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A SURVEY ON COLOR TRANSFORMATION ALGORITHM FOR COLOR VISION DEFICIENCIES

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Abstract: Hundreds of millions of people have vision problems. Color blindness affects as many as 1 in 12(8%) men and 1 in 200 (0.5%) women. Colour vision deficiency highly affects the daily life of the colour vision deficient people which the normal people cannot understand easily. People affected by the color vision deficiencies cannot visualize the things properly that causes many difficulties for them and performing some visualization based tasks becomes more challenging. People affected by color vision deficiency have much trouble for doing works like performing office work (i.e. web access, presentation work, chart analysis etc), communication, studying, shopping, reading, travelling and their other daily activities. Most common category of the color vision deficiency is red-green vision deficiency. This is happening due to percentage of cone are present in our eyes. In our eyes we have more amounts of cones for red color and green color while for blue color perception there is less percentages of cones. Blue-yellow color vision deficiency is very rare. Color Transformation is a process of changing colors from one color space to another color space. By doing this we can adjust the lost information using another color which can be perceived by the color deficient people. So they can easily can identify the information stayed in the documents and perform their daily routine easily without any difficulties. There are various algorithms are available for the color transformations. They are RGB to HSV algorithm, Color Contrast enhancement, LAB color correction, RGB to LMS algorithm and recoloring algorithm.

Keywords: **Colour vision deficiency, Colour Contrast enhancement, dichromacy, LAB color correction, LMS daltonization, RGB to HSV algorithm.**

I. INTRODUCTION

Color blindness or more specific term will be color vision deficiency is inability of person to identify the certain colors or some shades of mixed colors. Color blindness is first discovered by the John Dalton. He was affected by the deuteranopia (one type of color vision deficiency). He described his own deficiencies in 1794. He instructed that his eyes should be examined after his death. Color vision defects Person's color spectrum is shorter than the normal persons color spectrum. Dalton studies and gives explanation about the confusing line in the color spectrum where color deficient people cannot identity the certain colors. [5]

Human vision system

Color is a powerful descriptor that simplifies object identification and extraction of information from a scene. [5] We can see the colors because of the cells stayed in the retina of our eyes. These cells are known as rods and cones. Cones are mainly responsible for color perception. In our eyes totally 6 to 7 million cones are present (i.e. red (65% cones), green (33% cones) and blue (2% cones) color perception) and each cone is sensitive for some specific wavelength. [2] Mainly three type's cones are presents in the retina and they are L-cones , M-cones and S-cones. L–cones are sensitive to long wavelength (red), M–cones are sensitive to medium wavelength (green) while S–cones are sensitive to short wavelength (blue).

Types of color deficiencies

Due to the cone defects and not functioning of cones causes the various types of color vision deficiencies. Mainly color vision deficiencies or color blindness are divided in two categories. Total color blindness and Partial color blindness.[7] Total color blindness also known as Monochromacy in this type of blindness happens when two or three cones are not working. Person affected by this blindness can see only black, white and gray shades. Partial color blindness includes two types first one is Dichromacy. This type of blindness happens when one cone is not working. Person affected by this blindness can see colors except red/green or blue/yellow. Dichromacy is also divided into the two categories. (1) red-green blindness (deuteranopia, protanopia) and (2) blue-yellow blindness (Tritanopia). The another type of partial blindness is Anomalous trichromacy In this type of blindness happen when the cones are functioning but their sensitivity of perceiving color is slightly affected and person can get identify the certain shades of colors compare to dichromat people.

Causes of color blindness [8]

Mainly cause of color vision deficiency is genetic condition but disease or injury that damages the optic nerve or retina can also cause loss of color recognition. Some diseases that can cause color deficits are: diabetes, glaucoma, macular degeneration, Alzheimer's disease, Parkinson's disease, multiple sclerosis, chronic alcoholism, leukemia, sickle cell anemia.

II. COLOR TRANSFORMATION METHODS

The various color transformation algorithm are available for color vision deficiencies. They are discussed below.

RGB to HSV algorithm[3]

The RGB to HSV is a fast transformation. But is applicable only on the traffic lights only . This algorithm is less accurate for other complex images. The RGB to HSV transformations allow us to adjust image contrast, brightness, hue and saturation individually using formulas.. In addition, color matrix transformations concatenate in a way similar to geometric transformations. RGB to HSV is a nonlinear, but reversible transformation.

