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Colorblindness and Your Career Dreams: Development of an Assistive Technology for Individual with Color Vision Deficiency using Daltonization Algorithm

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***Abstract*:**
A website, especially a government website, is a universal address where every citizen is entitled to information access and retrieval. Environment for information retrieval such as government e-services caters to a wide range of audiences that could be of great value for everyone accessing it. However, while e-services became very used for every individual, there are still barriers to information for persons with a disability, although it is mandatory to have equal access [1]. Equality to information access is supported by the standards of Web Content Accessibility Guidelines (WCAG) 2.0 with the help of W3C organization disseminating information that covers recommendations for making the web content more accessible for PWDs. This study aims to present the processes of creating assistive technology for Philippine government websites specifically for users with color vision deficiency to help these individuals richly access e-services of the Philippine government. This paper also presents essential issues that persons with CVD are dealing with how it could affect in choosing and pursuing their dream career. The assistive technology was developed using JavaScript presented in the form of a plugin with applied daltonization algorithm to determine different types of colorblindness [2]. It gives a real-time assessment of the user's visual status in terms of colorblindness by adjusting the color of the website automatically. This paper concludes by suggesting the use of the developed assistive technology, given that the Philippine government can extend help to color deficient people while letting everyone use its website with special assistance.

Index Terms— assistive technology, cvd, daltonization, e-services, government website, PWD, WCAG 2.0

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I. INTRODUCTION

The sector for communication and information technology is continuously made an effort to elevate the government services to be transparent and accountable by providing information and engaging its constituents through electronic and web-based interactions [3].

As the world moves towards an information society, web interfaces of web transactional e-services must be accessible by system users whether disabled or not; therefore, they must be complied with the standards of WCAG 2.0 [1].

In relation to this, the Philippine government, through the Department of Information and Communications Technology (DICT), issued a memorandum circular no. 2017-004 stating that all Philippine government websites should be prescribed to the WCAG 2.0 standards [4].

One of the most common disability is visual impairment. An estimated 8% of men and 0.4% of women are afflicted with color vision deficiency, which is roughly about 200 million in the world statistics. Information percieved by color deficient people can be less meaningful brought about the seized color of this deficiency. [5]

This paper aims to present the processes used in the development of assistive technology for people with color vision deficiency as well to present important issues that color deficient people are dealing with in terms of the career they want to pursue or have.

II. LITERATURE REVIEW

According to the Magna Carta for Disabled Persons, still, they are part of the Phillippine society and should have an equal opportunity for employment [6].

However, because of the challenges faced by persons with disabilities, these individuals deprived privileges to employment and education. Almost three times the population of PWDs are unemployed, and yet 75% of them still wants to have a job [7].

Furthermore, colorblindness as visual disability is considered as the least type of visual impairment but there are much bigger issues that rely on it. It is the job or career the requires normal color vision.

Color deficient individuals are affected in choosing their career, and some of them have been terminated from their current occupation.One of the color deficient job difficulty is the traffic signaling lights for drivers upon recognizing the correct signal lights. [8]

In addition, people with color vision deficiency in the field of medicine are also having trouble with data being recorded that these individuals are having a hard time identifying the redness of inflammation and fresh blood in the body product [9].

More so, colorblindness can cause a critical accident if it works in the area of defense. Military officials usually handle explosives and added additional thoughts that could happen in the workplace having colorblindness [10].

Some workers hide their condition from employers and clients. A freelance commercial illustrator hides his severe condition and lets the family check his works [11].

Likewise, aspiring aircraft man can still pursue a dream career in aviation but is limited by not allowing to fly a commercial aircraft and is to fly on day time only, giving them lesser pay than the usual salary of commercial aircraft pilots [12].

Given the issues the CVD people are dealing with, helping them in accessing the website of such government agencies can be a big help to them.

Therefore, the development of Web-based applications is recommended most impotantly for color challenged individuals to adapt the color converting scheme which could be accessible in two color mode- for color blind and for normal vision [13].

III. METHODOLOGY

The following discussions are the tools and methods applied to meet the objectives stated.

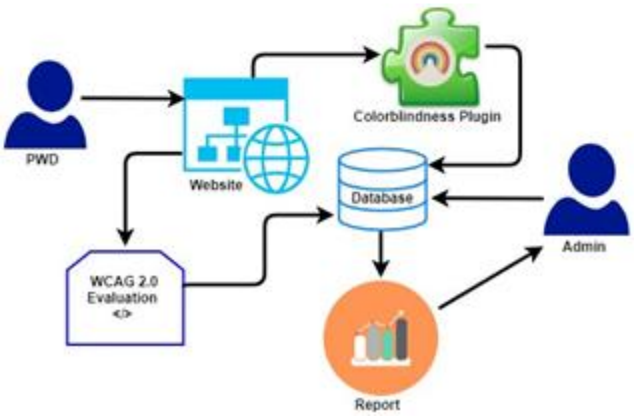

Figure 1 System Architecture for the Colorblind Assistive Technology

Figure 1 depicts the system architecture of the assistive technology. It shows how the users interact with the system allowing them to identify the processes before the system gives them the intended results.

Figure 2. Input-Process-Output Model used in the development of the assistive technology

Figure 2 shows the requirements in the development of assistive technology. For *Input phase*, the requirements are
(1) data requirements which consist of the users information, colorblindness test, accessed government websites and daltonizaton algorithm for color adjustment,
(2)people requirements are the users who will access and test the system from Department of Information and Communiations Technology, the arm the Philippine government that were tasked with handling computer technology, ophthalmologist, members of the academe, students, and PWDs, (3) *software requirements* are the applications used in system development like PostgreSQL for database, web application tools like CSS-HTML-JS, google chrome for accessing the plugin and Windows for operating system.

