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Removal of Color Blindness using Threshold and Masking

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Abstract— Color blindness is a color perception problem of human eye to distinguish colors. persons who are suffering from color blindness face many problem in day today life because many information are contained in color representations like traffic light, road signs etc. In this paper we proposed a method that use thresholding to create a red colour mask which when applied on the original image, and further processing provides a satisfactory output image that is distinguishable by color deficient person.

Keywords— Color blindness, Threshold value, mask, LMS color space, color segmentation.

I. INTRODUCTION

Colour blindness is deficiency of colour vision. Due to presence of color blindness, human eye becomes unable to differentiate colors with each other. Generally reason behind colorblindness is genetic but sometimes it happens due to some damage and disorder in brain and eye. Color blindness is of many types like Red-Green, Blue-yellow etc. Red green color blindness is most common type of deficiency in which person is unable to differentiate between red and green colours. Color blindness occurs when there is problem with Retina of eye. Retina is at the back of eye and is sensitive to color and light. There are some photoreceptors on retina which send information of color and light to the brain. These photoreceptors are of two types :- Rods and Cones. Rods are responsible for light and Cones are responsible for color sensing. Cones are again of three types: - L cones, M cones and S cones. L cones sense long wavelength (Red color), M cones sense medium wavelength (Green color), S cones sense short wavelength(Blue color). If there is any problem (Missing or improper functioning) with these cones then color blindness occurs. Color blindness can also come due to heredity. Genes that are responsible for color pigments are carried out by X chromosome so there is more possibility of colorblindness in male rather than female because female has two X-chromosome while male has only one X-chromosome. Since women inherit two X chromosomes, a healthy gene on one X chromosome can override the unhealthy gene on the other.

Types of color blindness

- *Monochromacy*
  If there is no cone or only one type of cone present at retina of eye then it is called Monochromacy. in Monochromacy person is unable to see any color. All things are seems to be black, white and gray.
- *Dichromacy*
  If there are only two types of cones present at retina of eye then it is called Dichromacy. in Dichromacy any one type of cones is missing. So information about that particular wavelength is lost. Dichromacy is again of three types according to missing cone:-
  - *Protanopia*
    If missing cone is L-cone then it is called protanopia. due to protanopia long wavelength color information is lost so the person suffered from protanopia is unable to see red color. This is called 'Red blindness'.
  - *Deuteranopia*
    If missing cones is M-cone then it is called Deuteranopia .due to deuteranopia medium wavelength color information is lost so the person suffered from deuteranopia is unable to see green color. This is called 'Green blindness'.
  - *Tritanopia*
    If missing cones is S-cone then it is called Tritanopia .due to tritanopia short wavelength color information is lost so the person suffered from tritanopia is unable to see blue color. This is called 'Blue blindness'.
- *Anomalous Trichromacy*
  In anomalous trichromacy all three cones are present but one of these cones perceives color slightly out of alignment so perceived image is not as it actual. It is of three types depending upon which cone is working improperly:-
  - *Protanomaly*
    In this type L cones are defective and do not function properly and sensitivity to red hue is lower. This is called 'Red Weakness'.

- *Deuteranomaly*
  In this type M cones are defective and do not function properly and sensitivity to distinguish red and green hue is lower. This is called 'Green Weakness'.
- *Tritanomaly*
  In this type S cones are defective and do not function properly and sensitivity to distinguish blue and yellow hue is lower. This is called 'Blue Weakness'.

- *Red-green color blindness*
  Red-green color blindness is a type of deficiency of color vision where sensing of red and green color is weak. Red-green color blindness term is used for Protanopia, Deuteranopia, Protanomaly and Deuteranomaly.

- *Blue-yellow color blindness*
  Blue-yellow color blindness is a type of deficiency of color vision where sensing of blue and yellow color is weak. Blue-yellow color blindness term is used for Tritanopia, Tritanomaly.

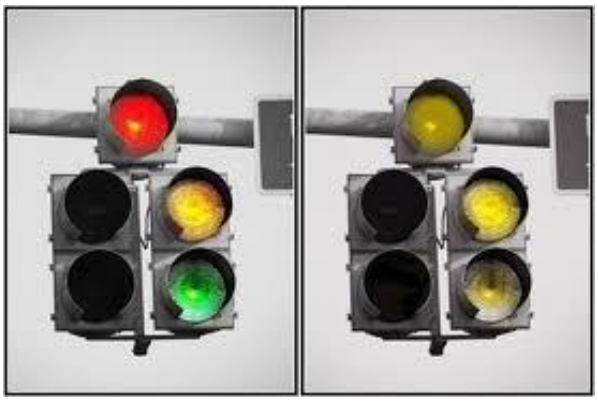

Fig.1 Effect of color blindness

II. PREVIOUS WORK

RGB to HSV conversion

As process starts first web contents are extracted from the websites and then out of these contents some images that are to be transformed are selected and saved. after saving these extracted images are passed through the colour transformation process, by which unrecognized colours are transformed to recognizable colors to the color blind person. This research focuses on the red-green colour vision deficient. transformation process result as red is transformed to yellow and green is transformed to blue and blue is remain same[1]. Green color's range is 120° because its hue value comes between 60° to 180°. Blue color's range is 180° to 300° because its hue value comes between 180° to 300°[3]. GreenRatio = (Hue - 60) / Green Range

RelativeBlue = GreenRatio x BlueRange

Hue value after the transformation process is Hue = 180 + BlueRatio

After transformation hue value is divided by 360° for HSV to RGB conversion

Hue = Hue / 360

Gradient map method

This is an approach that is able to indicate regions that encounter the accessibility problem for colorblind viewers, the regions contain information that may not be well perceived by colorblind This method can be applied in different scenarios, such as checking the accessibility of designed images and to help designers to avoid the accessibility problem by making changes on the image. There are main two steps :-inaccessible point detection and in-accessible region location[5].

