
Knowledge based Color Coordinate System and its Application

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Abstract :

The purpose of this study is the development of color coordinate system to realize upgrading and efficiency improvement of the color scheme design work which depended on a human sense. We propose (1) the calculation method for getting the saturation from the hue, (2) the calculation method for obtaining color scheme using the color scheme method of angles of hue. Then, design image generation by the color scheme system which combined these proposal methods are described. The color scheme method using angles of hue was a suitable technique for the computation process, and it became easy that the hue which satisfies the harmony condition. The following is the characteristic of this color scheme system. (1) It is possible to obtain harmonized color scheme example by the color scheme method using angles of hue. (2) The color scheme by the color that we wants to use is obtained. (3) It is useful for the education of the designer, because the comparison of the color scheme is easy. (4) Time shortening in the color scheme work is possible.

Keyword: Knowledge of color scheme, Color scheme using angles of hue, Color coordinate system

1. Introduction

According to the increasing of design and color scheme works, the computer has been used for supporting the design work. Therefore, some color scheme examples are shown by using computer graphics techniques to evaluate product designs. In this kind of color scheme approaches, the designer often uses the color card. One of the reasons is that there is almost no color scheme system which supports color scheme work of design. The color plays an impotent role in images, pictures, or products. For example, the color is an important element to decide the impression of the product. Moreover, the color scheme is also a useful element for information representation of an image, and effects to the image recognition and attention. Therefore, if there is a good calculation technique which can get a good color scheme suitable for the designer's intention, the work of industrial and graphics design can be more efficient than before.

In this paper, the goal is to develop a color scheme system for making the color scheme design work more efficient which depends on human's sense. Our color scheme system has the following functions:

- (1) By selecting one color, it is possible to show the harmonic color scheme is suitable for the color.
- (2) It is possible to show several color scheme candidates. For this goal, we propose the following two methods:
 - (a) By using angle color scheme method, the method to calculate the hue with good color harmony.
 - (b) For several given hues, the method to calculate the chroma and brightness.

Moreover, for the color scheme supporting system which uses our method, the color scheme can also be used in other environment.

The interests of color scheme depend on countries, times, and personalities. The requirement of the color scheme supporting system in this paper is to display the harmonic color scheme proposed in color science. The angle color scheme method used in this paper is proposed as one of the color scheme methods in the western color science. Because for a given hue, by selecting a color scheme classification, the hue of the harmonic color scheme can be calculated, it is easy to simulate it by

computer.

In this paper, we first propose a hue decision method for the harmonic color scheme based on the angle color scheme method. Then, from two or more hues obtained by the angle color scheme method, the brightness and the chroma are necessary to decide the color. However, there is no such a decision method and it is depends on designer's experience so far. Therefore, in this paper, the procedure to decide the brightness and chroma from two or more given hues is analyzed based on the color scheme work of the designer. Hence, for a user specified color, we propose a calculation method to decide the color by calculating the brightness and chroma based on the hue obtained by the angle color scheme method.

These two proposal methods have the following features:

- (1) The color scheme work becomes efficiency.
- (2) It becomes easy to obtain the hue which meets the harmonic requirement with our proposal method.
- (3) The color scheme calculation processing which meets the harmonic requirement of the chroma and brightness becomes possible and an innumerable color scheme can be obtained.

This method is different from the color scheme retrieval method using the color scheme database. Moreover, Senzaki et al. are developing a color scheme supporting system depends on the color scheme based on the angle color scheme method and the relationship after imaging.

In this paper, we first describe the angle color scheme method in Chapter 2 and propose a calculation method for the hue of the harmonic color scheme using the angle color scheme method in Chapter 3. Then, we propose a method for performing the calculation of chroma and brightness based on the knowledge of color scheme in Chapter 4. In Chapter 5, the concepts of the color scheme supporting system and the image generation and evaluation using the proposed color scheme supporting system "AYA" are described.

