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An Effective Color Image Detecting Method for Colorful and Physical Images

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ABSTRACT

In this paper, an effective color detection technique is presented. Color detection techniques are widely used in the image processing area, especially for measuring the amount of a certain color after some modifications on an image to check wither it gets enhanced or not. We test this technique on images that were carried out in a physical laboratory during some experiments. Moreover, we will use this technique to calculate the percentage of the red color before and after "red-eye" removal process. Finally, a comparison of these techniques with some other methods has been achieved.

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1. Introduction

The color detection technique is considered one of the important techniques in image processing and computer vision. In fact, it has many applications in many areas such as in medical field, physics, computer science and engineering. The focus of this recent work is going to be on measuring colors of modified images as well as presenting ways of image enhancements. For example, noise removal, which is a well-known process, can be carried out using colors detection. In other words, selecting a certain area of a full image by some popular methods can facilitate working on this image, as one will deal with less number of “Hue range” colors in most cases. Moreover, this will help in detecting the rest of other places in the same image, as the first region indicates the existing colors of that image, Figure 1.

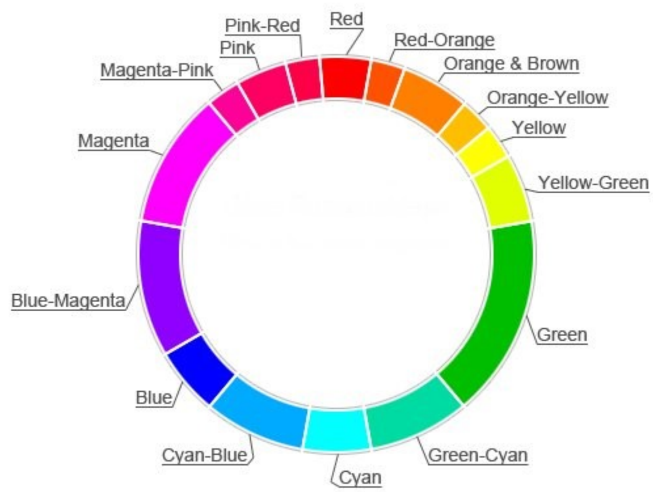

Fig. 1 – The color wheel (Hue).

Many approaches to color image detection have been presented over the years. In addition, color detection by region is the widely used approach for splitting color images into multiple regions. The main idea of region color detection can be initialized by selecting a region then extending the work in the surrounding area step by step by merging based movement on single or group of pixels to reach the full area of the image. One of the techniques of region-based color detection is clustering approach. The main issue of the clustering-based color detection is that one must specify the number of clusters and cluster formed based on images and then region merging can be done if the first selected region contained most of image colors (in some cases all colors must be in the selected region). Research study is reviewed on the areas of region color detection and the researchers work are analyzed this technique in many different methods [1-5]. Another important benefit of color detection can be seen in calculating the percentage of a certain color to find wither this color is decreasing or increasing after such modifications. This aspect is useful in red-eye removal where we can check if the red color and its shades are decreasing after such an enhancement on a particular image. More research study that is related to this topic can be found in [1-11]. Therefore, we will present here in this paper our method for detecting colors and apply it on images that were carried out in a physical laboratory during some experiments. Moreover, we will use other different images from a variety of fields. Finally, a comparison of our proposed method with some other methods is showed and discussed. The methods that we are going to compare with can be seen in [1-3].

2. Material and Methods

2.1. Color Spaces

RGB color model comprises of the three added substance primaries red, green and blue. These otherworldly parts are utilized to create any other color [2]. It is a standout amongst the most broadly utilized color for handling and processing of digital image information. Nonetheless, high relationship between channels, blending of chrominance and luminance information makes RGB not a very favorable choice for color analysis and color based recognition algorithms [1]. RGB is considered a color space originated and it was convenient to describe any color as a combination of the three mentioned colored rays is illustrated in Figure 2.

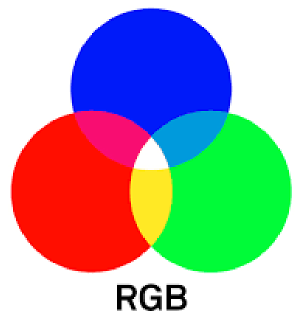

Fig. 2 – 2 RGB color model.

