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Shifting Colors to Overcome not Realizing Objects Problem due to Color Vision Deficiency

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***Abstract*— Color vision deficiency is an inability that the person could not realize the differences between some colors. This inability causes person not to read some writings, to see some of signs as in Ishihara Test. In this study to provide them to read that numbers, a method as shifting colors was applied on some Ishihara Plate images. JPEG format images are read and colors are shifted in different ratios in HSV color space. Consequently, color deficient person is able to read the numbers on the plates that the shifting method was applied. Images are tested with 3 different red – green color deficient people and results are declared.**

***Keywords*—Color Blindness, Color Vision Deficiency, Image Processing, Shifting Colors**

I. Introduction

Human eye can detect colors which are made up of mainly three colors red, green and blue. Eye has receptors which provide the detection of color. Some people have inherited problems with these color receptors as they are not working properly or that people do not have some of the receptors. These deformities generate color detection problems which are called as color blindness or color vision deficiency.

There are different types of color vision deficiency. The most widely seen type is red-green color vision impairment. 6 -10 % of men and 0.4 - 0.7 % of women have red-green color vision deficiency [1]. Red – green color vision deficiency belongs to a group called dichromacy. In this type of color blindness two different colors are perceived as similar by the person.

Concisely, most of color blind people have problem that they could not notice the different colors which are used together. It is hard to see and understand the shape on the t-shirt shown in Fig. 1, and it is impossible to see the number in Fig.2 by a red-green color blind person [2].

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Figure 1. Shape on the t-shirt is hardly understood by a red-green color blind person

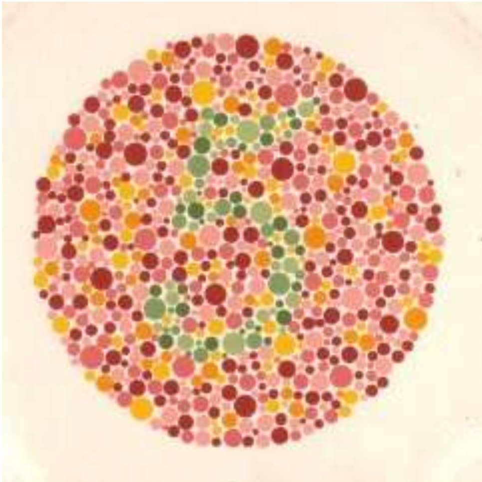


Figure 2. Person with red – green deficiency can not read the number on this Ishihara plate

In this paper, a study introduced which aims color blind people to overcome not realizing objects or scripts with image processing.

II. Literature Survey

There are several studies were made about color vision deficiency and to show the numbers on the Ishihara plate to the people.

Some studies were made about to read that plates by computer program in literature. The image processing technique is used to make segmentation and matching with the numbers [3]. Instead of this, fuzzy classifiers were added to classify the numbers from segmented images [4].

Generally color blind people could not read numbers on Ishihara plate because of two colors that they see similar. It is studied to filter one of these colors in past studies in literature [5]. For an enhancement of visual quality of a person who has red – green deficiency it is made that to filter red shades or green shades in image then the filtered image is shown to the color blind person. It results well for Ishihara test plates but it is said that it is not effective for natural images [5].

On the other hand, some studies were made to recognize the colors like colors of traffic lights, because some color deficient people could have difficulties to realize the traffic lights. Image processing techniques were used like thresholding, filtering to make computer to recognize the traffic lights [6].

Some studies that look similar to this study were declared in literature. It is studied that the images on websites are transformed from red to yellow to make websites view better for people who has red- green color vision deficiency [7]. The difference is making the shifting or transform only on one color type.

III. Method and Algorithm

A. *HSV Color Space*

In this study images are read and they are converted to HSV color space (Hue, Saturation, and Value). It is not desired that the information on the image would be damaged or lost, so the color in each pixel should be shifted with same rate. Hence in this study it is chosen that to use the HSV color space.