Inaccessible points detection:- Inaccessible points are defined as the points around which the patches are not identifiable by color blind people, due to the loss of color information. For this estimation of the information loss as the difference of gradient maps of the original image and its protanopic or deuternopic views is calculated we may obtain several points that are still able to be recognized by colorblind viewers even if there exists significant information loss. Therefore, we also compute the full gradient maps of the colorblind views of the image , which is the sum of the gradient maps of channels, and its inaccessible point detection is accomplished.

Inaccessible region location:- It is the region that covers inaccessible points.

Dalton Method

Colour difference image has been found useful to visually inspect perceived colour difference and additionally to build colour remapping methods. Two colour transformation methods are presented [4]. This research focused on two types of dichromacy (protanopy and deuteranopy).In this some methods are described as Image simulation, color transformation using color difference, color transformation using color difference scaling, color transformation using red/green scaling. LMS space plane is defined as: $\alpha L + \beta M + \gamma S = 0$.The whole process is as:

1)For each pixel do Gamma correction [R, G, B]= [R/255, G/255, B/255]^2.2

2.) Scaling of color coordinates to color gamut using scaling factor=0.992052)

3.) Transformation of RGB to XYZ to LMS:

$$\begin{bmatrix} L \\ M \\ S \end{bmatrix} = \begin{bmatrix} 17.8824 & 43.5161 & 4.11935 \\ 3.45565 & 27.1554 & 3.86714 \\ 0.0299566 & 0.184309 & 1.46709 \end{bmatrix} \times \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

4.) Transformation of 3D LMS space to 2D spaces for protanopes.

$$\begin{bmatrix} L_P \\ M_P \\ S_P \end{bmatrix} = \begin{bmatrix} 0 & 2.02344 & -2.52581 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} L \\ M \\ S \end{bmatrix}$$

for deuteranopes:

$$\begin{bmatrix} L_D \\ M_D \\ S_D \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0.494207 & 0 & 1.24827 \\ 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} L \\ M \\ S \end{bmatrix}$$

5.) Inverse transform LiMiSi to XYZ to RGB, i={P, D}:

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 0.080944 & -0.130504 & 0.116721 \\ -0.0102485 & 0.0540194 & -0.113615 \\ -0.000365294 & -0.00412163 & 0.693513 \end{bmatrix} \times \begin{bmatrix} L_i \\ M_i \\ S_i \end{bmatrix}$$

6.) Inverse gamma correction [R, G, B]= 255*([Ri, G, B]^1/2.2).

III.METHODOLOGY

In this paper we propose a new approach to remove color blindness to make image visible to the color deficient person. This approach has following processes:-

Image simulation

The basic idea is first to find the LMS values of the RGB (red-green-blue) image using some conversion matrix. Then a conversion is made to delete the information associated with the loss of any of the cone type to get the modified LMS values L'M'S'. then reverse transformation is done on the L'M'S' values to get the R'G'B' values. Now R'G'B' values represent that how the specific color RGB is perceived by a color blind person. When this operation is done for all the pixels, the image is converted. This linear transformation can be achieved by a matrix multiplication.

Creating red pixel mask

The main goal of image segmentation is domain independent partitioning of an image into a set of disjoint regions that are visually different, homogeneous and meaningful with respect to some characteristics or computed properties, such as grey level, texture or colour to enable easy image analysis (object identification, classification and processing).

Thresholding

Thresholding based image segmentation aims to partition an input image into pixels of two or more values through comparison of pixel values with the predefined threshold value T individually. Thresholding may be implemented locally or globally. In global thresholding the image is partitioned into two while in local thresholding the image is subdivided into subimages and the threshold for each subimage is derived from the local properties of the pixels.

Modifying image

Now that the mask has been created, a modifying matrix [2] along with this mask is applied on the original image. Modifying matrix (M) is given as

$$\begin{pmatrix} 0 & 0 & 0 \\ 0.85 & 0.1 & 0 \\ 0.85 & 0 & 0.1 \end{pmatrix}$$

This matrix is multiplied with all the pixels of the original image where the mask when applied on the original image has pixel value 1; else the pixel is same as the original image.

IV. EXPERIMENTAL RESULTS

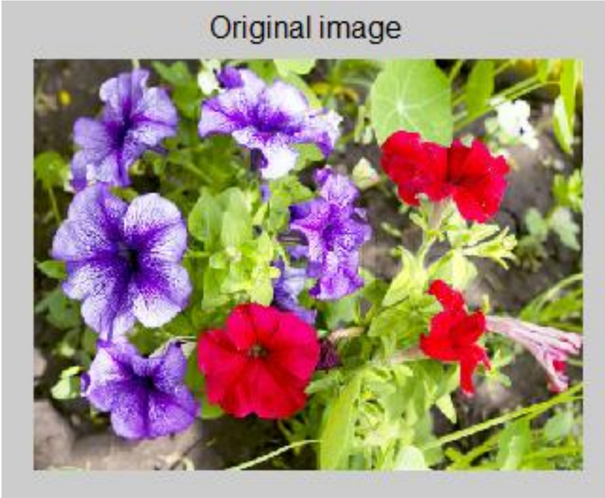

Fig. 2 Image seen by normal vision person

Fig. 3 Image seen by color deficient person

Fig. 4 Modified Image seen by color deficient person

V. CONCLUSION AND FUTURE SCOPE

The result shows that the process is successful in modifying the images for colour blind. The colour confusion between red and green is clearly solved. The process takes very less time to execute and is a very simple procedure. The program modifies images for Deuteranopians; it can be extended for Protanopia and Tritanopia. The program can be improved to modify images with various shades of red, to provide complete error free image.

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