Journal for Geometry and Graphics
Volume 3 (1999), No. 1, 77–84

A Method of Changing a Color Scheme with Kansei Scales

Hideki Yamazaki, Kunio Kondo

Graduate School of Science and Engineering
Department of Information and Computer Sciences, Saitama University
255, Shimo-Okubo, Urawa city, Saitama 338-8570, Japan
emails: ziro-cyo@ke.ics.saitama-u.ac.jp, kondo@ke.ics.saitama-u.ac.jp

Abstract. The purpose of this research is to propose a method of changing a color scheme with Kansei scales. "Kansei" is a Japanese word that means the capability that feels an impression, such as "pathos", "feeling" and "sensitivity". "Kansei" also has meanings such as "sense", "sensibility", "sentiment", "emotion" and "intuition" [1]. A method of changing a color scheme with Kansei scales can easily change the color scheme of an image by using Kansei words such as "warm" and "dark". An impression of an image can be changed by it. We constructed a system in accordance with the method. There are three main features of our system. The first is that the system can change any color scheme of an image, because numerical expressions change a color scheme. The second is that the system can change a color scheme colorfully by five Kansei scales. The third is that the system can easily pick up the index colors from the original image, though a well experienced inspector has to decide color species comparing it with a color-catalogue.

Key Words: Engineering computer graphics, design, Kansei information processing, color

MSC 1994: 68U05

1. Introduction

It increased to confirm the impression and to change a color scheme by using a computer, when the image of a new impression is made and a designer changes a color scheme. Thereupon, if it is possible to change a color scheme according to the impression that was decided by a discussion with a client, work time can be reduced. Using a computer for design is more efficient at working hours and cost than drawing with an illustration-pen. However, the usage of a computer that changes a color scheme is not supporting the work of the designer who thinks about the color scheme from an impression, because it is the instrument that depicts

ISSN 1433-8157/$ 2.50

an image. There are many softwares which can change a color scheme at the present time, but these can only change a specified range of color to a new selected one.

A purpose of this research is to propose a method of changing a color scheme with Kansei scales [4]. Five Kansei scales *("warm ⇔ cool", "soft ⇔ hard", "natural ⇔ artificial", "bright ⇔ dark", "gay ⇔ quiet")* were used in this paper. A Kansei scale is the axis that has an impression word of opposite meaning to two extremes. We defined these adjectives with the degrees as Kansei scale, and we established two vertical dimensional axes with the Kansei scale ranging from -3 to $+3$. We called such plane consisting of those two axes as Kansei plane.

2. Outline of changing a color scheme

A procedure of changing a color scheme can be divided into the following three parts (Fig. 1).

1. **Pick out of index colors**
   Index colors are requested out of an original image, to analyze an impression of an image ([2], [3]). The index colors are a combination of colors that shows an impression of an image strongly. We proposed an index color method that can represent the similar effect as looking as the index color instead of the original pictures. Thereupon, replacing index colors to a color scheme, and the color scheme is changed.
2. **Calculation of a Kansei scale value from a color scheme**
   The impression of the original image is calculated by a Kansei scale value calculation style from a color scheme. Thus an impression of an original image becomes possible to be shown with a Kansei scale.
3. **Calculation of a color scheme from a Kansei scale value**
   A new color scheme is calculated from a Kansei scale value that was modified by a color scheme calculation style from a Kansei scale value. By changing the color of an image using the color scheme , we can make another image of a different impression.