In fact, RGB is considered one of the most widely used color spaces for processing and storing of digital image data and it is usually the main source to initiate other color spaces such as HSV, TSL, and YC_rC_b. To illustrate this, we start first by defining the normalization of RGB, which is a representation that we can, obtained from the values of this color space by the following procedure:

$$\widehat{R} = R/(R + G + B) \quad (1)$$

$$\widehat{G} = G/(R + G + B) \quad (2)$$

$$\widehat{B} = B/(R + G + B) \quad (3)$$

where: the sum of the normalized components $(\widehat{R} + \widehat{G} + \widehat{B}) = 1$. This normalization can contribute to achieving getting rid of distortions caused by lights and shadows in an image. In addition, it is a way to define other color spaces. Another important color space is the Hue Saturation Lightness (HSL) or Hue Saturation Value (HSV), which can be represented as follows:

$$H = \cos^{-1}((1/2) \times \left((R - G) + (R - B)/\sqrt{((R - G)^2 + (R - B)(G - B))}\right)) \quad (4)$$

$$S = 1 - (3(\min(R, G, B))/R + G + B) \quad (5)$$

$$V = (R + G + B)/3 \quad (6)$$

Moreover, the color space Tint, Saturation, Lightness (TSL) that is a transformation of the normalized RGB into more intuitive values, that are close to hue and saturation in their meaning can be defined as follows:

$$T = (1/2\pi)\tan^{-1}(R/\hat{G}) + (1/4), \quad \text{if} \quad \hat{G} > 0, T = (1/2\pi)\tan^{-1}((R/\hat{G}) + (3/4)), \text{ if } \widehat{G} < 0, T = 0, \text{ if } \hat{G} = 0 \quad (7)$$

$$S = \sqrt{\frac{9}{5}\left(\widehat{R}^2 + \widehat{G}^2\right)} \quad (8)$$

$$L = 0.299R + 0.587G + 0.114B \quad (9)$$

where: $\widehat{R}$ and $\widehat{G}$ are the normalized R and G channels that we explained in Eq. 1. Finally yet importantly, the YC_rC_b space color (sometimes abbreviated to YCC) is consisting of Y, which is luminance and C_r and C_b are the red-difference and blue-difference chroma components respectively. This color space can be represented simply as:

$$Y = K_R R + K_G G + K_B B \quad (10)$$

$$C_r = R - Y \quad (11)$$

$$C_b = B - Y \quad (12)$$

where: $K_R = 0.299$, $K_G = 0.587$ and $K_B = 0.114$. More color spaces can be found in [10].

2.2. Method Modelling Process

The technique that we use here to calculate the percentage of a specific color in our proposed images is a logical indexing technique that depends on the matrix of RGB values. In other words, determining the pure blue color with no additional blue shades can be obtained by the RGB value (0,0,255). Moreover, the blue color with a range of blue shades can be obtained by manipulating the intensity of the three RGB channels in a way that blue channel dominates. For instance, we can set the range of the red color in MATLAB as (:,:,1)<=125, and the green color as (:,:,2)<=125, and the blue color as (:,:,3)>=125. Table 1 below illustrates the intensity of five shades for the three primary colors, red, green and blue, respectively.

Table 1 - Five different shades of the RGB channels.

RGB Intensity			Red Shades	RGB Intensity			Green Shades	RGB Intensity			Blue Shades
Red	Green	Blue		Red	Green	Blue		Red	Green	Blue	
240	190	190		190	240	190		200	200	250	
250	105	100		105	250	100		140	160	207	
255	0	0		0	255	0		0	0	255	
175	9	2		9	175	9		3	18	165	
120	5	0		7	80	6		8	8	88	

Since every color in the "Color Wheel" and it is different shades can be obtained by maintaining the intensity of the primary colors, we can function this feature in MATLAB and determine any color by their value that consists of three numbers, which represent the intensity of the RGB of that color. In other expression, the meant image will be read by MATLAB as an $(m \times n \times 3)$ array, where the third dimension represents the intensity of the primary colors in every pixel. Therefore, we can get any color by setting it is RGB values as explained in Table 2.

