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Implementation of a Chromatic Recognition Model for a Scenographical Representation with Different Shades and Color Intensities for Color Blindness Actors

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Abstract. At present some individuals are born with different capacities, some of these capacities are the perception of colors (color blindness); However, technology has advanced in medical matters, which recently through Artificial Intelligence (AI) techniques such capabilities can be improved and allow an adaptation of such individuals to participate in events where the perception of colors under certain lighting is essential, such is the case of the scenography in theaters and forums. In this research, a color labeling algorithm is applied in scenarios presented in theaters, said algorithm was proposed by Montes et al in 2019 [1], in this article methodologies of Genetic Algorithms (GA), Artificial Neural Networks are proposed (ANN), Particle Swarm Optimization (PSO) and Genetic Programming (GP); however, the GP methodology turns out to have better results compared to the others. That is why through this a color labeling is carried out in different scenarios where both actors with color blindness are presented, and in this way the lighting and color identification is not a limitation in the participation in said events.

Keywords: Color blindness, scenography, color labeling, color recognition.

1 Introduction

Throughout history, one of the senses that has had the greatest impact and relevance on human development has been vision, which is associated with the organs that enable it, called the eyes. This is responsible for seeing and knowing the size, shape, color, and location of everything around us, thus capturing images of our environment. To take care of our eyes we must read in good natural light, avoid being in front of the computer, television, or electronic device for a long time. One of the main alterations in our eyesight is color blindness, a condition in which we cannot see colors normally. It is also known as color deficiency.

According to the National Eye Institute, 8% of men and 0.5% of women worldwide suffer from some degree of color blindness. One of the main characteristics of color blindness is when a person cannot distinguish between certain color [2]. For example, they often do not distinguish between green and red, and sometimes blue.

There are two types of cells in the retina that detect light. These cells are called rods and cones. The rods only detect light and dark and are very sensitive to low levels of light. The cones detect colors and are concentrated near the center of vision. There are three types of cones: some detect red, some detect green, and some detect blue. The brain uses the information sent by the cones to determine the color we perceive [2]

Color blindness can occur when one or more types of cones are absent, do not function, or detect a different color than normal. Severe color blindness occurs when all three types of cones are absent. Mild color blindness occurs when all three types of cones are present, but one type does not function well. It detects a different color than normal [2].

There are varying degrees of color blindness. Some people with mild color-vision deficiencies detect color normally in good light but have difficulty in dim light. Others cannot distinguish certain colors in any type of light. The most severe form of color blindness, in which everything is seen in different shades of gray, is rare. Color blindness usually affects both eyes equally and remains stable throughout life [2].

In some cases, color blindness appears as a congenital problem, but in other cases it can appear at some other stage of life. A change in the way the colors look can indicate the presence of a serious problem related to the condition [2].

2 Motivation

This work arises from the need that people with color blindness have to visualize colors in social recreation centers. In addition to helping them to have a better development in a work environment, this through the implementation of technologies that have been developed over the years such as color recognition models, also the effective lighting scale. It comes in turn with the sense of humanity in which we all have the same development opportunities, and in a romanticized way an environment given the characteristics of any human being, as one very similar and preferably the visualization of it.

3 State of the Art

Over the time, the problem about people who are found with some type of visual problem, even more specifically, in the detection and how to determinate colors, has led to the technology and implementation of systems applying the same system makes it greater today [3].

Firstly, making a hierarchical relevancy which is part of the application is way ends in the most relevant ass significative in terms of technology and in the opposite way ends in the most relevant according to the same applied in some type of analysis or research, it has been obtained that, after defining in a concrete way what color blindness is and how it influences the lives of those who present it, we decided to take place in the investigations and analysis to provide a better experience in the aforementioned individuals. So it is in the analysis of how the detection of the range of colors that is usually presented outdoors works, and later in the interiors of places, it has been suggested to the understand this trough variations in the color of objects in the images with daylight and surface reflectance models. In addition, the realization of the same it's been proposed through the relation of two approaches where both propose recognition of color, in which the first develops models based on the context of daylight illumination and hybrid surface reflectance, also predicts the color of objects based on the context of the scene. Other hand, the second method shows that the color of the objects can be non-parametric ¨learned¨ through classification methods such as neural networks and multivariable decision trees [4].