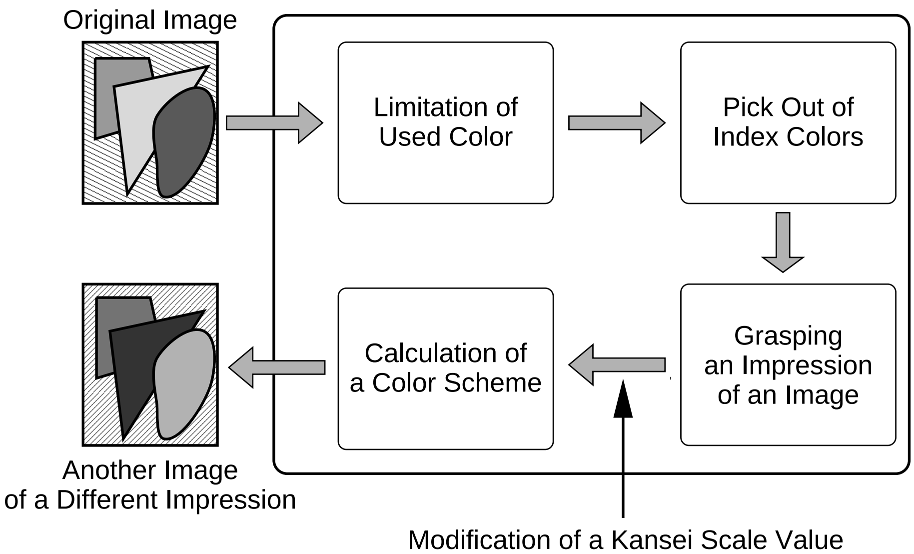


Figure 1: Outline of changing a color scheme

3. Pick out of index colors

Index colors are those colors which can represent the first impression of human sense against a target picture. In case of using few colors in a picture, all the colors become index colors. However, every color in a picture that is depicted with many colors is not necessarily deciding an impression. As for such a case an impression is decided by several colors in used colors of the image. When changing a color scheme , the color that decides an impression needs to be selected out of other colors. In this section, it expresses the procedure that move out index colors from an image.

3.1. Limitation of used color

A color of the voluminous number is used for the image and it depicted with a computer. Therefore, used color needs to be limited to process an image by using a computer.

Firstly, the image that is depicted with 8 bit RGB pixel is registered to a color list as each 4 bit pixel. Next, the color that is hardly used is mixed to a near color of distance in $L^*a^*b^*$color space [5]. Finally, mixing and combining near colors fellow in the color space. Used colors are limited to 5-16 colors as the result.

3.2. Pick out of index colors from used color

Among all colors used in an image we have the conspicuous and non conspicuous ones. When an index color is chosen from a color list, the color that is conspicuous is chosen as an index color. It is rare that the non conspicuous color is chosen. Accordingly index colors are obtained by selecting the color that is conspicuous, from the color that was calculated in a used color limit. A condition of the color that is conspicuous is decided in the following manner.

- **An area of a wide color**
  The color that occupies a wide area in an image can be conspicuous.

- **Eye-catching nature**
  There are conspicuous colors and non conspicuous ones. This nature is called eye-catching nature. A eye-catching level of chromatic color is higher than achromatic color. Similarly, level of white is higher than black. In hue, the eye-catching nature of red and yellow is higher than that of green and blue.

- **Contrast impression**
  The clear color depends mainly on the relation of lightness of the foreground color and background color. A big difference of lightness such as black with yellow and black with white are easy to be seen. On the other hand, a little difference of lightness such as yellow with white and red with green are difficult to be seen. When lightness approaches, it is difficult to be seen even if the difference of hue and a difference of chromaticness is great. This effect is called a contrast impression.

In consideration of the element that is expressed up to here, 3-10 index colors are extracted from the image that was limited to 5-16 colors . Only index colors that were chosen can be changed by color scheme.

4. The relation between Kansei scales and a color scheme

When the relation between impression of a color scheme and an image is requested, we used the method that requests impression by judgment of the integration of every color. The method does not request average of an impression of each color. The number of physical characteristic that expresses a color is needed, and the characteristic should express a general impression of a color scheme. From all that is expressed up to here, six evaluation elements were used as the physical characteristic of a color scheme.

4.1. Evaluation elements of a color scheme

We researched the relation between the six evaluation elements and five Kansei scales. The questionnaire system shown in Fig. 3-A was utilized, to research what kind of relation there is between the physical characteristic of the color scheme and the impression.

