Mood from painting

Estimating the mood of painting by using color image scale

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***Abstract*—A Color Image Scale is one of useful resources for allowing designer the expression of mood through the color combination. This study proposes a method for estimating the mood in Color Image Scale from three color combinations by using machine learning technique. After we find the correlation between the mood and the properties of color combination, we extract three dominant colors from an image. Finally, we estimate the mood of the painting by using the properties of three dominant colors.**

***Keywords*—color image scale, mood, color combinations, painting.**

I. Introduction

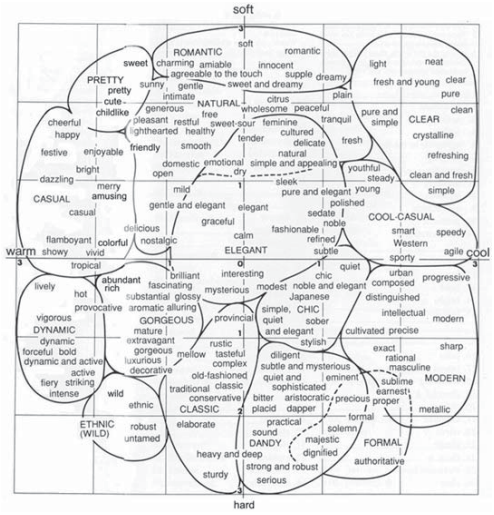
The color is psychologically perceived by human. Many people intuitively receive certain mood or feeling from color. Most of Artists even uses color intentionally in order to convey its own meaning. In numerous studies, the color of image was regarded as one of important factors affect the mood[1], [2], [3], [4], [5].

A Color Image Scale that proposed by Kobayashi[6], [7], [8] is a widely used tool for selecting colors with considering mood in various fields such as, designing product, coordinating the cloths, and etc. He designed a two dimensional space, color image scale, that consists of two factors relate to mood, coolness and softness. And he collected the coordinate of various things, such as single color, color combinations, paintings, potteries, buildings and keywords by using user study. For example, the coordinates of a number of mood keywords he collected are shown in Fig. 1(a). Among them, three-color combination (Fig. 1(b)) is very useful for designing the color of something to have intended mood. In his study [7], a number of three-color combination examples are presented with its mood, so that anyone can just employ it for creating mood.

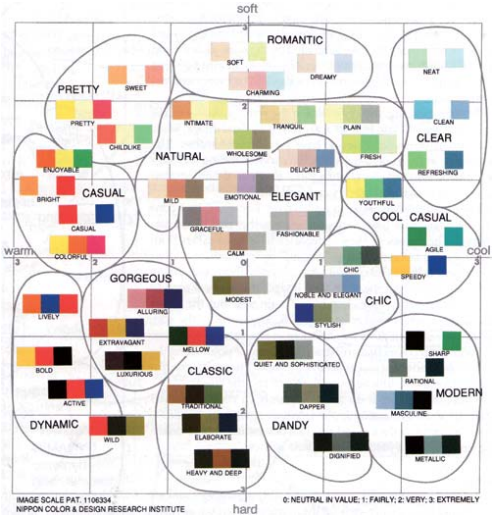
Although Kobayashi defined a number of three color combinations for a certain mood, he did not analysis the factors of color that affect the mood. Therefore, it is not easy for creating mood to use color combinations that are not presented in his work. Also, we do not know the mood of three color combination that has random colors.

In this paper, we aim to find the correlation between the factors of color and the mood, and to estimate the mood of painting by using the correlation. First, we construct a collection of three color combination examples presented in [3]. Next, we define several features of the three color combination, and extract it from the collection. Then we analysis the correlation between them by using a machine learning technique. Once we obtain the correlation, we extract three dominant colors from a painting image, so that we estimate the mood of painting from the correlation.

The remainder of this paper is organized as follows. In Section II, we explain our approach for finding the correlation



(a) the mood keywords



(b) three color combinations

Fig. 1. Kobayashi's color image scale.