For *the process phase*, collected input requirements initiated the process of the development. The software methodology used is the Unified Process Model with iteration. Series of testing and evaluation have done by the respondents, PWDs, and DICT personnel after the software Gamma Correction – In Image Processing, gamma correction is a non-linear pixel value transformation which brings the value of every pixel between 0 and 1. Generally, different color spaces have different ranges for the pixel value, but with gamma correction, any such discrepancies can be overcome. In our case, the gamma correction is used as follows – (value/255)
^ 2.2

1. The second step is converting the RGB values to LMS values – i.e. changing the color space. This is a simple matrix transformation.

$$[\square] = \begin{bmatrix} 17.8824 & 43.5161 & 4.11935 \\ 3.45565 & 27.1554 & 3.86714 \\ 0.0299566 & 0.184309 & 1.46709 \end{bmatrix} \times [\square]$$

2. Now, we have the LMS values of every pixel in the image hence, we can now calculate the amount of information that is lost due to any of the missing cones.

development.

Inverse matrix transformation for LMS to RGB values. Now once we have our final LMS values,

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we can change the color space back to the RGB space so that we can render the image on the screen.

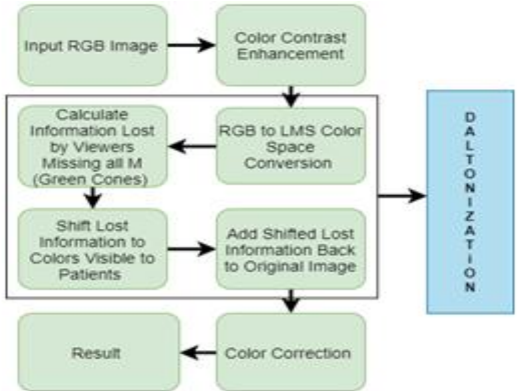

Figure 3. Daltonization Algorithm Process

Figure 3 shows the detailed processes/steps of how daltonization algorithm works.

3. Inverse Gamma Correction – Now is the time to change the range of pixel values from [0,1] to [0,255].
4.

IV. RESULTS AND DISCUSSION

Based on the tools and algorithm used, the following figures are the gathered results of the system. Some of the text content of the presented figures can be unreadable because authors prefer to show the tested results at the background of a selected sample Philippine government website.

Figure 4. Sign up form for logging into the colorblindness assistive technology.

In figure 4, once the plugin detects that the user accesses a Philippine government website, the sign-up form will be displayed. This is to get the demographics of the Philippines' government e-services users.

Figure 5. Sign in form for the new user of colorblindness assistive technology

As shown in figure 5, displayed is the sign-in form letting the users log into the system using the credentials made from the sign-up or registration process.

Figure 6. Plugin for Colorblindness test

As shown in figure 6, the assistive technology requests for the user to choose which row has the least visible letter. Coming from the selected row enables the assistive technology to change or adjust the color setting of a website according to the result of the colorblindness test.

Figure 7. Adjustment of the assistive technology for deuteranomaly colorblind users.

Shown in figure 7 is the adjustment made by the assistive technology for a user who positively

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has a tritanomaly type of colorblindness. It indicates that this is the view or website look of a Deuteronomic type of colorblind users while accessing the website. Deuteranopia or red-green color blindness is the most common type of cvd.

Figure 8. Adjustment of the assistive technology for protanomaly colorblind users.

Figure 8 shows the color adjustment for protanomaly type of colorblind. Protanopia or blue-yellow colorblindness is the second most common.

Figure 9. Adjustment of the assistive technology for Tritanomaly colorblind users.

Figure 9 shows the color adjustment for tritanopic type of colorblind. Tritanopia is a type of cvd where a person inflicted in the situation cannot distinguish between blue and yellow colors.

V. CONCLUSION

Based on the results gathered, it is therefore concluded that using daltonization algorithm, the normal color of a webpage for people with normal vision can be changed into the view of a colorblind people according to their type of colorblindness helping them improve their color visibility. In addition, through the developed assistive technology, users of the Philippine government website can now have the chance to access it with a touch of focusing to one's disability. They are now able to recognize the color that their naked eye failed to detect hence minimizing their difficulty in accessing the online government platforms.

VI. RECOMMENDATIONS

We can help other people in many ways, especially for the needy ones. Authors recommend the following for future researchers that will conduct a similar study.

1. It is highly encouraged that web designers and developers should conform to WCAG 2.0 standards in the development of web applications.
2. The tested platform of the study is based on the Philippine government websites only. Future researchers can create and develop an app for other types of web services.
3. Future researchers can add more technology- based enhanced projects intended for other types of disability.

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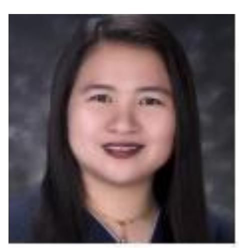
Professor Maricel L. Malabanan is an Associate Professor of the College of Computing and Information Technology at First Asia Institute of Technology and Humanities in Tanauan City Batangas, Philippines where she also serves as the Chair of the Information Technology Program. Prof. Malabanan completed her Masters in Information Technology at Manuel S. Enverga University Foundation, Lucena City. Her Bachelor of Science in Information Technology degree was obtained at AMA Computer College- Batangas, Batangas City. Her involvement in the academe started on June 2009 where she worked as an Asst. Instructor at AMA Computer College Calamba until October 2012. She also worked as IT coordinator/Professor at Philippines Women's University Calamba from June 2013-April 2014. She is currently a board member of the Philippine Society of IT Educators Region 4 Chapter. Prof. Malabanan is interested with research topics focusing on NLP, Big data analytics, Image Analysis, Machine Learning and Data Mining.



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