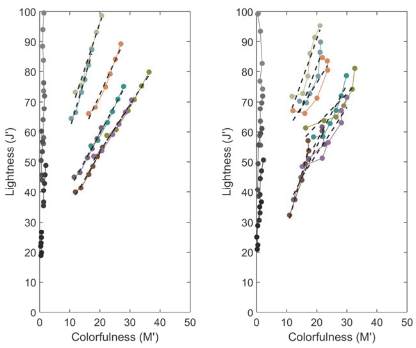


Figure 9. The revised CAM16-UCS prediction (left) and visual (right) results plotted in J'M' plane

After correction, the ΔE between measure results and visual results was reduced from 8.17 to 3.89, and $\Delta J'$ was reduced from 7.35 to 2.52 as shown in Table 2. The differences in lightness direction for high illuminance is greatly reduced. Take 32000lx illumination for example, the $\Delta J'$ was reduced from 14.95 to 2.74. This showed that the new formula was effective in matching the corresponding colour, and the optimization of high illumination is more obvious. And the addition of the new formula did not affect the colorfulness and hue of the original data.

Table 2: The colour differences calculated between the visual results and the predictions from the original CAM16-UCS and the revised model in each level (* The subscript R represent Revised)

Illumination (lx)	ΔE	ΔE_R	$\Delta J'$	$\Delta J'_R$
15	6.35	4.82	5.11	3.51
100	4.32	3.53	3.22	2.50
1000	2.95	2.86	1.74	1.76
3160	8.00	3.57	7.32	1.84
10000	12.11	4.16	11.74	2.73
32000	15.31	4.43	14.95	2.74
Mean	8.17	3.89	7.35	2.52

Testing the modified model using images

The modified CAM16-UCS model gave good prediction to the present results based on colour patches. Its effect on images was also tested. Picture of a painting was taken at different illuminance levels in IB1. In addition, 199 colours, including 175 Pantone colour patches (see Figure 10) and MCCC 24 colours were used to train a polynomial camera characterisation model [9]. The RGB data of the photos in the real scene were first transformed to XYZ data through the camera model, then to the newly modified CAM16-UCS model. Subsequently, its J'a'b' values were transformed to XYZ under the display condition, finally to the RGB signals on display via the GOG display model.

Figure 10. The test image including 175 pantone colour samples

The resulting images are shown in Figure 11(a) and (b) for the original and modified models at each illumination level, respectively. By comparing the corresponding figures, the modified model did give more closely visual effect of vividness perception from the high to low illuminance levels than that of the original CAM16-UCS model. When all the reproduction images comparing with real image in IB1, the modified CAM16-UCS images (Figure 11(b)) gave a closer image reproduction than those of the original model, especially for 10000lx and 32000lx. However, it gave poor performance under low illumination levels, i.e., the actual scene painting appeared much darker than the reproduction on display. This implies our perception on colour appearance of patches to be quite different from that of images.

(a)

(b)

Figure 11. The processed images via the (a) the original and (b) modified CAM16-UCS models at 6 illumination levels

Colour Image Experiment

As can be seen from Figure 11, the difference between the pictures under different illumination scenes was not very large. In actual observation, when the illumination of the IB1 was low, the image showed on the display screen was quite different from the real scene, the image was much brighter than the real scene. The background for colour matching experiment was grey, but when applied to the image, the background of a single pixel was the surrounding pixels, which caused the inconsistency between images and colour samples. For such cases, an additional experiment on the image were designed. The previous modified CAM16-UCS model will be referred to as the CAM16-UCS-patch model in the following.

Stimulus

For colour image experiment, three images were selected as shown in Figure 12. Each image generated six images under different illuminations through the CAM16-UCS model as the initial point of adjustment, i.e., the 6 images in Figure 12(a).

Figure 12. Three images selected in the colour image experiment

Observers

Colour image experiment invited ten observers, of which five observers participated in the colour matching experiment. In these ten observers, 5 were females and 5 were males. Their ages ranged from 22 to 29 years old, with an average of 24.7 years old (standard deviation is 2.1). Each observer in the experiment passed the Ishihara colour vision test.

Procedure

The experiment was conducted in a dark room. The experimental environment was basically the same as experiment 1, except that the painting as shown in Figure 14 was placed in the IB1, and the images generated were displayed on the monitor. The overall environment of the experiment was shown in Figure 13.