Table 2 - 2 RGB values in MATLAB.

RGB values intensity	Corresponding color(s)
(:,:,1)=255 & (:,:,2)==0 & (:,:,3)==0	Single color (pure red)
(:,:,1)<=255 & (:,:,2)==0 & (:,:,3)==0	Only red shades
(:,:,1)==255 & (:,:,2)<=255 & (:,:,3)<=255	Red and White shades
(:,:,1)>=125 & (:,:,2)<=125 & (:,:,3)<=125	Mixed red shades

In fact, we are depending here totally on the pure RGB color spaces that are explained in the previous sub-section by taking the color and it is shades through manipulating the three layers array in MATLAB. In the coming section, we are providing some examples to explain the proposed idea.

3. Experiments and Results

3.1. Binary Images

For the purpose of explaining the idea of the color detection, we provide a simple example using binary images where a binary image can be explained as a 2-dimensional matrix that contains just 0's and 1's values. The components 0's represent the pixels of black region and elements 1's represent the pixels with white region. The skin color area takes the white color in the binary image. The MATLAB function "im2bw" converts skin color segmentation images to binary images after applying the threshold on the components, see Figure 3.

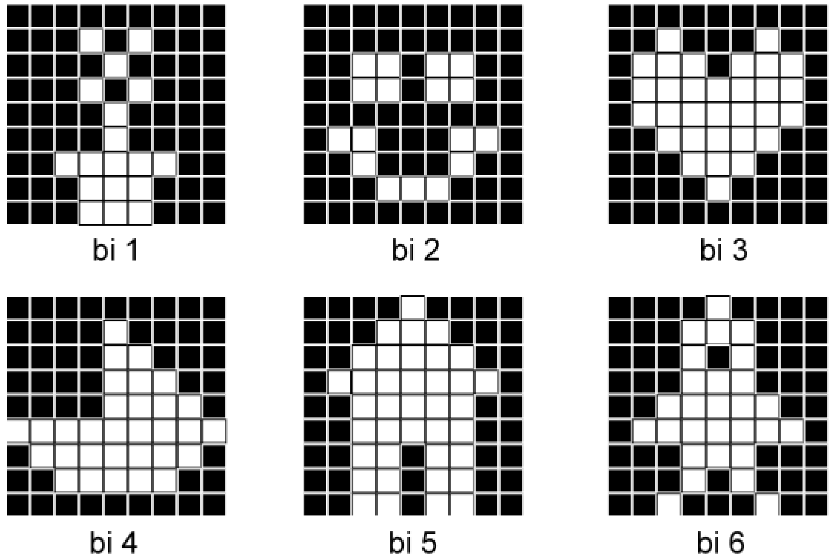

Fig. 3 – A group of binary images.

3.2. Standard RGB Image Example

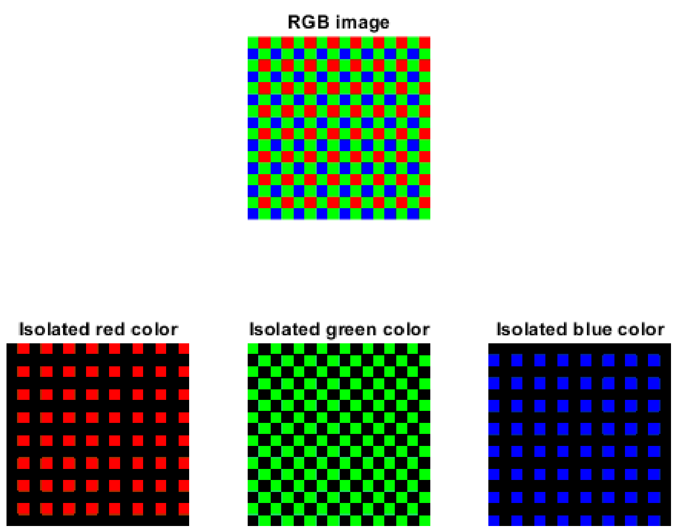

Fig. 4 – Isolating colors using the proposed method.

