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CON_PCA method to solve the human monochromacy color blindness

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ABSTRACT

Color blindness is an inherited genetic ocular disorder. Acquired or congenital color blindness can become a major cause of problems in everyday life tasks. Contributing to solving the trouble of color blindness is important. Because the problem of color blindness leads to the non-discrimination of data seen by the infected person. Data visualization can contribute to solving the hassle of color blindness. This paper proposed a new technique using data visualization ideas that may contribute to easy data recognition. Our focus has been on monochromacy color blindness. The results are based on the famous Ishihara data sets measuring color blindness. The efficiency of the results was mathematically proven using equations and images via a website to simulate color blindness.

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1. INTRODUCTION

Color blindness is a reduction in the ability to perceive color or variations in color and people with color blindness are unable to distinguish colors. Any images with converging colors or shades are difficult to distinguish [1]–[3]. Information visualization provides an effective and high-quality way to display information visually, mainly to knowledge and interpretation, without difficulty [4]. Information visualization is the study of interactive visual representation of information to enhance human understanding [5], [6]. This approach considerably influences because it helps the visible needs of humans. One of the most to view visualization strategies to view data and illustration is color. Through color, we can display complex data that make it easier for the person to analyze and interpret data [1], [6], [7].

In data visualizations, color is the most powerful element [7], [8]. Color is the reaction to light is the consequence of the brain's interpretation of color through ocular neurological processes. Colors seen by the human eye correspond to the visible region of the spectrum wavelength of 400-700 nanometers [5]. Information can be expressed using colors, as some colors provide guidelines to users, for example, street maps are designed in a way that can be without difficulty understood. The colors of road traffic signs may additionally be incomprehensible to humans with color blindness [9], [10]. Colors are the sensation generated in the brain and are related to measurable phenomena that allow the digital representation of data. The color consists of three primary colors red, green, blue, and different secondary colorings consist of blending specific aspects of the fundamental colors and this model is called red, green, blue (RGB). Color is represented by the computer using many models. Hue, saturation, lightness (HSL), hue, saturation, value (HSV), and RGB are three frequently used color models [9], [11].

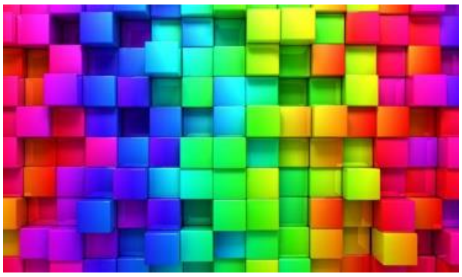
Through this paper, we'll color blindness, and through the technologies provided by the visualization, we'll attempt to solve the indivisibility problem of people with monochromacy color blindness. We'll base on Ishihara testing to see how much data is being processed. We are going to depend on coblis-color blindness simulator for simulating a person with color blindness

2. THE COMPREHENSIVE THEORETICAL BASIS

2.1. Color blindness

Color blindness is decreasing recognition of color differential colors. People with color blindness are unable to understand colors. Images with close colors or shadows are difficult to recognize. Easy tasks like buying fruit, choosing clothes, and analyzing traffic signs become challenging work [2], [3], [5], [8], [12]. Recognizing some objects depends on color variance and luminance. The color variance in pictures with colors may be sharp or dark whenever the distinction is dark it is greater difficult to distinguish a color [13], [14].

Figure 1(a) shows a clear color image for people with normal vision while Figure 1(b) is the color image as seen by a monochromatic colorblind person. We notice that, for example, the information in the picture cannot be distinguished because the colors in the picture are almost the same. The distinctive colors in the first image are similar to the second picture.


(a)

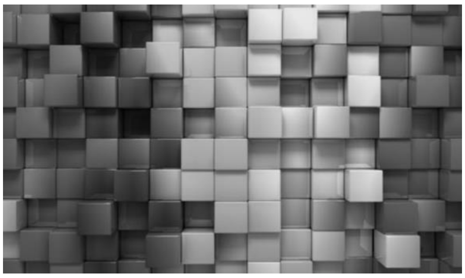

(b)

Figure 1. Color blindness (a) original image and (b) monochromacy

There are two reasons for color blindness. Genetic or accident that causes eye, brain, or nerve damage. The most common is genetic blindness, affecting both eyes, and does not worsen over time. The most common cause of color blindness is a development error in one or more of the three sets of color sensors in the eye. Monochromatism is seen as monospectral vision, it is impossible to distinguish visual characteristics based on color. As a result, the focus of this research is exclusively on monochromatism color blindness [1], [15]–[19].

