1. INTRODUCTION

Recently, users can access the Internet at significantly higher speeds and transmit large amounts of data more quickly due to broadband or high-speed Internet access. A large volume of digital information as multimedia can be transmitted and exchanged, regardless of time and place. As broadband Internet connections, digital broadcasts, etc., continue to expand, the demand for digital contents and their diversification will also increase.

To produce better contents, it is important to transmit a large amount of integrated data, and to send the meaning of messages accurately. To utilize the characteristics of multimedia and transmit messages efficiently and effectively to others, it is necessary to include sensibility aspects of the message.

Therefore, it is hoped that the KANSEI engineering viewpoint can be used as an important factor. Colors affect the viewer psychologically and physically. Color information plays an important role in receiving sensibility information from an image along with the objective shape of the image.

In order to incorporate the KANSEI engineering viewpoint and increased speed in the content production environment, we have proposed a tool to express gradation as a typical color technique. In this paper, the possibility of expressing gradation with a certain meaning statement using color scatter charts taken from certain meaningful images is considered. Next, the experimental method using Semantic Differential to assay the meaning of the images is explained. Finally, validation in relation to the KANSEI for the expressed gradation is discussed.

2. COLOR SPACE AND GRADATION

Among the named color space and color solid, many kinds and forms can be applied according to the intended purpose or objective. [1, 2]

In this paper, we demonstrate a color cube by computer image using a simple method that applies RGB color values on the X, Y, and Z axes. (Fig. 1)

Recently, “Color Cubic Palette” [3] was suggested as a mapping coordinate space by Masaki Fujihata. Fujihata assumed that the colors displayed on the computer monitor are located in the RGB color space. This way of thinking is achieved by a plug-in software tool for Adobe Photoshop. This is color distribution in RGB space. Such
color distribution is often called a “color histogram. (in Japanese)” ([4], p.1134.)

In general, gradation means a continuous change and transition. Gradation of colors is a continuous change from a certain color to another color or the act of making such change. A smooth gradation appeals to human emotions. When solid colors are displayed on a flat monitor, a monotonous impression is obtained. But when colored by gradation, a gentle and sensitive impression can be visually obtained.

In general, the following two methods are used to generate gradation.

• Calculate the reflection and transparency of the light source and object.
• Calculate the color.

The former is rendered as an algorithm represented by the ray tracing method or radiosity method using three-dimensional computer graphics. The latter calculates shading from colors or changes in hue, brightness, saturation and tone, either separately or combined.

3. EXPRESSION OF GRADATION FROM THE COLOR SCATTER CHART

The authors programmed two tools. One was a graphic tool that expresses color distribution in RGB space called a color histogram as described in Chapter 2. It is programmed using the 3D graphics multimedia library “Jun for Java” [5]. This “Color Scatter Chart Tool” plots RGB values of an image data within a three-dimensional color space as values on the axes. Color scatter charts were obtained from some images. Then, a textile photo of a Japanese tradition pattern and its color scatter chart are shown (Fig. 2, Fig. 3). Tendency for image color distribution can be observed from the color scatter chart shown in three dimensions. Color distribution is plotted on a gentle curve.

The other gradation tool slices a color cube at various angles on a plane then displays the surface of the plane. We produced a tool called the “Cutter Tool” (Fig. 4, Fig. 5) using “Jun for Java”. The tool displays various gradations existing in the color cube as a single plane. This tool can change plane position and angle interactively. If the color cube is dissected by a curve or curved face, an even richer gradation can be expressed.

We described the possibility of a gradation tool which combines these two tools. [6] When a group of points plotted by the “Color Scatter Chart Tool” is complemented with a curved face, we could input the curved face as parameters to cut out a color cube with the “Cutter Tool”. In this way, a new expression of gradation is considered possible.

This is an experimental method to express color gradation using 3D graphics tool, and its approach is different from other gradation generating methods.

4. SIGNIFICANT GRADATION

The gradation used in the contents should be significant in order for the contents, including color, to accurately be conveyed.

Designers tend to provide some nonverbal messages implicit in the contents when using color gradation. Sentences, images and design elements of multimedia contents individually have some messages.

Figure 2: Japanese Traditional Pattern

Figure 3: Color Scatter Chart for Japanese Traditional Pattern
Meanwhile, an image can have many meanings. For example, photos of nature or scenery, and images of industrial products or works of art, provide an impression and sensitivity to the viewer.

In this paper, we considered ways to add KANSEI expressions to the gradation tool described in Chapter 3. In other words, we considered ways to replace human impressions or images gained from pictures with design elements.

Images have meaning in the form of their constituent elements, colors and harmony. We think it is possible to produce significant gradations from images with several meanings.