This system collects data of an impression that a human saw each color scheme in 5 Kansei scale. From data that was collected, correlation relation between 5 Kansei scales and many physical elements of the color schemes were researched. Correlation between physical elements and Kansei scales is expressed numerical by using a coefficient of correlation. The absolute value of the correlation coefficient near 1.0 shows that relation between an evaluation element and Kansei scale are deep. If the absolute value of an evaluation element exceeds 0.55 there is relation between a Kansei scale and an evaluation element.

From this research it was understood six physical characteristics, *"hue average"*, *"chromaticness average"*, *"lightness average"*, *"lightness chromaticness average"*, *"lightness distributed degree"* and *"distance distributed degree"*, are closely related to Kansei scales. The six physical characteristics are called evaluation element. Explanation of six evaluation elements is as follows.

- **Hue average**
  Hue average is the mean value of the hue of a color scheme.
- **Chromaticness average**
  Chromaticness average is the mean value of the chromaticness of a color scheme.
- **Lightness average**
  Lightness average is the mean value of the lightness of a color scheme.
- **Lightness chromaticness average**
  Lightness chromaticness average is the value of geometric mean of the mean value of lightness and chromaticness.
- **Lightness distributed degree**
  Lightness distributed degree is the total absolute value of the difference between lightness and the mean value of lightness.
- **Distance distributed degree**
  Average coordinate in $L^*a^*b^*$color space of a color scheme are requested. The total of distance between this average coordinate and the coordinate of each color become a distance distributed degree.

Furthermore the upper limit and a minimum were set up to each evaluation element that was requested. So that it is placed between -3 from $+3$ a value was modified. A correlation coefficient of an evaluation element that is related with a Kansei scale is shown in Table 1.

Table 1: Correlation Coefficient

Kansei scale	**evaluation elements**	**correlation coefficient**
warm ⇕ cool	hue average	−0.637
soft	lightness average	0.813
⇕	lightness chromaticness average	0.590
hard	lightness distributed degree	−0.791
natural	lightness average	0.620
⇕	lightness distributed degree	−0.745
artificial	distance distributed degree	−0.724
brightly	lightness average	0.970
⇕	lightness chromaticness average	0.916
dark	lightness distributed degree	−0.654
gay	chromaticness average	0.796
⇕	lightness chromaticness average	0.909
quiet	distance distributed degree	0.566

4.2. Calculation of a Kansei scale value from a color scheme

A Kansei scale value (degree of an impression) of an image is able to calculate with the next procedure.

1. It calculates the sum of an absolute value of the correlation coefficient of all evaluation elements that it uses in the Kansei scale *(let A be this answer)*.
2. Correlation coefficient is divided by A *(let B be this answer)*.
3. It multiplies the evaluation element by B.
4. To every evaluation element that it calculates, the sum becomes a Kansei scale value.

In the case that Kansei scale value N is calculated, the evaluation elements which exerts an influence a, b, c, value of an evaluation elements X_a, X_b, X_c and value of the correlation coefficient Y_a, Y_b, Y_c, N is calculated with the style that next shows it.

$$N = \frac{(X_a Y_a + X_b Y_b + X_c Y_c)}{(|Y_a| + |Y_b| + |Y_c|)}$$

In case of "warm ⇔ cold", the numerical formula that was written upward is not utilized. Because hue average (evaluation element of "warm ⇔ cold") is ring-shaped. So, a Kansei scale value is requested with the nearness to the blue or orange of a hue average.

4.3. The calculation of a color scheme from a Kansei scale value

When a new color scheme is calculated from a selected Kansei scale value, first of all, a value of color scheme of an image in the case that there are two extremes of a Kansei scale axis is calculated (Fig. 2-A). An evaluation element has the upper limit and the minimum, and it is modified between −3 from +3. When the value that was modified is +3 and also −3, the color scheme is positioned to two extremes of the Kansei scale axis. Therefore modifying the value of hue / lightness / chromaticness that has an influence to the evaluation element related to a Kansei scale which utilizes a color scheme of the two extremes is calculated. When color scheme of two extremes of a Kansei scale decides, a color scheme of a new Kansei scale value is produced by extrapolating the scale value that was selected newly from the value of two extremes of a Kansei scale. The Kansei plane is utilized in a color scheme changing system. Therefore mixing the separate color scheme that was calculated by the two Kansei scales one color scheme is made (Fig. 2-B).