TABLE I. USED FEATURES FOR ESTIMATING THE MOOD FROM COLORS.

type	feature	description	dimension
hue	hue difference	angle between two lab vectors on ab plane	3
	dominant hue	a and b value in lab color space	2
tone	luminance difference	absolute difference between l value of two colors	3
	saturation difference	absolute difference between the length of two lab vectors on ab plane	3
	dominant saturation	magnitude of lab vector on ab plane	1
	dominant luminance	magnitude of lab vector on l-axis	1

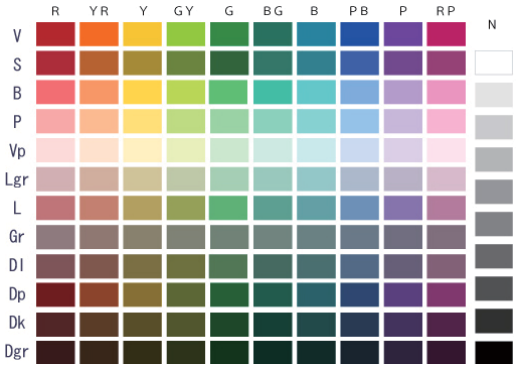


Fig. 2. The Hue & Tone 130 system used in color image scale.

between colors and the mood. Then we present the method estimating the mood of painting by using the correlation in Section III. In Section IV, we demonstrate the results of our proposed method and discuss the algorithm used and its limitations. Finally, we conclude this paper with a summary of our ideas and an outline of future work in Section V.

II. FINDING CORRELATION BETWEEN MOOD AND THREE COLOR COMBINATION

In order to estimate a mood from a painting, we use three color combinations that are surveyed by Kobayash. His research[7] provides three color combinations tagged as the name of mood, so that we can estimate the mood of painting by extracting three color combination from the painting. In his research, the name of each color in three color combination and the keyword (mood) are provided. Although the coordinates of every moods are graphically represented, exact numerical value of them are not provided. Therefore, in order to estimate the coordinates from graph in his article, we obtain bounding boxes of all of keywords in the graph, and acquire the center position of them.Consequently, we obtain three color combinations include the name of three colors, the name of mood keyword tagged on the combinations, and the coordinate of them in color image scale.

Although Kobayashi provided a number of three color combinations that tagged with its own mood keyword, it does not cover all of three color combinations can be generated from random colors. Thus it is most important for estimating a mood from random three colors to find the correlation between each color in the Kobayashi's three color combination.

In order to find the correlation by using machine learning technique, the features of three color combination are required. Kobayashi used Hue & Tone 130 system (Fig. 2) for defining three color combinations. From this, we assume that most two important elements of color in his theory are hue and tone (combined luminance and saturation). The rgb color model which is mostly used in various imaging field is not suitable for dealing with hue and tone. Another color model, the hsv model, is best for treating hue and tone. However, it does not provide perceptual uniformity, so that it is unsuitable for extracting normalized features. For this reason, we employ lab color model for extracting features. Because lab color model has no hue and tone component explicitly, we use the angle and length of lab vector on ab plane as if it is h and s components in hsv model.

In his article[8], he briefly mentioned that the contrast and similarity of hue and tone of each color in three color combinations affects the mood. From this, we calculate the difference of hue, saturation and luminance, and employ them as the features of three color combination. For a three color combination, there are 3 pairs that consist of two colors. For each pair, we calculate the angle and length differences of two lab vectors, and the difference of each l value. We employ these values as the features of three color combination. In our observation, we found that not only the correlation between colors but also dominant hue and tone strongly affect the mood. For this reason, we add dominant hue and tone to our features. In this paper, we define the dominant component as the average value of two similar components. We obtain dominant hue by calculating average a and b value of two nearest color vectors on ab plane. For dominant tone, we calculate the average value of two colors in l axis and the average length of two color vectors in ab plane. Table. I summarize the features we employed.

After extracting features from the three color combinations, we find the correlation between the moods and the features by using machine learning technique. By using regression, we generate the prediction fuction that maps the features into two-dimensional coordinate on the color image scale. We demonstrate the experimental results in Section IV.

III. ESTIMATING THE MOOD FROM A PAINTING IMAGE

In previous section, we predict the mood from three color combination. Therefore if we obtain three color combinations from paintings, then we can estimate the mood of the painting. However, to select three color combination from the painting is challengeable problem, because the distribution of colors, the way for treating similar colors and more complicate factors that affect human perception must be considered. In this study, we naïvely assume that three colors that are frequently used in the painting mainly affect the mood similarly to the three color combination.

Generally digital color image has color of 24bit depth. There are too many discrete colors (about 16M) in an image, thus it is not meaningful to find most frequently used color among every colors in the painting image. For this reason, we normalize an image by enforcing limited number of colors. As mentioned

(a) an input painting image (b) normalized image (c) three dominant colors

Fig. 3. Color normalization using Hue & Tone 130 system.

previously, Kobayashi used Hue & Tone 130 system (Figure 2) in [7] for constructing image scale of three color combinations, so that we also normalize the colors of painting image to 130 colors he used. For every pixels in the image, we find nearest color among the 130 colors, and assign it as the color of the pixel(Figure 3(b)). Then, we find most frequently used three colors among 130 colors(Figure 3(c)).