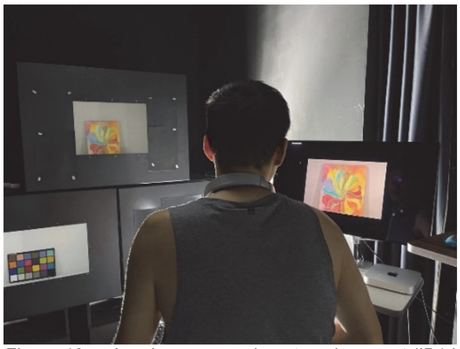


Figure 13. colour image experiment environment (IB1 in the middle, monitor on the right)

The observer adjusted the overall lightness and colorfulness of the image to match the painting in the real scene. In the experiment, the RGB value of the image was first converted into XYZ value through the display GOG model, and then entered the CAM16-UCS model to obtain the J'M'h' value, and all J' and M' were multiplied by the coefficients FJ' and FM' to change the lightness and colorfulness of the image. The observer adjusted the size of FJ' and FM' through the keyboard, and the initial value of FJ' and FM' is 1.00. The experimental results were used to build an image-specific model, which is called the CAM16-UCS-image model in this paper.

The results for Colour Imaging Experiment

Refinement of CAM16-UCS based on images

Table 3 shows the results of parameters FJ' and FM' in Experiment 2. The results of 10 observers were very close, which was reflected in the low standard deviation. In addition to this, images need to greatly adjust its lightness and colorfulness to match the real environment, especially in low luminance conditions.

Obviously, FJ' and FM' are related to the ambient luminance. Take the logarithm of La (Luminance of test adapting field) to fit FJ' and FM' respectively, and obtain the formula (5) (6) (7). Since the maximum brightness of the display is only 550cd/m^2, which cannot be numerically close to the actual environment, the adjustment coefficients FJ' and FM' will not increase all the time.

Table 3: The results of Colour Imaging Experiment, the mean and standard deviation for FJ' and FM' factors under different illuminations together with standard deviations

Illumination (lx)		15	100	1000	3160	10000	32000
FJ'	Avg	0.05	0.27	0.92	1.10	1.16	1.10
	Std	0.01	0.04	0.07	0.08	0.02	0.06
FM'	Avg	0.39	0.78	1.03	1.08	1.05	0.99
	Std	0.04	0.06	0.06	0.05	0.08	0.05

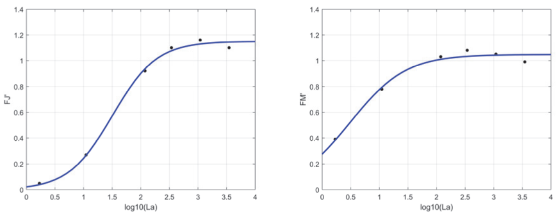


Figure 14. (left) FJ' vs. log(La) and fitted curve; (right) FM' vs. log(La) and fitted curve

$$V = \sqrt{(\mathrm{FJ}' \cdot \mathrm{J}')^2 + (\mathrm{FM}' \cdot \mathrm{M}')^2} \tag{5}$$

$$\mathrm{FJ}' = \mathrm{a1} \cdot \frac{1}{\mathrm{a2} + e^{-\mathrm{a3} \cdot \log(\mathrm{La})}} \tag{6}$$

which a1 = 0.023, a2 = 0.020, a3 = 2.60.

$$\mathrm{FM}' = \mathrm{a1} \cdot \frac{1}{\mathrm{a2} + e^{-\mathrm{a3} \cdot \log(\mathrm{La})}} \tag{7}$$

which a1 = 0.375, a2 = 0.358, a3 = 2.08.

Figure 15 shows the images generated by the new revised model (CAM16-UCS-image) under different illumination levels. Different images (pictures No.2 -5) and illuminance level (34, 316lx) were used to test the effect of the new model. The difference between different illuminances was better reflected, and images were closer to the appearance of paintings in real scenes, especially for low illumination levels.