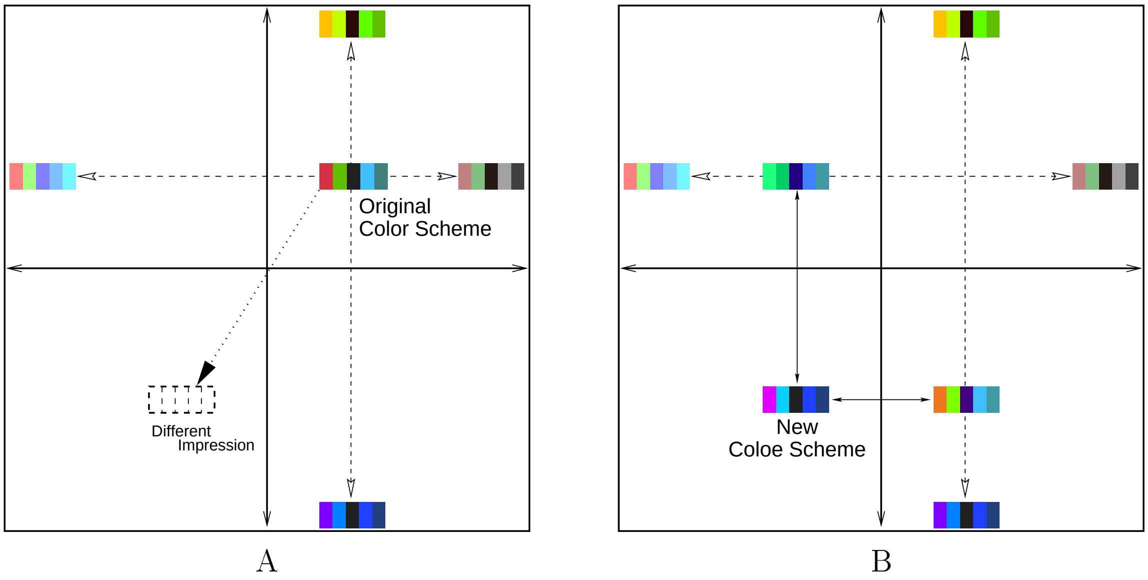


Figure 2: A process that requests a different color scheme

5. JAVA applet that used method of changing a color scheme

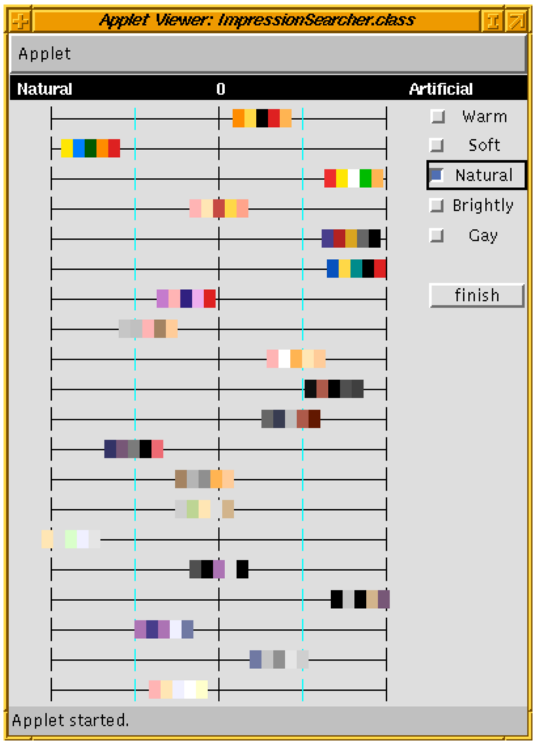
Java Applet was constructed by using a method of changing a color scheme that was expressed up to here. Java was utilized to use an image on WWW (Fig. 3-B).