2.2. Dimension reduction

The dimension reduction is a necessary technique to save the data without losing information. There are many technologies provided by data reduction. The most famous method is principal component analysis (PCA), which depends on deviations of large data to find linear estimates while reserving greater variation in data [20], [21]. PCA, is one of the most widely used techniques for reducing the dimensions of high-resolution images. It is an unattended and multivariate algorithm. It reduces the dimensions by utilizing converting high-resolution data space. It is divided into several principal components that recognize important variables in higher data. To enhance and extract important characteristics [20], [22].

PCA presents a linear method of transmission to low dimensions. It aims to minimize data dimensions by identifying a few linear orthogonal structures for each of the original dimensions [20], [23]. PCA is achieved by analyzing the inherent values of the variance matrix. For many data sets, a few principal coordinates can explain most of the data differences so that the rest of the coordinates can be disregarded with less loss of information [20]. The method is summarized in the following steps: i) calculate centers of original data and subtract them from each value to generate a new area; ii) calculate the variation matrix; and iii) depending on the low target dimensions, PCA computes eigenvectors u1; u2; :::; and eigenvalues λ1; λ2; :::; λd of covariance matrix cov; and iv) calculate the principal component of transport.

3. METHOD

The third kind of coloration blindness is full-color blindness. Although this type is rare, people with this type are not able to see only the colors black, white and grayscale. To maintain data differentiation, the PCA method is used. PCA is a common dimension reduction algorithm, it is a fast approach and preserves as much of the original information as possible [20], [21]. The approach is summarized as follows, and Figure 2 and Figure 3 explain it: i) read the information (choose where to display the picture); ii) concentration of image, we increase the concentration of image colors based on:

$$Ai = IMi * Ri \tag{1}$$

IM denotes the image to be processed, but the R-value is 2 2 2. Because the blinded person sees the colors at the grey level. save the result in value im_con; iii) converts the original data (the picture we choose to display) to the HSV color space to get a greater accurate result. The saturation of the components s is increased, while the value of the components v is decreased; iv) convert to rgb color space, return the result to rgb color space and save the result in value im_rgb; v) integrating the results, to achieve high accuracy while preserving the greatest amount of data possible. we combine the output of the first step im_con in three dimensions with the output of the second step im_rgb to create a single variable, that is, we layer the output of the previous step with the layers of the first step to produce an output of size n*m*6 since each variable is n*m*3 in size; vi) image data analysis, the previous result was a matrix of data the size of n*m*6. To get all the information in the output we analyze the output. This is done by storing each point of data that is 6 dimensions in a data matrix while saving the location of this data. Since we will save only different points of data and to ensure that the information is not lost, we will save their positions in the matrix of locations that are n*m sized and equal to the size of the original image. we analyze to get as much information as possible. this phase will build a k*6 color matrix and an n*m color location matrix [7]; vii) apply pca dimension reduction: use pca to decrease the color matrix's dimensions to one layer without losing information; viii) reposition colors: using a color location matrix, each location in the picture is returned to the color matching the result of the previous stage; and ix) display the result.

