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Colour Identification System for the Colour Blinds

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Abstract

Image processing involves converting an image into a digital format and executing specific procedures to extract essential information from it. There are various types of images processing techniques, including visualization, which enables the detection of objects that may be invisible in the original image, and recognition, which focuses on identifying objects within the image, among others. The objective of this project is to develop a mobile application to determine the presence of colour blindness among users and to identify the colours of clothing using image processing techniques. Image processing has been widely utilized across numerous fields to enhance quality of life, such as in medical image retrieval, where it aids in increasing the accuracy of treatment plans. In this project, image processing will be applied to assist individuals with colour blindness in identifying the actual colours within images. The project consists of two main sections: a colour blindness test and real-time colour identification using the device's camera. The system will be developed using Android Studio, utilizing both Java and Python, with the assistance of a Python plugin to enable the execution of Python code on the Android platform. During the testing phase, the functionality and accuracy of the system will be evaluated by individuals with normal vision as well as those with colour blindness. For this project, the Mobile Application Development Lifecycle (MADLC) framework is chosen, as the end product is a mobile application. MADLC comprises five phases: planning, designing, developing, testing, and deploying.

Keywords: Image Processing, Color Blinds, Color Identification, Mobile Application Development Lifecycle (MADLC).

Introduction

Colours play a critical role in facilitating our daily activities. For example, traffic lights guide us on when to stop and when to proceed, while distinguishing between earth, live, and neutral wires is essential in electrical wiring, among other instances. However, individuals do not universally perceive colours in the same manner. Colour blindness, also known as colour vision deficiency (CVD), is a condition where individuals have difficulty identifying specific colours such as red, green, and blue. People with colour blindness may require user-friendly and effective tools or software to assist them in distinguishing the precise colours of objects, such as clothing. Furthermore, raising awareness about colour blindness can foster equality in societal treatment and comprehension. With the progression of technology, digital image processing has emerged as a versatile and extensively utilized tool across various domains. It plays a pivotal role in extracting information from images, enabling tasks like image enhancement, object detection, and recognition. In this context, image processing techniques are particularly pertinent and advantageous for addressing the challenges associated with colour blindness.

Although colour blindness is a well-documented condition, many affected individuals are unaware of their status (Khan et al., 2021). Consequently, they may struggle to perceive the true colours of objects, relying on their initial visual impressions like the majority of people. This can result in various difficulties, especially for children with colour blindness, who may fall behind their peers in identifying specific colours (British Journal of School Nursing, 2015). Additionally, individuals with colour blindness encounter obstacles in professional settings that depend on colour distinctions, such as clothing stores, particularly those with branded items. The task of organizing clothes becomes notably challenging when garments of various colours are randomly mixed together, posing a significant hurdle for colour-blind staff members. Moreover, in business environments, accurately matching or contrasting the colours of logos or product designs can present a formidable challenge for individuals with colour blindness. Research, such as the study by Ridgway & Myers (2014) on consumers' perceptions of colour in fashion brand logos, offers valuable insights into selecting logo colours to effectively convey brand personality. These findings underscore the significance of addressing the challenges faced by individuals with colour blindness in various aspects of daily life and professional pursuits.

Color blindness is a hereditary genetic disorder characterized by defects in the development of retinal cone photoreceptor cells, which are crucial for color perception. According to a study cited by Reinaldo et al. (2021), approximately 8% of men globally are affected by color blindness, whereas only 0.1% of women exhibit the disorder. This notable gender disproportion is attributed to mutations typically found in the X chromosome, particularly the 23rd chromosome. The X chromosome is linked to red-green deficiency, a prevalent form of color vision impairment, as elucidated by Khan et al. (2021). Since males inherit only one X chromosome, they are more susceptible to developing color blindness if they inherit a mutated gene on that chromosome. This mode of inheritance elucidates why males have a higher predisposition to color blindness in comparison to females.