2. Angle Color Scheme Method

In this chapter, the decision method of the hue which uses the angle color scheme method is described. The angle color scheme is proposed as the harmonic color scheme theory in the color science and is the method for obtaining the harmonic color scheme for showing the hue difference in the hue circle at the angle. A method called Itten's harmony theory is the color scheme theory using this kind of hue circle which is similar with the angle color scheme. Although by using this kind of hue circle, several kinds of color scheme can be obtained according to the angles, we just propose the color scheme method in this paper with the following features: 5 classifications for 3 color scheme, 7 classifications for 4 color scheme, 2 classifications for 5 color scheme, 1 classification for 6 color scheme.

Figure 1 shows the classification of 3 color scheme in the angle color scheme method. For the hue circle in the P.C.C.S system, for the hue of a given color, the similar and contrast hues are shown in 30-60 and 120-150 degrees, respectively. For example, if the color scheme classification is the portamento, by combining the hues located at the clockwise and counterclockwise 30 degrees in the hue circle for the given color, the harmonic color and smooth effect can be achieved.

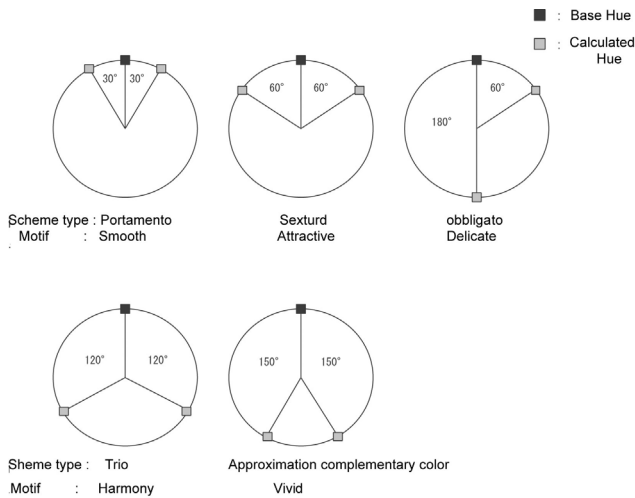


Figure 1. 3 color scheme sample

3. Hue Decision Algorithm for Harmonic Color Scheme

In this section, the hue decision algorithm for harmonic color scheme is described. The concept for obtaining the harmonic color scheme is first introduced. Then, the hue decision algorithm using angle color scheme method is described.

3.1 Steps of Harmonic Color Scheme Decision

Figure 2 shows the steps for obtaining the harmonic color scheme. The user first input the color scheme classification, color scheme number, and a

given color. Then, from the data the harmonic hue is obtained and the similar and contrast hues and the hue of the given color are also obtained in the hue circle as the following positions:

- Similar: corresponds to the hue located in 30-60 degrees.
- Contrast: corresponds to the hue located in 120-150 degrees.

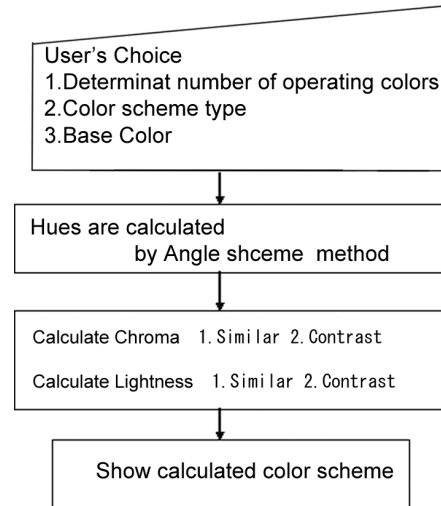


Figure2. System flow

3.2 Hue Decision using Angle Color Scheme Method

In this section, the angle color scheme algorithm which decides the hue for harmonic color scheme using color scheme classification and the input color is described. In the angle color scheme method, the angle is specified for obtaining the harmonic hue. The hue decision algorithm for obtaining the harmonic color scheme from the hue circle is shown as the follows:

1. Mark each hue as 1-24. Due to these numbers, the number on the hue circle is decided every 15 degrees.
2. Calculate the angles by the angle color s cheme method.
3. Obtain the hue number for the given color.
4. Add the value obtained from the relative angle / 15 to the number of the specified hue.
5. Obtain the hue number which is requested.