Figure 4 shows the calculating the ratio of each three colors using the MATLAB command "100*(sum(sum(colorIntensity))/(size(ImgName,1)*size(ImgName,2))); would give us that the image contains 65311 red pixels, which means that 24.91 % of the image is red. In addition, the image contains 123392 green pixels, which means that 47.07 % of the image is green. Finally, the image contains 65311 blue pixels, which is the same number of pixels for the red color. Summing the three result together would give 96.89 % is the total percent of pixels, which indicates that 3.11 % is lost as shades of the three colors. In fact, these values are the suggested values setting for indicating any other colors for RGB images.

3.3. Physical Images Example

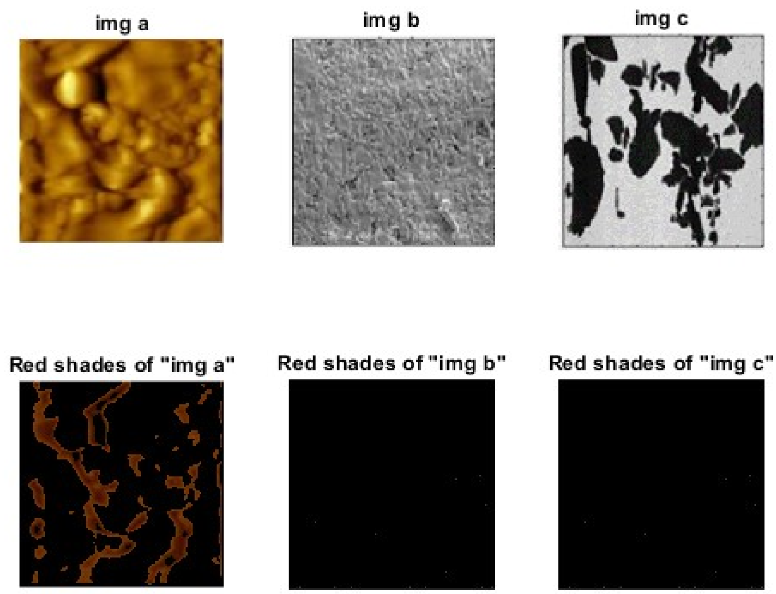

Fig. 5 – Isolating red shades using the proposed method.

Figure 5 shows the calculating the ratio of red shades for the physical images in Figure 5 using the MATLAB command "100*(sum(sum(colorIntensity))/(size(ImgName,1)*size(ImgName,2))); would give us that "image a" contains 16667 of red shades pixels, which means that 19.41% of this image is the shades of the red color. In addition, "image b" contains only 95 red shades pixels, which means that the ration of the red shades in this image is less than 0.05%. Finally, the "image c" contains 0 red shades pixels.

3.4. Methods Comparison

In this example, we compare our method of detecting colors with the methods in [1-3] by using an experiment of red eye removal showed in Figure 6 that we previously prepared. In Figure 6 shows the calculation of the ration of six different shades of the red color in the original image and the modified three images (after red eye reduction) in three phases. The six different shades that we will calculate are listed in Table 3.

Table 3 - Six shades of the red color.

RGB Intensity			Red Shades	Color Name
Red	Green	Blue		
255	192	203		Pink
250	105	100		Dark pink
255	0	0		Pure red
175	9	2		Dark red
128	0	0		Maroon
84	4	0		Dark maroon

The comparison is going to be illustrated using a chart with a scale of 10. The maximum number 10 for a shade indicates a full intensity of this shade and the minimum number 1 indicates that this shade has been reduced completely.

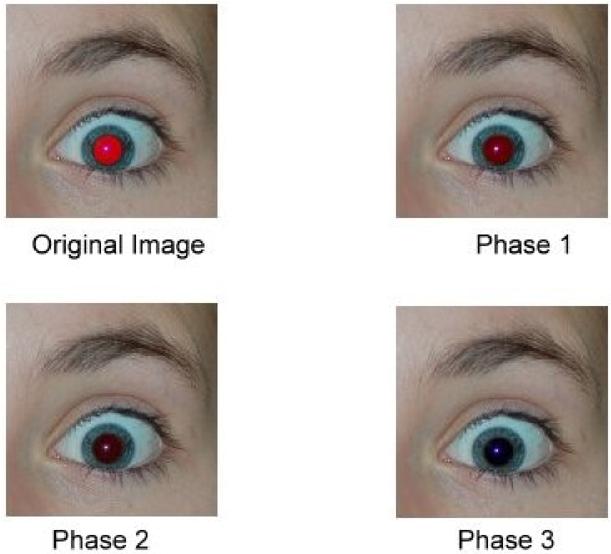

Fig. 6 – Four phases of red eye reduction.