In HSV color space all numerical values are between 0 and 1. For an image there are three groups of matrices. Each matrix has the numerical values for Hue, Saturation and Value. For "Value" matrix, if numerical value is 0, that color is black, but as it gets towards to 1, it gets brighter. So the "Value" means brightness. Hue changes the color from red through yellow, green, cyan, blue, magenta and again red. As saturation changes from 0 to 1, colors get fully saturated from unsaturated form. Unsaturated colors are forms of gray. Fully saturated form of color means that color has no white component. HSV color space is shown in Fig. 3 obviously [8].

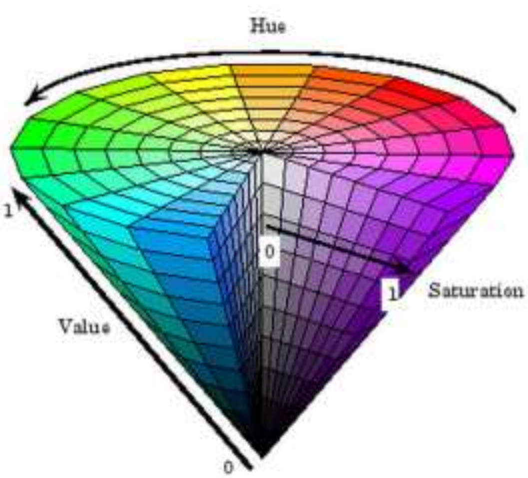


Figure 3. HSV color space – Hue, saturation, value

B. *Shifting Colors*

In this study the aim is to make a color blind person to read scripts or to notice objects which seems to him / her in similar colors. For example a red – green color blind person is not able to read the number which is written on the plate in Fig.2 . That color blind person could not read the number because he/she could not make out the difference between reds and greens. The person sees red and green colors are similar colors. But if the hue values of the whole image are shifted with a fixed rate the colors will be changed and at the same time the information will be preserved.

As a result of this process the number and the plate in the image would be formed with the colors and shades of blue, green and magenta instead of shades of red, green and yellow as seen in Fig.4. After this process the color blind person would notice the number written on the plate easily.

After the same process applied to the image in Fig. 1, the shape of object could be easily noticed by a red – green color blind person. The image with the shifted colors is shown in Fig.5.

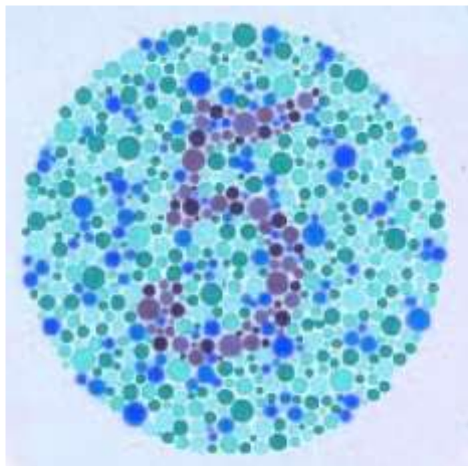


Figure 4. Colors on the plate are shifted with k=0.5. Same image with *Fig.2*

Figure 5. After colors are shifted, star shape could be noticed easily by a red-green color blind person.

C. *Algorithm*

A simple algorithm is used in this study which is shown in Table. I. The “m” value inside the B matrix defines the subgroup as “Hue”, “Saturation” and “Value” matrices. If the m value is “1” the operation will be done on Hue value. If m is 2 and 3, then Saturation and Value will be changed respectively.