Kobayashi carefully determined the sequence of three colors by certain rule. Our learning process in Section II also take three color combination with sequence. Therefore we must consider the sequence of three cominant colors. In [7], Kobayashi noted that a color of a contrasting tone should be placed between two colors of same tone in order to separate them- a weak tone between two strong tones or a strong tone between two weak tones. He also noted that subtle gradations of hue and tone should be in the three color combination. By using his rule, we adjust the sequence of three dominant colors, and generate the three color combination of the painting.

From extracted three color combination, we extract the features proposed in Section II. Then we calculate the coordinate on the color image scale from the features by using our predict fuction.We present the prediction results in Section IV.

IV. Experimental Results

In our experiment, 936 three color combinations provided in [7] and 174 moods tagged on each three color combination were used. The range of both coordinates of the color image scale we used was $[-3 : +3]$. For machine learning methodology, we used linear regression by using Weka library[9]. We evaluated our prediction performance by using 10-fold cross validation. In our experiment that predicts the mood from three color combination, Mean absolute errors for the coolness and the sofness were recorded as 0.65 and 0.63. In our analysis, most significant factors seemed to be dominant hue in both axis. However, for the softness, the influence of dominant hue was less than the coolness. On the other hand, the hue difference seemed to have more power for the softness than the coolness.

Kobayashi already studied the mood of 16 famous paintings, and showed them on the color image scale (Figure 4(a)). For experiment, we acquired the same images that Kobayashi used by web searching, and estimated the mood of each images through our algorithm. In our experiment, mean error was recorded as 2.08. The results are graphically shown in Figure 4(b).

In our experiment, the performance of the mood estimation from painting was lesser than that of the mood estimation from three color combination. Generally the colors of digital images for same painting slightly differ to each other, so that prediction mainly depends on the color of image. We did not experiment with the exactly same images that were employed by Kobayashi, thus predicted mood can differ to the Kobayashi's ground truth. Moreover, we obtained the three color combination from an image by naïve approach, so that there is no guarantee that extracted three color combination successfully represents the image. Therefore, more robust approach for obtaining three color combination from an image is required.

V. Conclusion and Future Work

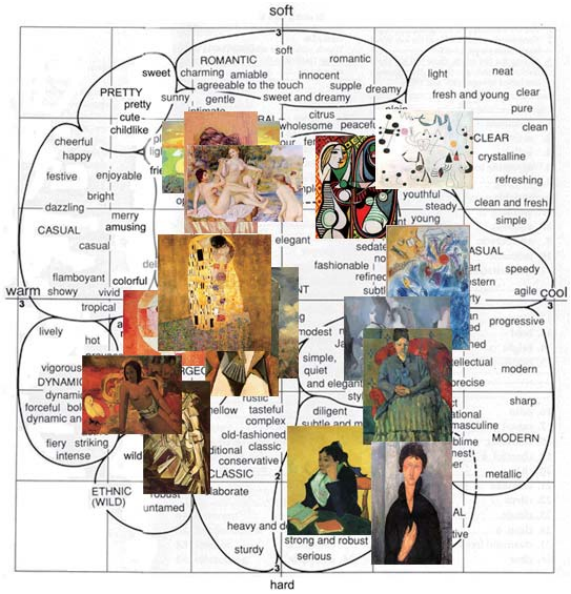
In this paper, we studied the correlation between the mood and the three color combination by using machine learning technique. First, we collected three color combinations that have the mood tags. And we define several features for the three color combination based on Kobayashi's color image scale theory[7]. Then we found the correlation between the mood and the features extracted from the Kobayashi's three color combinations by using the regression.

After we established the prediction function that predicts the mood from the features of three color combination, we estimated the moods from painting images by using it. For this, we normalized the color of image by using Hue & Tone 130 system, and extracted the three color combination by finding three dominant colors from the image. Finally we estimated the mood by using our prediction function and the features of extracted the three color combination.

The limitation of this work is low performance of mood estimation from the painting image. Therefore, the goal of our next work is to increase the performance. For this, as mentioned above, more robust method for finding the three color combination from image is required.

Our experiment mainly depends on Kobayashi's data. However, for same painting and colors, the mood affected can be changed according to the era and culture. In our future work, we will survey the mood of more paintings and colors for the users of nowadays, and evaluate our method by using

(a) ground truth



(b) our results

Fig. 4. Mood estimation results.

them.

The factor that affects the mood of painting is not only the colors. We will find more factors that affect the mood, and refine our prediction function.

ACKNOWLEDGMENT

This research is supported by Ministry of Culture, Sports and Tourism(MCST) and Korea Creative Content Agency(KOCCA) in the Culture Technology(CT) Research & Development Program 2014.

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