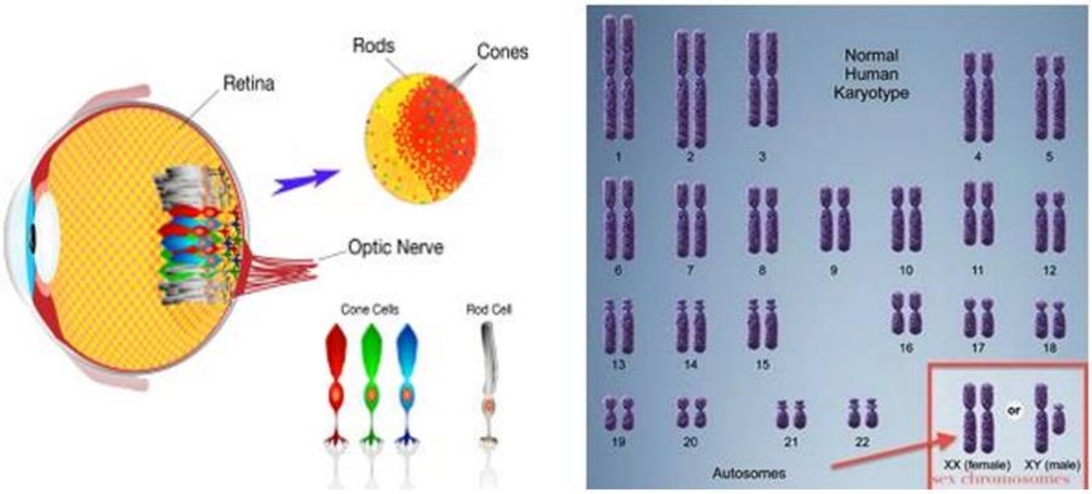


Figure 1. Defects in development of cone cell (left) & colour blinds mutated genes at 23rd (right) (Colour and Light-Linear and Log>>Human vs Video & Colour blindness)

Methodology
The project methodology is defined as a procedure that helps determine how to plan, develop, and keep the project on track. For this project, the Mobile Application Development Lifecycle (MADLC) is chosen because the end product is a mobile application, making it relevant to use MADLC for this colour identification methodology project. MADLC consists of five phases: planning, designing, developing, testing, and deploying.

Planning Phase
In the Mobile Application Development Lifecycle, the planning phase marks the beginning of a project where the problem statement, significance, end product, and purpose are identified. Subsequently, the process proceeds to determine the techniques and features suitable for the project, drawing from various techniques applied in previous projects. Furthermore, the methodology of this project determines where it will be helpful and useful as a reference to keep the project on track. The system architecture is then constructed based on the plan to illustrate a clear system flow that will soon be developed. All necessary data and information, such as the source for collecting the Ishihara colour plates, are gathered in this phase. Additionally, the requirements of the software and hardware for this project are considered, aiming to alleviate problems during the implementation process by meeting appropriate needs.

Design Phase
After the project planning phase, the system's design involves creating a flow chart, pseudocode, use case diagram, and a draft interface. The flow chart and pseudocode illustrate the flow of the colour identification process, while the use case diagram provides an overview of the processes and the individuals involved. Both the flow charts and use cases will be created using an online website called draw.io. Meanwhile, the draft interface will be hand-drawn and uploaded to the report in image format.

Development Phase

The next phase is the development phase. During this stage, the mobile apps are being developed using Android Studio, specifically tailored for Android users. Python has been chosen as the primary programming language due to its compatibility with NumPy and other related libraries, which will be utilized for feature extraction and the KMeans Algorithm in identifying the colors of clothing. Additionally, other programming languages involved include JAVA, HTML, and CSS, as per the current implementation. Actual screens are integrated into the mobile app at this stage.

Testing Phase

During the mobile app development process, conducting tests is essential to ensure applications are stable, usable, and secure. There are five testing processes involved in mobile application development before deployment, including User Experience Testing, Functional Testing, Performance Testing, Security Testing, and Device Testing (Mobile App Development Process: A Step-by-Step Guide). However, for this project, only User Experience Testing and Functional Testing will be implemented. The rationale for both testing methods is outlined below:

- Functional Testing: In Functional Testing, the application's functionality is evaluated by approximately ten users to encompass a wide range of potential testing scenarios. The primary objective of Functional Testing is to verify that the features and functions of the application are user-friendly and operate smoothly.
- User Experience Testing: User Experience Testing involves preparing a survey form for participants to provide feedback on the system easily. Ensuring that the final implementation aligns with the user experience envisioned is crucial in mobile app testing.