TABLE I. Pseudo-Code for shifting colors

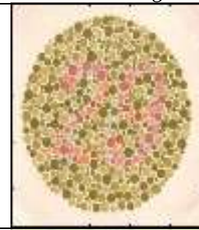
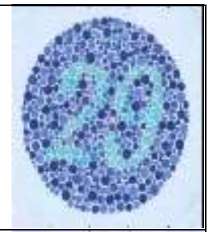
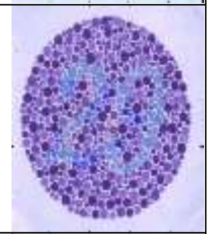
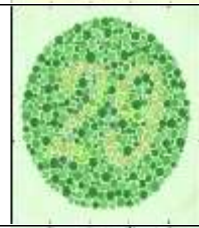
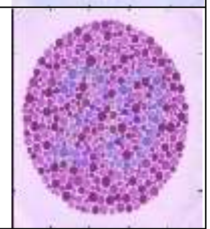
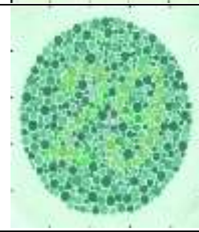
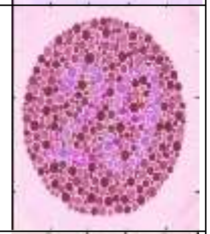
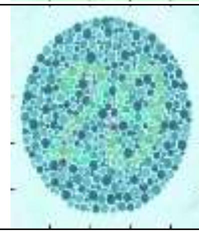
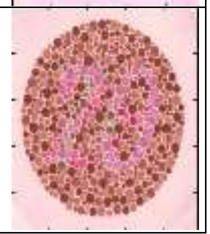
```
//Data collection:
   A=Read  image

//Preprocessing:
   HSV_image=RGB to Gray(A)

//Shifting Colors:
   B= HSV_image
   B(:,:,m)=B(:,:,m)+k;

   if(B_xy>1)
     B_xy=B_xy-1
   end if

//Again Convert to RGB
   RGB_image= Gray to RGB(B)
```

The “k” value in the algorithm defines the shifting ratio of the colors. In HSV color space, all values are between 0 and 1. So after the “k” value added to the whole Hue matrix, also the new Matrix has to be values between 0 and 1. To obtain this result, the elements of the “B” matrix are checked and the ones greater than 1 are determined. To turn to the real Hue value range, 1 is subtracted from these elements.

In this study, some plates from Dr. Shinobu Ishihara’s color blindness test book are used [2]. “k” values are changed from 0.1 to 0.9 with a step of 0.1 and the shifted images are presented in the Table. II.

The “k” ratio would be changed according to the color vision deficiency type. This will be come out after the results and different “k” values are tested with several subjects who has different types of color vision deficiency.

TABLE II. Shifting colors with different ratios

Original Ishihara Plate No. 3		Colors are shifted with k=0.5	
Colors are shifted with k=0.1		Colors are shifted with k=0.6	
Colors are shifted with k=0.2		Colors are shifted with k=0.7	
Colors are shifted with k=0.3		Colors are shifted with k=0.8	
Colors are shifted with k=0.4		Colors are shifted with k=0.9	

IV. Results and Conclusion

In this study whole colors in an image are shifted with a constant ratio. This subject is studied to aim that a person who has color vision deficiency to get ability to notice objects, shapes, scripts, etc. that he/she could not see or read before.

Constant ratio while shifting colors provides that not to cause any information loss that image is having.

The Table II is asked to three people with red – green color deficiency. All three color blind people stated that the shifting with k=0.5 is the clearest one. Also normal people stated that the star shape on the t-shirt is sharper and clearer than the original image. It would be studied that to ask these shifted images to color blinds who has different deficiencies other than red – green, and according to the degrees of clear results a manual could be prepared to apply the shifting ratio for each different type of color blindness.

Figure 6. Colors are shifted in a football match image.

As a future work, it is aimed to use this method in video processing to see or read something with eyeglasses. For a person who has red – green color deficiency it is very hard to watch a football match that the teams have the jerseys with colors red or green. That study could be helpful to them. Also there is an example for that situation which is shown in Fig.6.

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