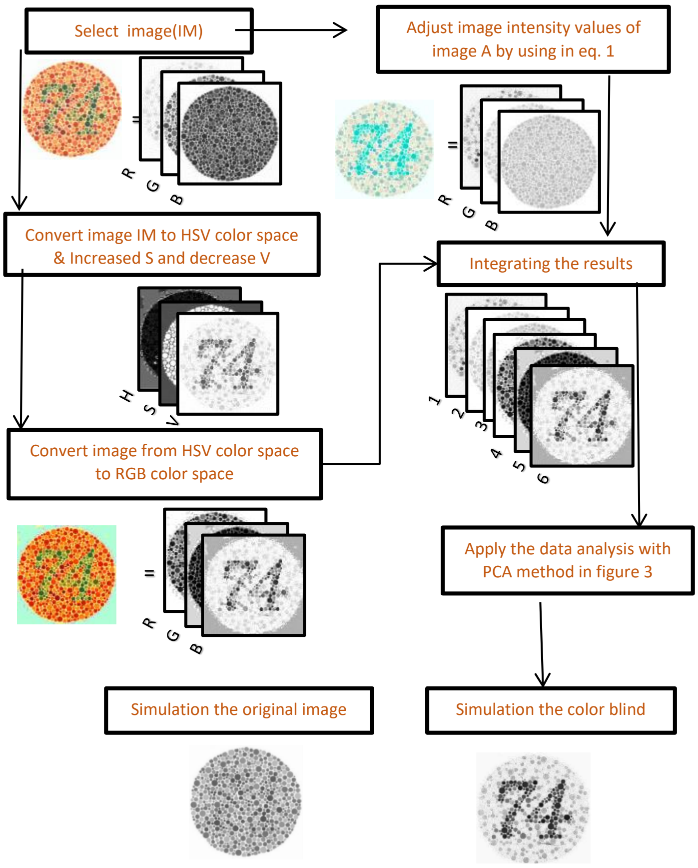


Figure 2. CON_PCA method to solve the macharomancy color blindness

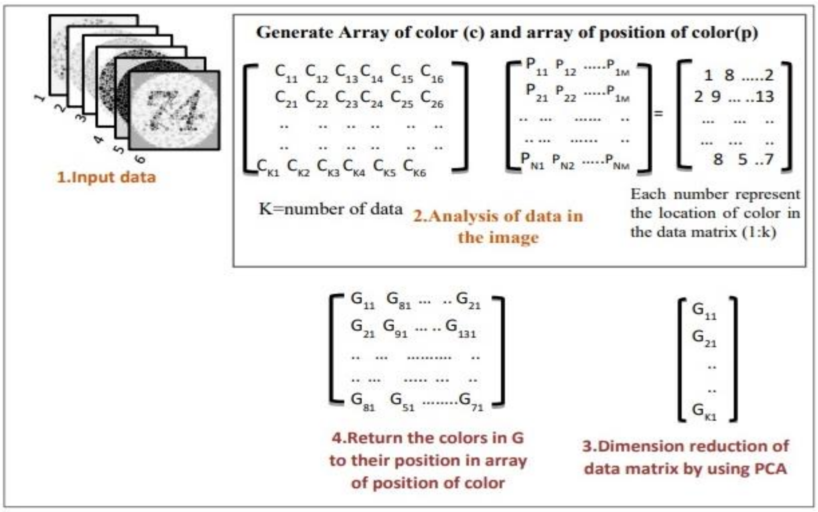


Figure 3. The data analysis and apply PCA method

4. DISCUSSING AND RESULTS

Ishihara's 38 image data sets are used to evaluate the proposed methods. The Ishihara data sets include standard visuals for testing color blindness. The test consists of several color images, each containing a group of colored circles of various sizes and colors. These circles make up a number or object that persons with normal vision must be able to see. Color-blind persons are unable to perceive particular numbers and objects depending on the type of color blindness. The color blindness simulation system was created to represent a monochromacy color blindness disease.

Table 1 (in Appendix) represents the results of data processing in the proposed technique of simulating monochromatic color blindness on the Ishihara data set. The first column represents the sequence of data, the second column represents the original data, the third column is a simulation of color blindness or monochromacy for the original data, and the fourth column is a simulation of color blindness after data processing. Through the third and fourth columns, the data in the third column are unclear and we can't distinguish the numbers. Although a person with this type of color blindness cannot see the colors, it only sees the color white and black, and grey gradients. In this case, the injured person loses the necessary data he needs in everyday life. In applying the proposed method, we note that the figures are seen to the infected persons. The figures are clear and no distortion in the data.

The essential information is not lost. For example, in sequence 4, the plate contains the number 15 when this plate is observed for a person with total color blindness, it cannot distinguish the number 15 as proven in column 3, whereas in data processing the number is clear and the person with damage can easily discern it. Another example is sequence 7, which contains the number 45 before the image is processed. We can't discern the number, while after the processing we can determine the number, that is, by applying the proposed method, we can preserve as much information in the image as possible, even if the data will become colorless, the infected humans can see without problems distinguish the organisms within the data.

To identify the efficiency of the proposed method of solving color blindness of persons with complete blindness. The resulting image is grey with a single color channel, in which case the number of colorings is 255. Because as many colors as possible in the channel are 255. We compare the percentage between the number of colors in the resulting image and 255 with the percentage between the image before processing and 255 as in the following (2):

$$\text{Percent of color} = \frac{number\ of\ color\ in\ image1}{255} * 100\% \tag{2}$$

where image 1 in (2) denotes the final image after applying the suggested approaches to color blindness, or the image after simulating the original image with color blindness. If the percentage of the image that was processed is more than the percentage of the image before processing, the resultant processing image is better, and a person with color blindness can distinguish the information clearly. The data is important if the percentage is close to one. Table 2 represents the result of Ishihara's data set after applying (2). The first column is the sequence of panels (experiment number) and the second column represents the percentages of the proposed method and the third column is the percentages of the original data before processing.