At the same time, the implementation of algorithms that have been integrated for the identification of patters developed to date are suitable for very specific cases, however, these end up somehow without covering all this existing field, since they are based on background substation to identify an output image. As an example, members of the ¨University of Engineering and Management ¨ have proposed as a method an algorithm that satisfies this, so in respect to the existing ones. In this, the main image (front)is implemented as a complement to the image subtracted from the background, in addition it creates an image with a relatively minimal loss of details [4].

In the same way, the implementation of course, it has been successful within the subject, has been applied in eastern countries, as it is in the case of japan, where the concern of inhabitants reside in an equitable environment where all you have to do is promote the infrastructure application culture as support is incredible [3].

In addition, laboratory studies to measure the visibility of lines under 100 and 1000 lx lighting conditions, information has been provided to reach an essential benchmark for the visually impaired when walking. The visibility of this it has been tested and its exact behavior that is based on the contrast of lines and backgrounds, in chromatic and achromatic color combinations. A total of 43 colors have been used to define target lines, and three achromatic colors for the backgrounds, therefore, a total of 129 color combinations were used. This is how the data from this experiment can aid in the design of walk lines on pavement surfaces, which can provide directions, warnings, and other helpful guidance to visually impaired. In recent years, improvements have been made to the living environments of the elderly and the disabled in countries around the world, along with developments that even become legal to facilitate independence in their daily and social lives [4].

In today's daily life we do not find directly related to technological equipment, the interaction with these equipment's is usually in the most cases of a single type called ¨interface¨ this interface does not allow interacting and managing the equipment. As well as performing the various tasks that it offers us, the interface being mostly visual represents a problem for people who suffer from an eye condition such as color blindness, since there is this problem; investigations have been given by a solution or have helped improve the user experience [3].

So is the case of research carried out by the ¨National Chung Cheng University¨, which proposes a re coloration algorithm based on the eigenvector processing for a robust color separation under the transformation of the deficiency [3].

This re coloration is performed by means of proposed technique called ¨color deformation¨ (CW), this technique uses the orientation of the results of a simulation of color vision deficiency to deform the color distribution. In general terms, this technique performs a transformation of images in an RGB color space to a λ, Y-B, R-G based on the CIECAM02 model [5].

These algorithms can be completed with analysis of vision patterns, so as is known, humans tend to fix some specific points and regions in the images perceived during the first seconds of observation, these points and regions summarize the most important and significant parts of the observed scene. The ¨Istituto di Astrofisica Spaziale e Fisica Cosmica di Palermo¨ carried out studies on the differences in behavior of the human visual system, these studies are carried out by means of humans with normal vision and with color deficiency, in these tests the fixations will be traced. In the first 3 seconds of observation of color images for construction of fixation point maps, through these real fixation maps they performed an analysis of the differences between people with and without color vision [6].

This research resulted in a method to enhance the color regions of the image using a detailed color map of the segmented salient regions of the given image.

4 Genetic Programming (GP)

Genetic Algorithms (GA) are adaptive methods, generally these are used in parameter search and optimization problems, these are based on sexual reproduction and on the schemes proposed by Darwin on natural selection, specifically following the definition given by Goldberg. GA are search algorithms based on the mechanics of natural selection and natural genetics. They combine the survival of the fittest among sequence structures with structured albeit randomized, exchange of information, to constitute a search algorithm that has some of the genius of human searches [7].

In these types of algorithms, we start form an initial set of individuals, which are called population (this population is generated randomly). Each of these individuals symbolizes a possible solution to the problem posed, these individuals evolve based on Darwin's theory of natural selection, and adapt to a greater extent after the passage of each generation, this in order to get closer to solution required [7].

One of the variants or evolutions of genetic algorithms is Genetic Programing (GP), in which it preserves the same principle of genetic algorithms, genetic programming as genetic algorithms seek the solution to a problem, GP begins with thousands of programs randomly created computer models, which apply the Darwinian principle of natural selection, recombination (crossover), mutation, gene duplication, gene deletion and certain mechanisms of developmental biology. Therebefore, it generates an improved population over many generations [7].