Applying the three methods in [1-3] and our proposed method on the images in Figure 6 gives the results illustrated in Figure 7.

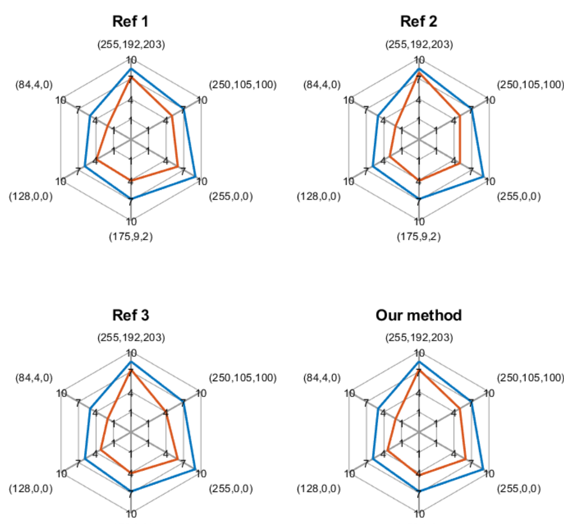

Fig. 7 – The comparison of the original image and phase 1.

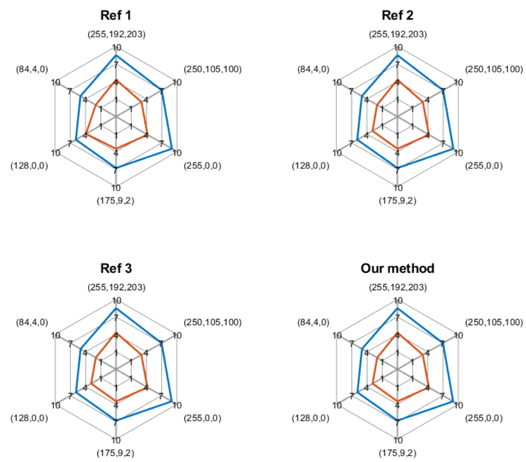

Fig. 8 – The comparison of the original image and phase 2.

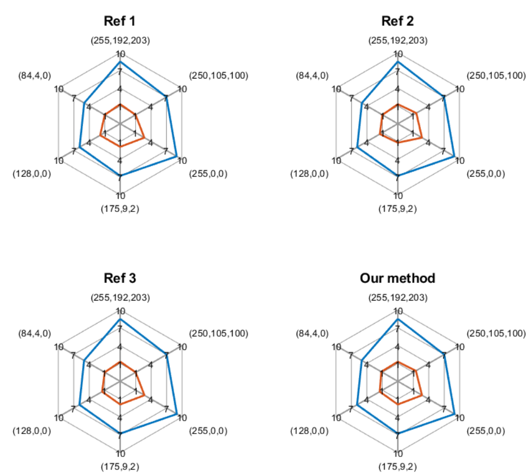

Fig. 9 – The comparison of the original image and phase 3.

It is clear from Figures 7, 8 and 9 that the proposed method is competitive comparing with the methods in [1-3]. In fact, our proposed method overcame the methods [1] and [2] in the last phase of the red eye experiment, and this can be seen in the two shades (128,0,0) and (255,192,203). Many researchers have been used iterative methods for solving non-Linear expressions [12-107].

4. Conclusion

Color detection plays an important role in the field of image processing and many other fields. A new and effective method for detecting colors for different types of images has been presented in this current work. We provided four examples using a variety of images such as binary, colorful, and physical images. In addition, a comparison using an experiment of red eye reduction was illustrated to confirm the validity of our proposed method. Finally, we showed that our method is competitive method comparing with some popular methods that we listed in the literature.

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