Due to the above steps, the hue for the harmonic color scheme can be decided from the given color and color scheme classification. In the next section, the calculations of brightness and chroma using this hue are described.

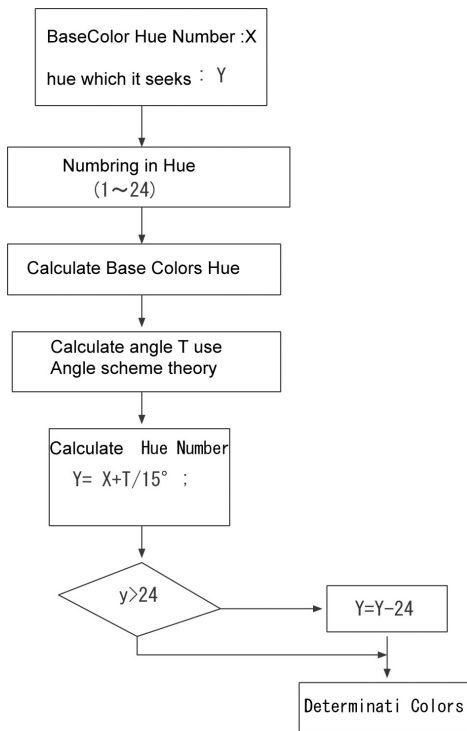


Figure3. Angle color Scheme method system flow

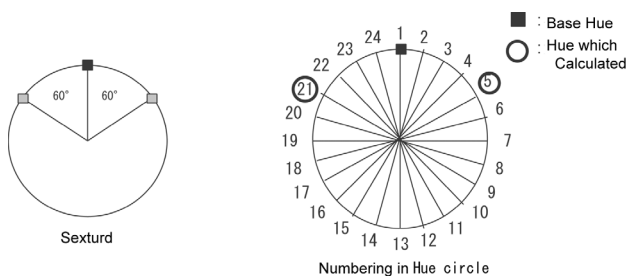


Figure4. Numbering in Hue circle

4. Calculations of Brightness and Chroma

The brightness and chroma of the hue obtained by the angle color scheme method is unique. In this section, the method to change the brightness and chroma for harmonic color scheme is proposed.

4.1 Calculation Algorithm of Similar and Contrast

We first describe the algorithm for calculating the brightness.

For the hue obtained by the angle color scheme method, when applying the similar process, the changes of the brightness and chroma of the hue are small. When the contrast process is applied, the changes are large. The calculation method is as the follows:

1. The brightness y of the hue located at both ends is changed due to the parameter k (similar: small value, contrast: large value) as shown in Figure 5.

The brightness y of the hue between the given color and the endpoint is obtained from several calculated hues by $y_n = y + n * k / n$ with the hues $x_1, x_2, x_3, \dots, x_n$ between the specified hue and the endpoint.

2. When the calculated brightness or the chroma exceeds the minimum or maximum value, the brightness or the chroma of the hue is set to be the minimum or maximum value. Then, the process is repeated.

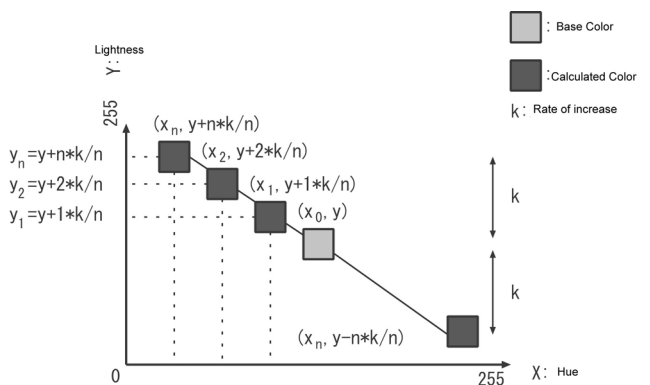


Figure 5. Calculation method of Lightness and Chroma

4.2 Similar and Contrast Brightness

When applying the similar process to the brightness classification, the change of the brightness is small. When applying the contrast process, the change is large. Figure 6 shows the similar and contrast processes for the brightness.