Figure 15. Five different scenes generated by the CAM16-UCS-image model under six illuminance level (15, 34, 100, 316, 10000, 320000lx from left to right)

Conclusion

78 sets of corresponding color data under high dynamic range were collected through color matching experiments. The experimental results were shown in the CAM16-UCS color appearance model. By comparing new corresponding color dataset, it proved that the model was more reasonable in predicting colorfulness (M') and hue (h) for the corresponding color. The average $\Delta M'$ was 1.54 and average $\Delta H'$ was 1.60. However, for predicting lightness (J'), the average $\Delta J'$ was 7.35. By modifying the CAM model, especially on the lightness (J') scale, the new model CAM16-UCS-patch had better performance in predicting the corresponding color. The ΔE between measure results and visual results was reduced from 8.17 to 3.89, and $\Delta J'$ was reduced from 7.35 to 2.52. The modified results were more consistent with the visual results under different illuminance levels.

In order to further verify the performance of the CAM16-UCS-patch model on the image, the real scene under different illumination levels was photographed. A camera model was established to convert the RGB value of the photo to the XYZ value of the real scene. However, the image restored by the CAM16-UCS-patch model was not ideal, as well as CAM16-UCS original model. These images did not reflect the difference between different illumination levels. Especially in the low-illumination condition, the image generated by the model was much brighter than the actual scene. Therefore, in colour imaging experiment, observers were asked to adjust the overall lightness and colorfulness of the image so that the image displayed on the monitor matched the actual scene as closely as possible. The results were used to establish a CAM16-UCS-image model which was suitable for image restoration.

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Appendix 1

This is a color matching experiment. You need to sit in the designated position to conduct the experiment. The experiment costs about 2.5 hours.

There will be six different illumination environments. After switching the illuminance environment each time, you will have 1-2 minutes adaptation time.

You need to take a closer look at 13 color samples in turn for each illumination, and then adjust the colors on the monitor using the keyboard to match the color samples in the light box.

Figure 1 shows the CIELAB color space, where L* represents Lightness, a* represents the red-green direction, and b* represents the yellow-blue direction. In the equal lightness plane of color space, the distance from the origin of coordinates to the chromaticity coordinate is C_{ab}*, representing the Chroma, the value ranged from 0 to 100; and the angle from the chromaticity coordinate to the axis +a* is h_{ab}, representing the hue angle, the value ranged from 0° to 360°.

By adjusting the L*C*h coordinates or L*a*b* coordinates, you can select the color you want on the monitor. Therefore, you need to be familiar with the color space and know the approximate position of different colors in the space, which will be of great help to your future color matching.

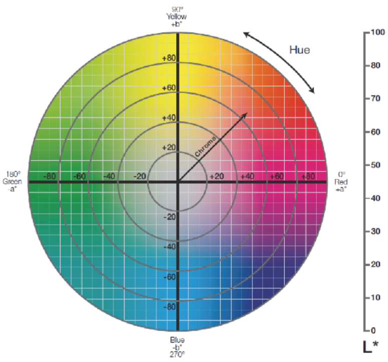

Figure 1. *CIELAB Color Space*

The set of keys on the left of the keyboard is fine tone, where Q/A is the increase or decrease of L*, W/S is the increase or decrease of C_{ab}*, and E/D is the increase or decrease of h_{ab}. The set of keys on the right of the keyboard is rough tone, where U/J is the increase or decrease of L*, I/K is the increase or decrease of C_{ab}*, and O/L is the increase or decrease of h_{ab}. In addition, you can use the arrow keys to adjust a* and b* for gray samples, where right arrow/left arrow can be used to increase or decrease a*, and up arrow/down arrow can be used to increase or decrease b*.

There will be several training sessions where you can try using the keyboard to adjust the colors on the monitor to match the inside of the light box.

Appendix 2

This is an image evaluation experiment, please perform the experiment according to the experimental instructions, the experiment costs about 1h.

There are six different illumination environments, and there are 5 different scenes in each illumination environment, with a total of 30 groups. After switching the illuminance environment each time, you will need 1 minute to adapt.

After the experiment starts, the experimenter will set up the scene in the left space (the lightbox side) according to random order, you will first adapt to the lightbox in the left space and observe the scene for 1 minute, and then go to the right space (the display side) to observe the image on the monitor. The monitor displays images of the current scene generated by the three models in random order.

Depending on how well the two matches, you'll need to score between -3 and 3.

-3	Very dissimilar
-2	Dissimilar
-1	Slightly dissimilar
1	Slightly similar
2	Similar
3	Very similar

If you forget what the real scene looks like when rating, you can go back to the left space to re-adapt and observe.