As described in Chapter 3, it is possible to obtain a color scatter chart from an image. Using this chart, creating significant gradation is thought possible.

Using an approach with KANSEI engineering to reflect human sensitivity in the creation of gradation is considered effective. [7, 8] This can achieve the concept of “gradation like ~”.

5. MEANINGFUL EXTRACTION OF IMAGE AND CONSIDERATION ON GENERATION OF GRADATION CORRESPONDING TO THE KANSEI WORDS

Regarding plans to generate significant gradation with a specific message, we discussed the possibility of extracting KANSEI words from certain images and then creating a gradation from an image that corresponds to the KANSEI words.

We plan to develop a gradation tool that combines the “Color Scatter Chart Tool” and the “Cutter Tool.” As described in Chapter 3, this gradation tool generates gradation from the color scatter of the input image.

The input image in this tool is assumed to reflect KANSEI in the gradation. For example, an image with an elegant feeling such as Fig. 2 is thought to be able to generate an elegant gradation like the color scatter chart in Fig. 3. We hope to construct a system which will combine the gradation tool with the database of the KANSEI words.

First, we extracted the meanings of original images to examine this possibility. SD (Semantic Differential) method [9] is often used to determine sensitivity. This method can determine abstract and ambiguous images, as well as sensitivity. By evaluating stimuli using a set of bipolar adjectival scales, the impression of the object presented as a stimulus can be understood.

Next, we conducted a questionnaire survey to obtain generality by selecting pairs of adjectives using the SD method. From the collected answers, we selected some adjectives by text mining.

The experimental methodology and results are described in Chapter 6 and Chapter 7.

Up to now, data analysis has been performed on original images. It is necessary to confirm whether gradation that corresponds to the image sensitivity has been generated. From now, we plan to test and analyze the results of the image evaluation for gradation in order to clearly identify the correlation between the image and the
extracted KANSEI words. Methodology and hypothesis are discussed in Chapter 8.

6. EXPERIMENT FOR EXTRACTION OF KANSEI WORDS FROM THE IMAGE

6.1 Experimental Method

We performed an experiment to extract KANSEI words by questionnaire and evaluation of the image feelings.

In this experiment, 10 images were prepared, such as natural and artifact photos (Fig. 2, Fig. 7(a)-(i)), and displayed them on a computer monitor.

As the monitor uses colored light, maintaining the experimental environment is relatively easy. To ensure sufficient brightness for the examinees to fill in the evaluation sheet, the room was lit. Illumination from the lightning was not reflected onto the monitor.

Eight persons, 6 men and 2 women, ages 30-50, were chosen as the examinees.

Adjective pairs used as the rating scale were Japanese words corresponding to the adjectives shown in Table 1. Each adjective pair is opposite in meaning. So each rating scale is defined by a pair of polar adjectives. The examinees observed each image and filled in an evaluation form such as Fig. 6.

6.2 Results

Results are shown in Table 2. The table shows the average point and standard deviation obtained from the SD evaluation values by the examinees.

The graphs (Fig. 8, Fig. 9) show the results of two images, a traditional Japanese pattern (Fig. 2) and a rusted machine (Fig. 7(a)). The image of traditional Japanese pattern is “bright, beautiful, vivid and complex”. The image of the rusted machine is “heavy, dirty, static and sober”. Therefore, the results shown in Table 2 are considerably natural.

In this examination, we selected and arranged adjective words from scales defined by Osgood, an advocate of the SD method. Some adjective pairs that we selected in this examination were not suitable for KANSEI words. Scales which had a large standard deviation in their answers, as well as those with many ‘Neither’ responses, were not considered suitable as KANSEI words for the images. Adjective pairs with small standard deviation and a clear tendency were considered to be most appropriate.

Table 1: Adjective pairs

| 2. Heavy – Light | 7. Dynamic – Static |
| 3. Warm – Cold | 8. Vivid – Sober |

Figure 6: A part of the Evaluation Form

Figure 7(a): Rusted Machine

Figure 7(b): Trains

Figure 7(c): Building
6.3 Discussion

Some adjective pairs that we selected in this examination were not suitable as KANSEI words. So it was necessary to prepare a rating scale that could be used for KANSEI words, as well as obtain greater variety and
interesting words. However, when an experimenter selects adjective pairs, his bias is reflected. So text mining is considered to be more effective for generality. [10] This method selects adjectives before SD method testing. This provides generality and simultaneously extracts adjectives more suitable for expressing KANSEI.

Examination by more examinees and more rating scale items is expected based on this experiment.

7. EXTRACTION OF VIEWER’S IMPRESSION OF IMAGE BY TEXT MINING

There is a problem that the experimenter’s bias influences the selection of the adjectives, as mentioned above. Moreover, more diversified and interesting ways to measure evaluations as KANSEI words is needed. Thus, to provide generality to the selection of adjectives, and to obtain various KANSEI words, text mining was performed. The experimental methodology is described as follows.