Color Contrast enhancement[4]

In this method initial step is to increase the reddish components for those images which are less red have been increased and keep constant the red color for those which are naturally red are kept constant. The green component of each pixel is operated next by applying exactly the same logic as used on the red components. Finally, for the pixels which are mostly red, the value of the blue component is reduced. For pixels that are mostly green, the blue component is increased. Thus an image is taken to enhance the RGB values in order to keep contrast between red and green.

LAB color correction[4]

The original image pixels are transformed from RGB to LAB color space. The first procedure is on each pixel's A component, where a positive A means it is closer to red and negative A means it is closer to green. In each pixel the B component is adjusted relative to how green or red it is in order to bring out blue and yellow hues in the image. Finally, L, the brightness of the pixel, is also adjusted relative to the pixels A value. The image is rehabilitated back to the RGB color space and concatenated to ensure pixel values lie between zero and one.

Daltonization[4]

In this process, the RGB image is first converted into the LMS color space. The operation is a simple linear matrix multiplication operation. The operation, applied to every pixel of the image, produces a new set of pixels whose information is now distinct for the LMS color space. Now that the image presents in the LMS color space, information related with the M cone has been removed and replaced with information observed by L and S cones. Now that the medium wavelength information has been detached from the image and the new M pixel has been filled properly, deuteranopia has been replicated. In order to view the results, the final image is to be converted back to the RGB color space by repeating the matrix multiplication on each LMS pixel.

III. METHODOLOGY

The General Block diagram of the color transformation method is shown below.

Figure 1: General block diagram

In the Image pre-processing the image enhancement is done if required.

In the Feature extraction step different color transformation is applied.

In the post processing color correction and other processes are applied if required.

LMS daltonization method

This method is more efficient than the other color transformation algorithms. It works very well for the complex images too. It uses RGB space - LMS space conversion technique. Using the transformation matrix conversion is done in the algorithm. It is slow transformation because of more matrix multiplication is used in the transformation. So it takes more time to respond but it provides accurate image in the output side. The block diagram of LMS daltonization algorithm is shown in the figure 2.

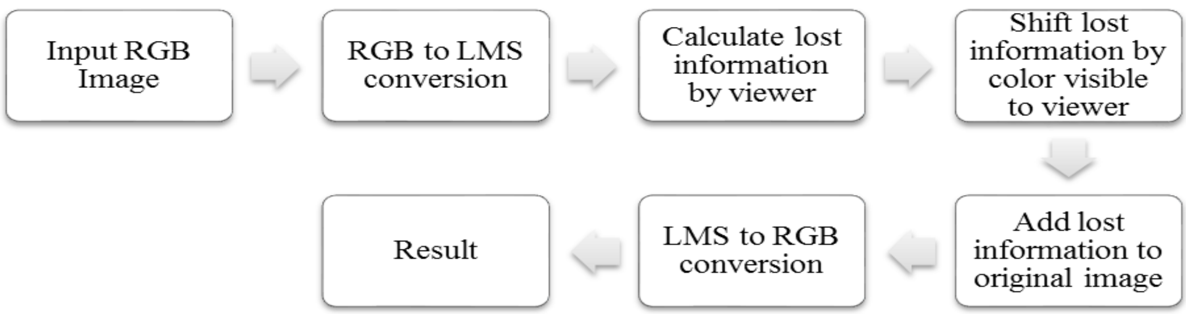

Figure 2: Block diagram of LMS daltonization

The output of the color transformation method is look quite different to the normal vision people. The evaluation parameter for the color transformation method will be Delta E, means, naturalness, processing time etc.

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IV. COMPARISON OF COLOR TRANSFORMATION METHODS

Criteria	Color Contrast Enhancement	LAB color correction	LMS daltonization
Ease of use	This algorithm is easy to use.	This algorithm is quite complex.	This algorithm is easy to compute.
Quality	Good.	Better than color contrast Enhancement	Quality of image is similar to LAB color correction
Accuracy	less accurate	better than color contrast Enhancement	More accurate for complex image..
Efficiency	Moderate	High	High
Limitation	For complex images the result is not as acceptation.	Complex computation	Slow processing speed
Result for Normal user	Output image is significantly changed compare to input image.	Output image is less changed compare to input image.	result is better than color contrast Enhancement.

V. CONCLUSION

The color transformation algorithms have still some limitations like image sizes, accuracy, efficiency some device & platforms and type of deficiency.

Some parameters also affect this algorithms like degree of deficiencies (i.e. strong, week & moderated), Application of algorithm changes, image types, image quality.

These algorithms can be still modified to overcome most of above parameters so the result will be more effective and it can be very useful to the color blindness people.

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