Introduction

“How do you think this image is? Is it good or bad to you? Is it your type?”

If you were asked these questions, what would you answer? Can you actually predict what answer would you get from another when he or she is given questions like these? The answer must be not. Answers to these questions contain an element called “sense,” which is actually the hardest part of rating things, making it difficult to make a hundred percent accurate prediction. That is, we do not get general answers to these kinds of questions.

The rating to an image by a person depends on the events one has experienced. Since we know that any of experience of two arbitrary users can be totally different, how come they might adore a same image without any discussions? Why some paints or photos are adored by many people with varied backgrounds while some are not? There might be some common essence of image rating that makes this happen.

There might be a bunch of reasons of ratings to a picture. Not to mention the spatial reasons, color scheme is the one of the most essential issues of rating to a colored image. If the combination is appropriate, image can be more harmonious than one which is not appropriate, even they are both in the same spatial structure. Color scheme would be the primary thing we discuss in this project report. We will find out how the color scheme works with visual sense of human.
It is discovered that particular combinations of single colors produce better visual experience. These combinations are with respect to the hue ring of HSV. Colors with particular angles between would provide better combination.

As shown in Fig. 1, scheme with the angle between 18, 90, or 180 degrees, or combinations that is symmetric or vertical give out more pleasurable scheme.

Since better color scheme can be found, we are able to adjust color of an image by the same idea and strategy. However, some difference lies between color scheme and color of image. Color in an image is more complicated than the color combined by few single colors. Areas should be decided instead of single colors. Actually, we found some defined models from our reference paper, as shown in Fig. 2.

There are few models with single domain of hue while others with two areas. Angles of hue area and ones between centers of two hue areas in the same model are all arranged into 18, 90 or 180 degrees. As shown in Fig. 2, the i and I type and the small area of L and Y type has 18 degrees; the V, X type and the larger area of L, Y type has 90 degrees; the T type has 180 degrees. Centered points in two areas between L type has difference 90 degrees, and other models with two areas has 180 degrees between their areas’ centered points.

Our goal is to adjust colors of an image into these models to make it more visually harmonious. The strategy would be described below.
After analyzing the hue of an image, we modify it with eight different models. We need to find out the best angle to rotate each hue model.

$$F(X,(m,\alpha)) = \sum_{p} \left| H(p) - E_{\alpha}(p) \right| \cdot S(p).$$

By this formula, we are able to find a value calculated by every angle the specific model rotated applying to the image. To find the best angle to rotate, the following formula decides which the best way is to rotate. We define this value as the energy changed with respect to the model and the angle rotated.

$$M(X,T_{\alpha}) = (m,\alpha) \quad \text{s.t.} \quad \alpha = \arg \min F(X,M(X,T_{\alpha})).$$

The energy should be fewer if it is a better solution to adjust the image by the model. That is, the best solution should change the fewest energy among all of the rotations.

The reference paper provides a formula calculating the best model to apply.

$$S(X) = \{m_0,\alpha_0\} \quad \text{s.t.} \quad \alpha_0 = \arg \min F(X,M(X,T_{\alpha})).$$

This is the formula the paper used. However, we refrain from doing that. Many elements affect the final visual rating to image by human. We are worrying that if the model chosen by the formula is not the best image people would rate. We believe the result might be great if we choose a good image with its color originally not bad and with a little color mis-painted only. What if the input image has large part of weird color scheme? Moreover, the t-model and the X-model would generally get more chances since they cover more hue area than other models do.

Results are shown on the right side and the next page.

Adjustment to colored words. We made up an image with weird colored words purposely. The program with different models generate different adjustments.

Adjustment to an average photo. We’ve also done our adjustment on an average photo. The top image is the original one while the followings are modified by the models denoted.
More Results

Advanced Strategy

After finishing these operations, some tricky problems appeared. The first flaw we discovered was the color coherency.

The coherency problem is not seen in single area model-modified images. However, when applying multiple area models, some part of image whose color supposed to be continuous is split into two totally colors and with dividing edge between different colors. To solve this problem, we introduce a geometry way to deal with it. During processing image, we reverse the previous neighbor pixels, which are adjusted already. Check the difference between their hue value and the way to change. If the current one is adjusted in a totally different way and gives out a totally different color, it will be re-adjusted by the same way the similar neighbors have been changed. Finishing generating the whole image, we apply median mask on the image. The array we filter is the way the pixel is adjusted instead of the original image. After applying the mask few rounds, a more color coherent image would be generated. It is obvious that color of the green pen become much more coherent and smoother than the one applied original method only.

Another flaw was also discovered: sky interruption. Sky part is usually not the most important part of an image. Objects might affect analysis and adjustment of the sky part and vice versa. To date, we still cannot get a general solution to detecting sky part of an image. We construct a map, which sky part would be 0, and others would be 255. The whole process would neglect sky so that it can reamin as its original color. The result is shown on the right side.

Coherency Adjustment. The top image is the original image. The left one is generated with i-model in the basic method while the right one is done by also i-model in enhanced way.

Sky neglect. The left one is generated in general way while the right one is finished with skymap.
This application might be useful if a program of this kind of function is released on a website. It is expected to be online as Google App Engine Application or Flash website during or after winter vacation.

Similar concepts can also be applied in artistic purposes. Automatically-generated monochrome photo is one of our targets. By using v-model or t-model, a monochrome photo can easily be generated by simply remove the saturation value of pixels whose hue lays out of the model. The most important part of image would stay with its color remain and other parts would be gray scale image. This idea is already done by our codes.

Another application is adjusting an image into the style of given sample image. User is able to give a sample image, such as a flag of a country, a scene of a movie, or even a image with the style user simply wants, the average saturation and hue distribution would be calculated before the program automatically adjusting the image into eight different models and saturation with respect to the given sample. This function is actually provided in our program.

Image generated in **monochrome program with V-model**. Colors of the most significant objects would remain.
Reference

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http://colorschemedesigner.com/

Image Resources
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La Boca, Buenos Aires, Argentina
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http://winetraveller.files.wordpress.com/2008/08/dcn3583.jpg
21_21 DESIGN SIGHT in Tokyo Midtown, Tokyo, Japan
Railway near Daikanyama, Shibuya District, Tokyo, Japan
photo by 吳鎮宏
Flags of Jamaica, UN, and Spain
from Wikipedia.org
Item: Jamaica, United Nation, Spain
Scene from Sakuran
http://img.allabour.co.jp/Live/relationship/womanlove/clubsp/LV20070228A/sakuran1.jpg
Fushikitane from Pokémon
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Image with Colored Words
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