7.1 Experimental Methodology

A free description questionnaire survey for the impression of images was carried out for the same images used in the experiment by the SD method in Chapter 6. In this method, a questionnaire form with a blank column as shown in Figure 10 was used, called the definition method.

19 persons, 13 men and 6 women, ages 20-60 looked at images displayed on a monitor, and then freely filled in words on the questionnaire. The words were then used as the text data and analyzed. Analysis method and experimental results are shown as follows.

7.2 Results

Each text which was answered by all examinees was set as a keyword. Keywords with similar concepts were grouped together. As a result, about 360 keywords were collected. A histogram for each keyword was obtained, and graphs were created for those with a frequency greater than 2. The graphs (Fig. 11, Fig. 12) show the results of two images, a Japanese traditional pattern (Fig. 2) and a rusted machine (Fig. 7(a)).

As described previously, about 360 keywords were recognized for 10 images. For each image, the number of keywords with a frequency of more than 2 ranged from 7 to 14.

8. DISCUSSION OF METHODS TO GENERATE MEANINGFUL GRADATION

If gradation can be generated from images by using the aforementioned gradation tool, image color scatter charts, and a curved face, which is an appropriate value for the drawings; can be color representative values of images, such as hash values of data, or message digest. Gradation, which is a representative value of images, appears to reflect the meaning of the original image.

Gradation data do not contain the shapes and position information of the images. Gradation can never have the exactly equivalent meaning as the original image. It is difficult to directly extract the meaning and a variety of KANSEI

<table>
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<tr>
<th>Q1</th>
<th>This image is like:</th>
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<td>( ), ( ), ( ), ( ) , ( ) , ( ) and ( ) .</td>
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</table>

<table>
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<tr>
<th>Q2</th>
<th>This image is like:</th>
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<tbody>
<tr>
<td>( ), ( ), ( ), ( ) , ( ) , ( ) and ( ) .</td>
<td></td>
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</tbody>
</table>

Figure 10: A part of the Questionnaire Form
Study on Gradation of Colors Corresponding to KANSEI Words

8.1 Database on Kansei Words and Image Gradation

Image lists, lists of gradation generated from images and lists of KANSEI words are prepared as database items. Results of the text mining of each image and evaluation results, using the SD method are also prepared as data.

It is necessary to obtain KANSEI words of images through text mining and to perform an extraction experiment of KANSEI words of images by the SD method in advance.

8.2 Database Maintenance Tool

This is a tool to link KANSEI words with gradation. An explanation of this tool is described below.

When users select a KANSEI word, images are selected in the order of those having the highest average value evaluated by the SD method. Or, an image with the highest frequency of KANSEI words obtained by text mining is selected in order. We will discuss which data is better, based on results and operational aspects.

This tool displays the gradation generated from selected images. The user evaluates how much the KANSEI words express the gradation.

For example, the following 6 scales are used for the evaluation.

- Perfect (5)
- Almost perfect (4)
- Neither perfect or different (3)
- Different (2)
- Totally different (1)
- Not applicable (0)

These points are accumulated in the database to evaluate how closely gradation and KANSEI words correspond to each other. A degree of correspondence is calculated by multiplying evaluated points and frequency.

This is how to link KANSEI words with gradation.

8.3 Database Use Tool

This is a tool to search for gradation that corresponds to KANSEI words by using database maintained by the aforementioned tool.

When the user enters the KANSEI word, some candidates of gradation that are linked with the KANSEI word are selected from the database and displayed. Candidates of gradation linked with that KANSEI word are displayed in order of the highest degree of correspondence. The user selects the gradation that is most applicable. At the same time, when the user evaluates how closely the selected gradation and the KANSEI word correspond to each other, the evaluation is fed back into the database.

In addition, gradation application; image attribution according to targets; narrowing of the candidates based on users’ attribution; and data analysis; will be discussed.

9. CONCLUSION

In this paper, a new approach to display abundant KANSEI gradation using an expressed RGB color space model locating a color in a cube was proposed, and the possibility of reflecting a KANSEI word from an image as the method of expressing a meaningful gradation from the meaningful image was discussed.

Human beings visually grasp color and light through
electromagnetic waves as a physical occurrence. When this occurs as a subjective color with human sensitivity and feeling, a newly expressed color space, along with interesting and various impressions, is generated. In the future, technology which can bridge this gap is required.

As the versatility of content and multimedia advances, the point of view for KANSEI engineering which can handle further important elements is desired. We hope this study contributes to the awareness of such necessity.

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REFERENCES


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