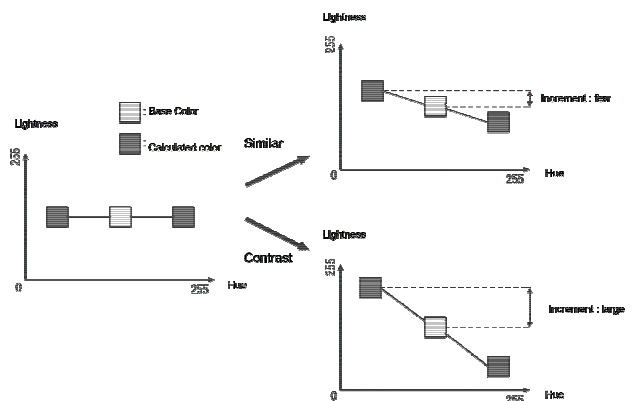


Figure 6. Similar and contrast processes

4.3 Calculation Algorithm of Chroma

In this section, the steps of chroma calculation are described. The process is as follows:

1. When the chroma classification is similar, the changes of the chroma at both ends of the calculated hue are small.
2. When the chroma classification is contrast, the changes of the chroma at both ends of the calculated hue are large.

As shown in Figure 6, the steps of the chroma calculation are the same as the steps of obtaining the brightness. By selecting the changes of the chroma due to the similar or contrast, when setting the specified color in the center, the chroma of the color at both ends can be obtained.

5. Color Scheme System and its Applications for Generating Images

5.1 Concepts of Color Scheme System

In this section, the color scheme system which uses the proposed harmonic color scheme method in this paper is described. The processes and usages of the color scheme system are described as follows:

1. Select the hue which is the nearest one to the target color from the hue circle.
2. Select the brightness and chroma from the gradation.
3. The user-selected color and data are shown.
4. The color scheme is shown where the brightness and chroma are performed the unique, similar, and contrast processes from the hue according to the angle color scheme method.

Figure 7 shows the example of the color scheme process when the color scheme number is 3 and the color scheme classification is portament.

In this paper, due to the above algorithm the system can obtain various color scheme candidates depends on the display of the harmonic color scheme candidates which used the similar or contrast processes. In addition, the color scheme candidate display system which the user can dynamically change the slopes of the brightness and the chroma is also implemented. Due to the system, the comparisons of the results when changing the slopes of the brightness and the chroma can be performed.

When changing the slopes of the brightness and the chroma, the examination of the color scheme according to the generated harmonic color scheme can also be performed. The screen capture of our system is shown in Figure 7.

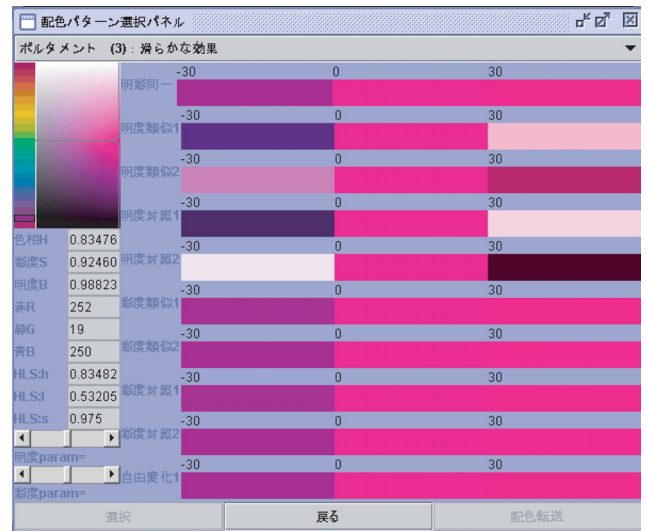


Figure 7. System preview

5.2 Image Generation using Color Scheme Supporting System

In this section, the results generated by our system are shown. Figure 10 is the screen capture of the image generation system using our color scheme supporting system “AYA”.

By using the obtained color scheme in the color scheme supporting system, the color scheme of the input image can be changed, and the images with different impressions can be generated.