The biological function of genetic programming is the same as that of genetic algorithms. For this reason, the operation is similar. The difference between one technique and another consists in the way of coding problems, which allows its use in series of environments where previously genetic algorithms could not be applied [7].

The origins of GP officially date back to 1992 after the appearance of the book entitled ¨ Genetic Programming¨ written by John Koza, where the term was coined and the formal foundations of this technique were laid, although there are previous works that without explicitly using the name of genetic programming can be considered as precursors of the matter [7].

5 Methodology

The representation of the color space for digital images, which come from a digital camera, is represented in the $\mathbb{R}^3$ space, where each color is represented by the triple (r, g, b) in RGB space. Sometimes AI techniques are used to separate a specific color [1].

An alternative for color classification is through the projection of the vector of a color in the subspace RG, GB and BR, in order to reduce the number of parameters for the optimization of six coefficients that satisfy the restrictions (1),(2) and (3), these are still related to the RGB native space [1]:

$$r \leq \alpha_1 g + \beta_1 \,, \tag{1}$$

$$g \leq \alpha_2 b + \beta_2 \,, \tag{2}$$

$$\gamma_1 \leq r \leq \gamma_2 \,. \tag{3}$$

In the article by Montes et al., of 2019, the inequalities generated by the GP for the color red are obtained, these restrictions are shown in (4, 5, 6), other colors generate a similar structure with this methodology [1]:

$$\frac{16}{sin(g)} - 6 \leq sin^2(g) + \frac{6}{b\,sin(b)}, \tag{4}$$

$$\frac{\cos(g)}{gr} - \frac{3}{\sin(g)} \leq \sin(g) - \sin(b) - \cos(g) + r^2 - 6\,, \tag{5}$$

$$b - 9g\sin(g) - 5 \leq 7\sin(r) - \frac{9g}{2b}. \tag{6}$$

The generated equations obtain similar efficiency results compared with human proposed equations, but the variations of luminosity can be supported by the algorithm, with the generation of new equations adapted to support light variation, and all these generated structures are highly parallelizable because r, g, and b are arrays with all the pixels of the image, obtaining one thread per pixel [1].

The labeling of the images was carried out using the algorithm proposed by Montes et al of 2019, using the results obtained by the GP and training for different illumination

Table 1. Symbols of ColorADD™ in for the real-time labeling assistant here proposed [2].

Symbol						
Color	Red	Orange	Yellow	Green	Blue	Purple

Fig. 1. Original Image 1.

Fig. 2. Image 1 as seen by color blindness.

Fig. 3. Image 1 labeled by symbols ColorAdd™.

Fig. 4. Image 1 labeled by color name.

Fig. 5. Original Image 2.

Fig. 6. Image 2 as seen by color blindness.

of the scenarios, with a population size of 400, a tournament size of 20 , a mutation probability of 0.275 and 1000 generations [1].

Some special symbols used to label the colors are shown in table 1, these codes were proposed by ColorAdd™ and can identify different colors and their luminosity, but despite these possible solutions, there is no definitive recognition [2].

Fig. 7. Image 2 labeled by symbols ColorAdd™.

Fig. 8. Image 2 labeled by color name.

6 Results

The processed images have a resolution of 960×720 and are in jpg format, some of these images are shown in Figures 1 and 5. In Figures 2 and 6 show the images as seen by a color blind. In Figures 3 and 7 it is shown in labeling by the symbols ColorAdd™ and in Figures 4 and 8 they are shown labeled by means of the name of the color.

7 Conclusion

In recent years, advances in AI allow the development of different products to identify and classify colors in people with color blindness. Although there is currently no cure, there has been a great advance in technology through AI techniques, so that people with such condition adapt and participate in cultural and recreational activities, such as works presented on stage sets.

In this research, the GP was used to carry out the labeling of colors for people with color blindness. These applications help users to identify colors in cultural activities where lighting and color are involved.

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