Emotion-Based Color Transfer of Images Using Adjustable Color Combinations

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***Abstract*—This study developed a novel framework for the color-transfer between colored images, and that can further achieve emotion-transfer between colored images based on the human emotion (human feeling) and a predefined color-emotion model. In this study, a new methodology is proposed. The main colors in an image can be adjusted based on the complexity of the content of images. The others contributions in the study are the algorithms of the Touch Four Sides (TFS) and the Touch Up Sides (TUS), which can improve the identification of the background and foreground and the other main colors that are extracted from the images.**

Keywords-Emotion-Transfer; Color-Transfer; Color-Emotion; Image Content Analysis.

I. INTRODUCTION

Images are the important media for conveying human emotions. Colors are also the main component of an image. In recent years, researchers have intensively studied the usage of images to convey emotions, opinions [1]-[5], and be used for one method to take single main color or a fixed number of main colors combinations to implement color-transfer. Nevertheless, an unsolved problem is how to understand and describe the emotions caused by an image. Another problem is how to understand the inherent subjectivity of emotional responses by the user. This study develops a novel framework for the color-transfer focusing on color images and emotion-transfer implementation between color images based on human emotions and a predefined color-emotion model.

II. METHODS

The new emotion transfer method uses one scheme of dynamic and adjustable color combinations which is based on the complex content of a color image to determine which number of color combinations is used. Additionally, the proposed method can accurately identify the primary representative colors of the image, and also support both solutions, *i.e.*, using relative images and semantics which come from a predefined color-emotion model for emotion transfer. The method follows five steps as below.

1) *Color Emotion Model*
2) *Dynamic Extraction of the Main Colors*
   a) *Identification of the Main colors*
   b) *Determination of the amount of main colors*
3) *Identification of the Background and the Foreground*
4) *Emotion Transfer*
   a) *Matching for the Amount of Color Combinations*
   b) *Color Transfer*
   c) *Pixel Updates*
   d) *Gradient Preservation*
5) *Output Image Producing*

The flow chart of the proposed emotion-transfer framework is shown below.

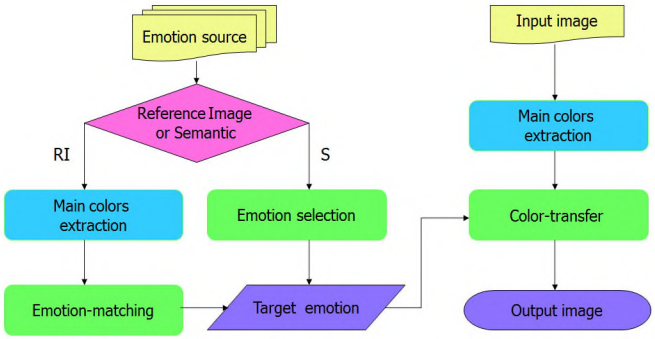

Figure 1. The flow chart of the proposed emotion-transfer framework

The target emotion from source can be separated in two ways. The first approach adopted the Reference Image (RI) to get a target emotion, which is acquired by two steps:

1) *Main colors extraction:* extract the main colors for the input image and reference image. These main colors can be categorized as three kinds of color combination: two-color, three-color, and five-color. Moreover, our method also supports other color-emotion model that may provide more than five-color combinations. Also, we combine two methods to identify the representative points from image-pixels, which are Independent Scalar Quantization (ISQ) [6] and Linde-Buzo-Gray (LBG) algorithm [7], which is similar to a K-means clustering algorithm. In order to determine the amount of main colors, the proposed method is then used to determine the background and other main colors.

2) *Emotion-matching:* analyze the input image to compare with other reference images based on the number of main colors. Here, there are two cases. If the number of main colors is the same, the main colors of reference images will be adopted as the color combinations of target emotion

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directly. One example of this way is shown in Figure 5. When the number of main colors are different, the target emotion will be assigned with same emotion and search the closest color combination from a predefined color-emotion model. Another way is to allow users to choose a desired emotion directly from a predefined color-emotion model which is the model developed by Chou [8] and contains 24 emotions, each one includes 24 two-color combinations, 48 three-color combinations and 32 five-color combinations. All of the colors in the Chou model are mapped to the RGB color space and the CMYK color space. However, this study uses the CIELab [9] color space, which is converted from the RGB color space. In this study, the number of color combinations is chosen according to the complexity of the contents of the input image or reference image. The main colors extracted from the input image are mapped to the target emotion with the same amount of color combinations. Therefore, the number of main colors must be controlled within this range. After the color-transfer algorithm is used to transfer the target emotion to the input image, the output image is obtained, and the procedures of the color- emotion transfer is completed.