When observing Figure 4, the results of the proposed technique for color analysis are better than the results of the original data sets. Although the results are grey because the individual with this type of color blindness does no longer see colors, the percentages of the facts are close to 1 and the reason is that the percentage was calculated based on (5). We divided the number of colors by 255. The suggested technique is able to maintain the information and show all information to the people with color blindness.

Whereas the study investigates how to extract the character information of a road sign and efficiently transmit it to the visually impaired via a character recognition system for visually impaired humans and included in the implementation process of a voice guidance application, so they can understand better but not show the other data in the road [24], and the other study was performed to enhance a color recognizer for visually disabled people. The color recognizer used the color sensor to identify the color, and a microcontroller to understand the color and notify the person using a speech generator and speaker. This study defined the colors and cannot show the all information to the people who are color blind thus they cannot identify the images or objects surrounding them [25].

Table 2. The percentage results of the proposed method when color blindness is monochromacy type

Number of experiments	Mean the process	Mean the no process	Number of experiments	Mean the process	Mean the no process
1	0.980392	0.721569	20	0.960784	0.843137
2	0.956863	0.815686	21	0.964706	0.85098
3	0.980392	0.807843	22	0.988235	0.929412
4	0.984314	0.847059	23	0.968627	0.937255
5	0.94902	0.831373	24	0.976471	0.917647
6	0.992157	0.72549	25	0.976471	0.937255
7	0.972549	0.709804	26	0.992157	0.929412
8	0.988235	0.737255	27	0.980392	0.94902
9	0.988235	0.745098	28	0.976471	0.85098
10	0.984314	0.686275	29	0.984314	0.85098
11	0.984314	0.705882	30	0.984314	0.760784
12	0.988235	0.737255	31	0.992157	0.733333
13	0.988235	0.72549	32	0.988235	0.701961
14	0.945098	0.780392	33	0.988235	0.709804
15	0.976471	0.780392	34	1	0.72549
16	0.996078	0.768627	35	0.980392	0.717647
17	0.980392	0.764706	36	0.960784	0.827451
18	0.972549	0.854902	37	0.972549	0.819608
19	0.956863	0.854902	38	0.992157	0.670588

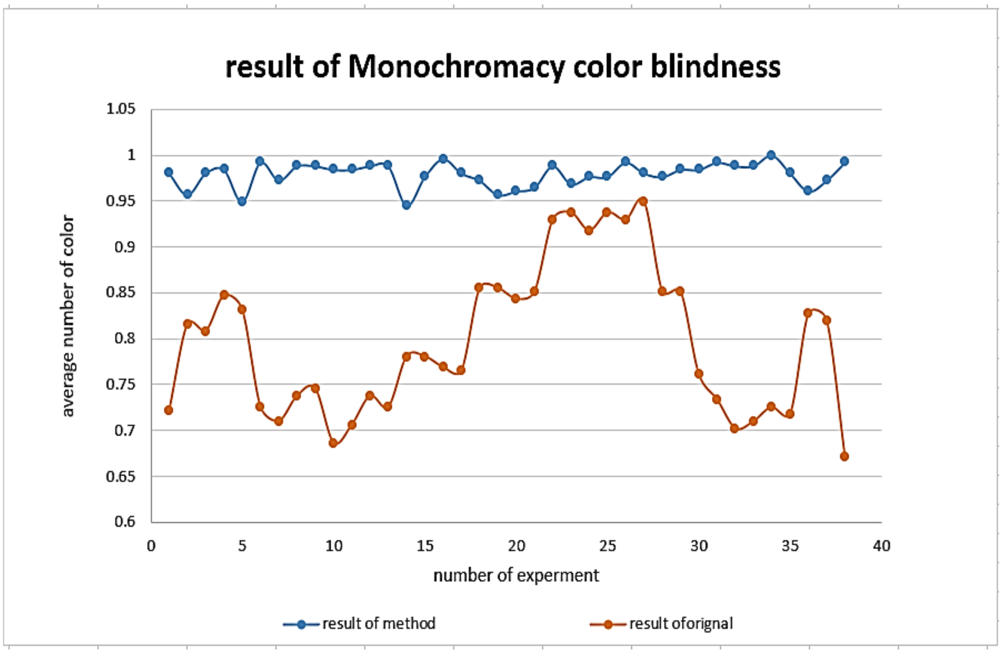


Figure 4. Percentage results of Ishihara images when processing monochromacy color blindness. Blue curve represents percentage results when applying the proposed method and red curve, percentage results before data processing (for original data)

5. CONCLUSION

If a person does not have difficulty distinguishing colors, he cannot imagine what color blindness would affect his vision. We present data imaging-based approaches for enhancing the vision of persons with monochromacy color blindness in this study. The suggested technique was able to clarify the missing objects, discriminate between them, and maintain the information, and they achieved success and proved the efficacy of the proposed method through the results of experiments. They can be developed the technique to solve the other type of color blindness.