Moreover, we also make the color scheme, which is obtained in the color scheme system, can be used in other applications, for example, Photoshop. Figures 12, 13, and 14 show the generated examples by designer using our system. The color schemes of the examples are decided in our system, then using other applications for rendering. Therefore, using the color scheme obtained by our system to generate images is possible.

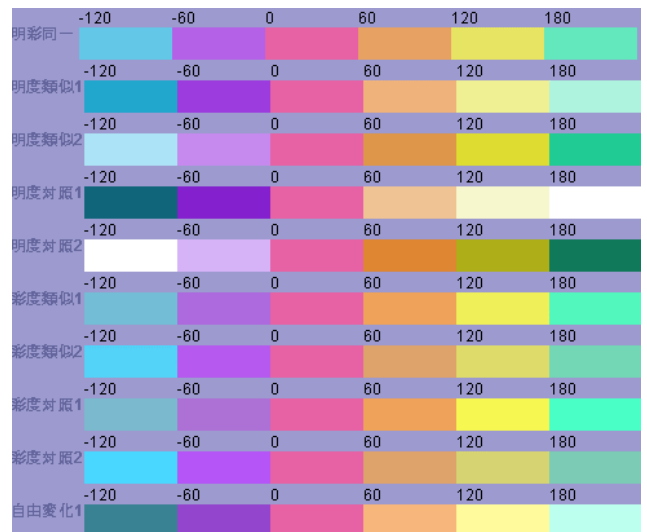


Figure 8. Sample Using Color support system

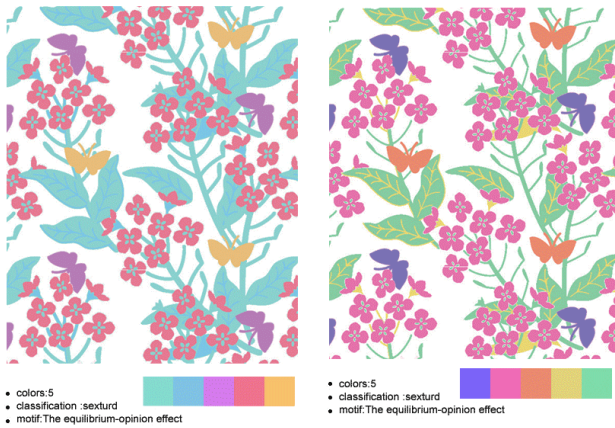


Figure 9. Image sample



Figure 10. Image sample2

5.3 Evaluation of Color Scheme Supporting System

Due to the results which are generated by designer using the color scheme supporting system “AYA”, the following evaluations are obtained:

1. Because the color scheme method in our system is designed by using one of the techniques that the designer uses, the example of the harmonic color scheme can be obtained easily.
2. Because several color schemes can be obtained by simply choosing the feature of color scheme, the color scheme number, and the used color, the color scheme work of the design can be achieved in a short time.

6. Conclusion

In this paper, the calculation method of obtaining the harmonic color scheme is proposed, and the color scheme system using this method is also described.

The proposed method can be roughly divided into two processes: the decision of the hue and the decisions of the brightness and chroma. The decision of the hue is based on the angle color scheme method. The calculation method for deciding the brightness and the chroma is proposed by analyzing the designer’s knowledge. In addition, the color scheme system using the computer is constructed with the combination of the proposed methods. Moreover, the experimental results are generated using our system in cooperation with the designer. Due to our system, the following knowledge can be understood:

1. The angle color scheme method is a suitable technique for the calculation, and it became easy to obtain the hue which met the harmonic requirement by our method.
2. The color scheme calculation which meets the harmonic requirement of the brightness and the chroma is possible.

The features of the color scheme system in this paper are as the follows:

1. By using the angle color scheme method which is used in the color science, it is possible to obtain the harmonic color scheme.
2. Because the number of colors is abundant, the color scheme due to the color that the user wants to use can be obtained.
3. It is useful for the education of the color scheme generation as the system which obtains the harmonic color scheme.
4. Because the harmonic color scheme can be obtained in a short time, the color scheme work can be done quickly.

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