Estimating the Mood of Paintings from Color Combinations using Machine Learning

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***Abstract*—A color image scale is a useful tool that enables designers to express mood through color combinations. This paper proposes a method for estimating the mood in color image scales from three-color combinations using machine learning. First, we find the relation between the mood and the properties of the color combinations. Then, we extract the three most dominant colors from the image. Finally, we estimate the mood of the painting via the properties of the three dominant colors extracted.**

***Keywords*–color image scale;mood; color combinations; painting.**

I. INTRODUCTION

Color is psychologically perceived by humans. Certain colors intuitively evoke certain moods or feelings in many people. Most artists even intentionally use color to convey its own meaning. In numerous studies, the colors in images have been determined to be an important factor that affects mood [1].

A Color Image Scale [2] is used extensively as a tool for selecting colors while considering mood in various fields, such as product design and cloth coordination. A color image scale consists of two axes: warm/cool and soft/hard. The positions of single color, color combinations, paintings, potteries, buildings, and moods on color image scales have been determined from user studies. For example, Figure 1 shows the positions of various three-color combinations on a color image scale. In this paper, we assume that an item in one position on the color image scale is strongly related to any other in the same position. The objective of this paper is to find moods from paintings by considering this underlying assumption.

The remainder of this paper is organized as follows. In Section II, we explain our approach for finding the correlation between colors and mood. In Section III, we present our proposed method for estimating the mood of a painting using correlation and discuss the results obtained. Finally, we conclude this paper with a summary of our ideas and an outline of future work in Section IV.

II. ESTIMATING MOOD FROM THREE COLOR COMBINATIONS

In our estimation of moods from paintings, we use three-color combinations surveyed by Kobayashi [3]. Kobayashi provides three-color combinations tagged as moods, such that the mood of a painting can be estimated via three-color combinations extracted from it. The name of each color combination and the position of the corresponding mood in the color image scale are also provided. Because the positions of mood

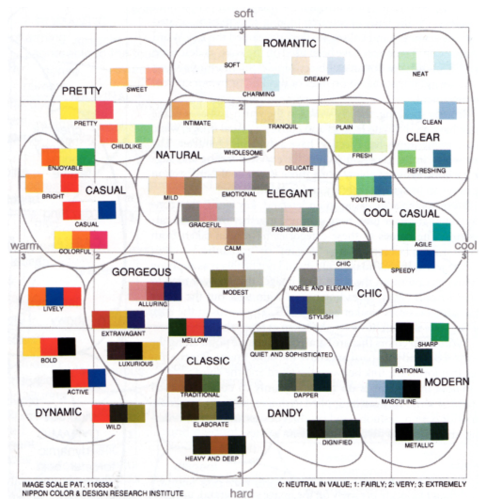

Figure 1. Three-color combinations on a color image scale.

keywords are graphically represented in [3], we estimated the position each mood by acquiring the center position of text in a graph, also obtained from [3]. Consequently, we obtained three-color combinations, with the names of the three colors, the name of each mood tagged onto each combination, and the position of the moods in the color image scale.

Although Kobayashi provided a number of three-color combinations, each tagged with its own mood, not all the three-color combinations available in paintings are represented. Thus, in order to be able to estimate mood from any three random colors, determination of the relation between each color in Kobayashis three-color combination is very important. To estimate this relation, we employed a machine learning technique. First, we extracted features from the colors in each combination, such as the hue/saturation/luminance difference between two colors and the average hue/saturation/luminance value of the three colors. Consequently, we obtained a 12-dimensional feature for each three-color combination. Next, we generated data pairs, with the features and the two-dimensional position of the mood tagged onto the data, for each three-color combination. Finally, we derived a prediction function that is able to estimate the coordinates of the mood of random three-color combinations using linear regression [4].

We then conducted an experiment using 936 three-color combinations and 174 moods. In order to ignore the order of colors in a combination, we generated all possible combinations of the given 936 three-color combinations, resulting

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in six combinations being generated from each three-color combination. The range of both coordinates of each color image scale was $[-3 : +3]$. In our experiment, the prediction error magnitude was recorded as 0.64. In further analysis, the significant factors appeared to be average hue, hue difference, average saturation, and intensity.