APPENDIX

Table 1. The results of the method's application color analysis to distinguish it for people with total colour-blindness

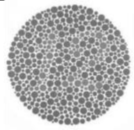
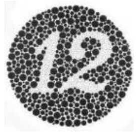
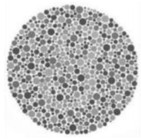
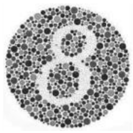
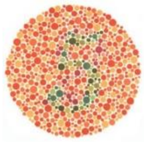
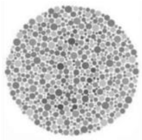
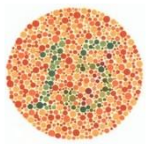
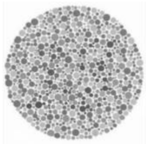
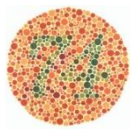
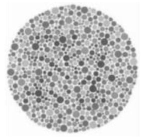
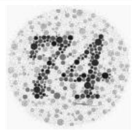
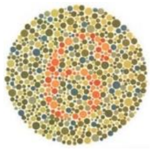
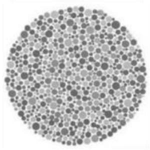
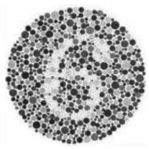
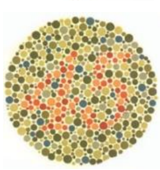
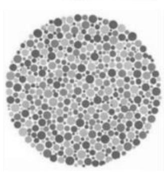
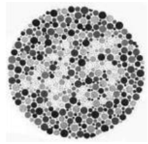
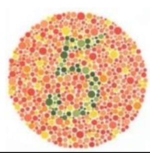
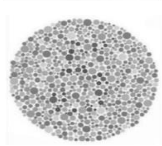
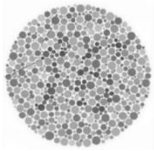
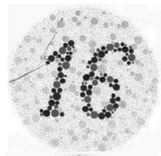
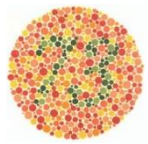
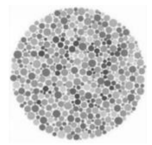
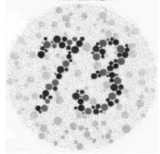
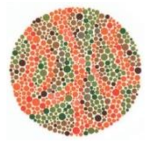
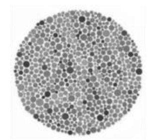
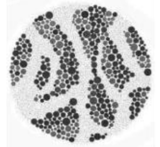
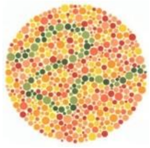
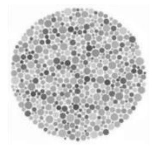
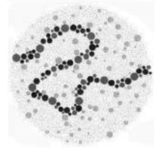
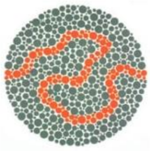
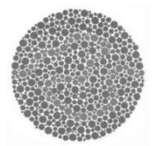
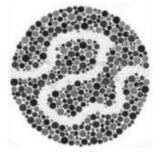
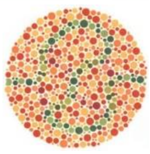
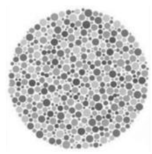
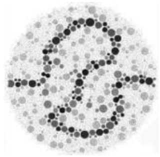
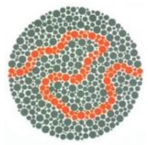
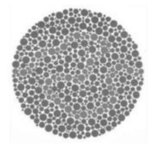
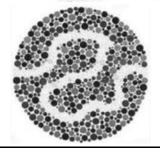
Number of tests	Original image	Colorblind of original data in (monochromacy) color blind	Result of the proposed method to solve (monochromacy) color blind
1			
2			
3			
4			
5			
6			
7			
8			

Table 1. The results of the method's application color analysis to distinguish it for people with total colour-blindness (continue)

Number of tests	Original image	Colorblind of original data in (monochromacy) color blind	Result of the proposed method to solve (monochromacy) color blind
9			
10			
11			
12			
13			
14			
15			

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