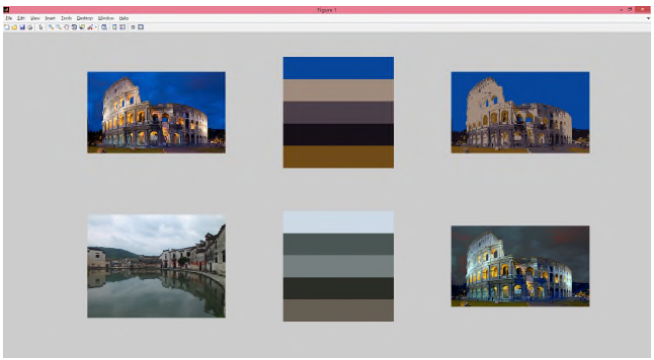

Fig. 5. When the input image and the reference image have the same number of main colors, the target emotion can adopt directly the main color from the reference image

III. Conclusion And Future Work

This study proposes a novel method and framework for performing emotion-transfer based on adjustable and dynamic color combinations for color images. The results for adjustable and dynamic color combinations have several advantages. They illustrate the emotions in images and enables color transfer to be performed separately in different regions of the images. The results show that the method improves the expression of color and emotion in images.

Non-professionals can also use the proposed method to describe objectively and efficiently for the communication of human emotions. The experimental results show that the proposed approach can naturally alter the emotions between photo and painting. It also allows emotionally rich images for art and design. Since previous color transfer algorithms use only one color or a fixed color combination to obtain new images, the images are usually not rich or natural in terms of colors and emotions, and the clustering result sometimes does not recognize the dominant main color correctly.

The proposed approach uses the methods of ISQ + LBG, which is more effective than LBG alone, and the quality of images are similar. Other new algorithms in the proposed approach, the Touch Four Slides (TFS) and Touch Up Slides (TUS) algorithms, can extract the background and dominant color correctly from the main colors for most images. Furthermore, the representative colors are obtained from the method of the adjustable and dynamic color combinations, which provides a closer link between human and emotion.

In the future, different color-emotion models could be used in this framework. For example, since the main colors extracted from color images are the most important representational colors, they can be used to identify specific images. In addition, it can also be used for the feature of the emotion. However, although the method always extracts the background color accurately, the dominant color may not be absolutely and correctly identified for all images. Therefore, the method may be still improved by additional elements to enhance the extraction of emotion from images, such as shape, texture, and so on.

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References

[1] C.-K. Yang and L.-K Peng, “Automatic mood-transferring between color images,” IEEE Computer Graphics and Applications 28, 52‑61,March 2008.

[2] W. Fuzhang, D. Weiming, K. Yan, M. Xing, C. P. Jean and Z. Xiaopeng, “Content-Based Color Transfer,” Computer Graphics Forum Volume 32, Issue1, pages 190‑203, February 2013.

[3] T Pouli and E Reinhard, “Progressive histogram reshaping for creative color transfer and tone reproduction,” Computers & Graphics 35 (1), 67-80, 2011. 40, 2011.

[4] Y. Chang, S. Saito, K. Uchikawa and M. Nakajima, “Example based color stylization of images,” ACM Transactions on Applied Perception 2, 3 , 322‑345, 2005.

[5] H. Li, Q. Hairong and Z. Russell, “Image color transfer to evoke different emotions based on color combinations”, Springer, SIViP, 9:1965‑1973, 2015.

[6] J. D. Foley, A. V. Dam, S. k. Feiner, and J. F. Hughes, ” Comput. Graphics: Principles and Practice,” Ma Addison Wesley, 1990.

[7] Y. Linde, A. Buzo, and R. M. Gray, “An Algorithm for Vector Quantizer Design, ” IEEE Transactions on Communications, vol. 28, pp. 84-95, January 1980.

[8] C. Chien-Kuo, “Color Scheme Bible Compact Edition,” Grandtech information Co., Ltd, 2011.

[9] CIELAB, “CIELab - Color Models - Technical Guides,” internet:ba.med.sc.edu/price/irf/Adobe_tg/models/cielab.html, accessed Feb 2019.

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