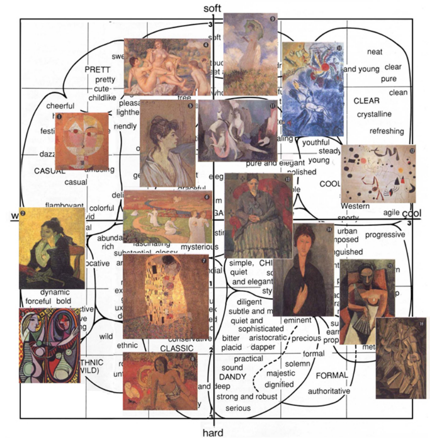
III. Estimating mood from dominant colors of image

In the previous section, we discussed and predicted moods from three-color combinations. Consequently, we hypothesized that if we obtained three-color combinations from a painting, then we should be able to estimate the mood of that painting. In this paper, we assume that the three colors that are most dominant in a painting affect the mood of the painting in a manner similar to the three-color combinations. Thus, we used the three colors most frequently used in a painting to estimate its mood.

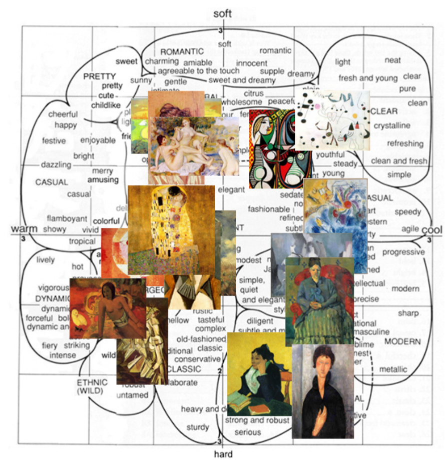
In general, a digital color image has a color depth of 24 bits. Such an image has too many discrete colors, resulting in attempts to ascertain the most frequently used color being a meaningless exercise. For this reason, we first normalize an image by enforcing a limited number of colors. Kobayashi [3] used the Hue & Tone 130 system to construct a three-color combination image scale. We utilized the same color system to normalize the colors of the image.

After normalizing the colors, we estimated the coordinates of moods in the color image scale from the image of a painting by using the prediction function acquired in Section II. Kobayashi indicated the coordinates of 16 famous paintings in [3] (Figure 2(a)). To conduct a similar activity for the name of moods, we acquired the coordinates of paintings by calculating the center position of each painting on the figure in [3]. For 16 paintings with ground truth mood, we estimated each mood as coordinates in the color image scale (Figure 2(b)). In our experiment, the magnitude of the mean error was recorded as 2.08.

In our experiment, mood estimation performance from paintings was lower than that of mood estimation from three-color combinations. In general, the colors in digital images of the same painting differ slightly, such that prediction depends primarily on the color of the each image in isolation. In our experiments, we did not utilize the same exact images that were employed by Kobayashi; thus, the predicted mood differed from Kobayashis ground truth. Moreover, we obtained our three-color combinations from an image via the naïve approach; hence, there was no guarantee that the extracted three-color combination precisely represented the image. Therefore, a more robust approach for obtaining three-color combinations from an image is required.



(a) Ground truth provided by Kobayashi



(b) our results

Figure 2. Mood estimation results.

IV. Conclusion and Future work

In this paper, we estimated the mood of paintings using the three-color combinations color image scale. First, we defined the features of a three-color combination as several properties of each color. Then, we established a mood prediction function from feature-mood pairs using linear regression. Finally, we extracted three dominant colors from images of paintings, and estimated moods by using the prediction function.

Our experiment depended predominantly on Kobayashis data. However, for the same painting and colors, the mood evoked varies according to the era, age, culture, type of education, and types of color blindness. In future work, we will survey the mood of more paintings and colors in relation to todays society. In addition, we will consider various individual conditions, such as age, education, and cultural area.

In addition to color, several other factors affect the mood of a painting. We plan to determine those other factors and refine our prediction function by incorporating them in our analysis.

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