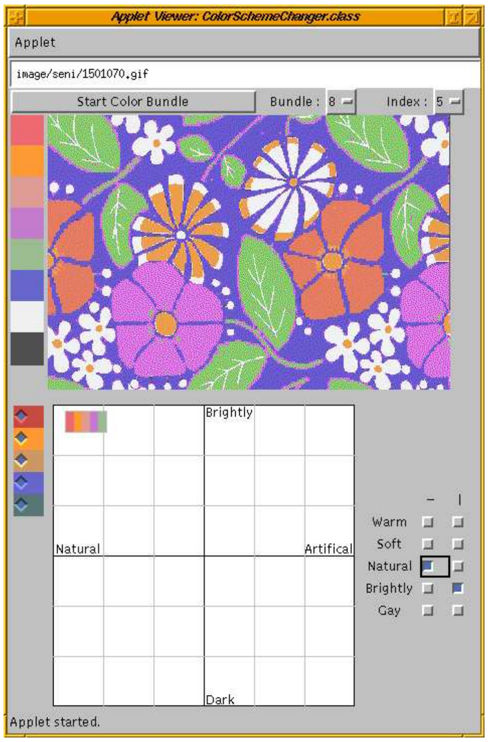
URL of an image that wants to change a color scheme, the numbers of limited colors and the numbers of index color are designated. The index color of an image is moved out. Next, the color scheme that was calculated on the Kansei scale plane that the two Kansei scale axes made x-y axis is displayed. By modifying a Kansei scale value, move the color scheme with a mouse, the color scheme of an image can be changed. The example that changed a color scheme is shown in Fig. 4.

6. Conclusion

The purpose of this system is to decrease the burden of work in the changing color scheme. This system can change color scheme in a short time. Such characteristic that supports changing color scheme is shown below.

1. This system can change a color scheme with a calculation style. Therefore, any color scheme can be changed.





A: The questionnaire system

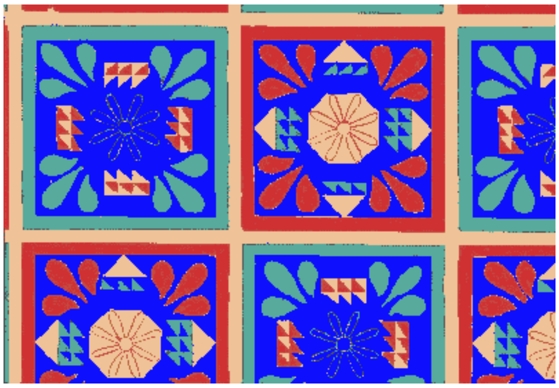
B: Color scheme changing system

Figure 3: Java Applet

original image

hard

natural + warm



gay + bright

Figure 4: Example of changing color scheme

2. This system can change color scheme colorfully by using five Kansei scales.

3. This system can pick out index colors that shows an impression of an image strongly.

From these points, this system is effective as a support system for changing a color scheme.

References

[1] Y. Kitahara: *Kansei Information and Media Processing Technology.* The Journal of IEICE **81**, no. 1, 60–67, The Institute of Electronics, Information and Communication Engineers (1998).

[2] Y. Morohara, K. Kondo, S. Shimada, H. Sato: *Automatic Picking of Index Colors in Textile pictures.* Proc. 6th ICECGDG, 19-23 August 1994, Japan, 643–647 (1994).

[3] U. Naoki, T. Inohara, Y. Morohara, K. Kondo, H. Sato, S. Shimada: *Analyses of Graphical Features of Textiles by Human Impressions.* Proc. IAPR Workshop on Machine Vision Applications, 307–310 (1994).

[4] H. Xiao, K. Kondo, H. Sato, S. Shimada: 1995, *Analyses of Human Impressions on Features of 3D-Shapes.* Proc. Intern. Conf. on Computer Aided Design, Engineering and Management (CADEM '95), 273–278 (1995).

[5] M. Takagi, Y. Shimoda: *Hand Book of Image Analysis*, Publishment of The Tokyo University 1991.

Received August 14, 1998; final form June 15, 1999