Deploy Phase

The final phase is deployment. Once the mobile application has been constructed and tested, it is now prepared for launch. Users can download the application to utilize the color identification feature designed for individuals with color blindness.

Table 1
Mobile Application Development Life Cycle (MADLC)

Objective	**Phase**	**Activities**	**Resources**	**Outcome**
To identify the type of colour blindness	Planning	Determine the problem statement, objective and significant of the project. Choose the best technique to apply in developing the project.	Research article Article Review	• Problem statement • Objective • Significance Techniques are listed and compared to find the most relevant technique to be applied.
	Designing	Propose a flow chart of the project as a reference for the project.	Draw.io	Flow chart of the project.
To develop a mobile application to identify the colour of clothes using image processing technique.	Development	Build the mobile application with a suitable environment on cooperative devices.	Android Studio	Mobile Application with interactive interface.
To evaluate the effectiveness of the system	Testing	Inspect and solve any errors in the project.	Android Studio Phyton Anaconda3 Jupyter Notebook	All the features in the mobile application work properly.
	Deploy	Releasing the mobile application in a completed edition for people with colour blinds.	Play Store	The mobile application is available on the Play Store and ready to be downloaded anytime.

Results and Discussion

Mobile Application Development Lifecycle (MADLC) consists of five phases: planning, designing, development, testing, and deployment. All phases were analyzed before implementation throughout the development process. The mobile application, named WARNA, is now available for download and use on Android devices running at least Android version 7.0. Currently, WARNA is in the Beta version, allowing for changes to be made at any time to enhance the system's quality. The game was developed using Android Studio and tested on mobile devices running Android version 11.

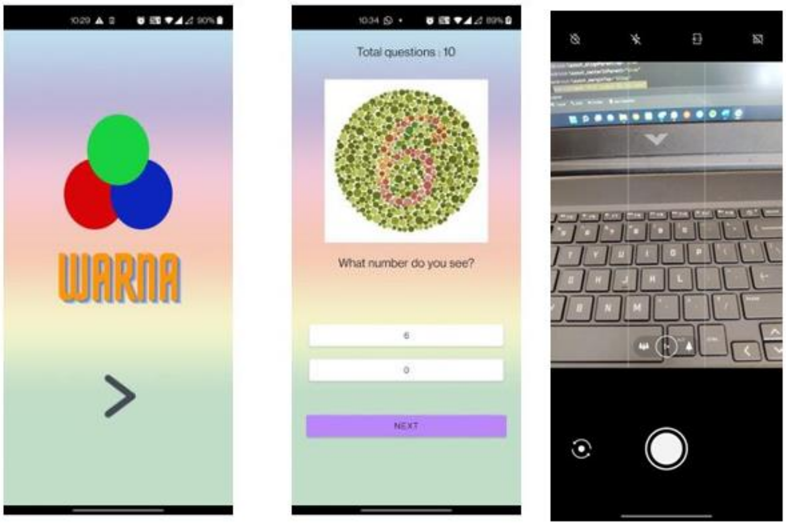


Figure 2. Interface of WARNA's home page (left), colour blindness test page (middle) and real-time camera for identification colours (right)

Figure 2 above depicts the home page of WARNA, featuring a button that directs users to the next page on the left. The middle image illustrates the interface of the colour blindness test page, while the rightmost image showcases the real-time camera used for colour identification. The chosen logo symbolizes the three primary colours, red, green, and blue (RGB), which can generate a broader spectrum of colours when combined. Beneath the logo lies the name of the mobile application, WARNA, which translates to "colour" in Malay. Regarding the background, it is intentionally neutral. Although individuals with colour blindness may not perceive the background colour, this design choice aims to prevent the application from appearing overly simplistic to users with normal colour vision.
WARNA is developed using Android Studio, with the primary programming languages being Java and Python. The system is divided into two main components: the colour blindness test and the real-time camera-based colour identification of images. WARNA underwent testing by five individuals with colour blindness and six individuals with normal colour vision to fulfill the Functional Testing method. In addition, the User Experience Testing method was employed during the testing phase, which involved evaluating user experience through a questionnaire survey distributed via Google Forms to WARNA's testers. Figure 3 and Figure 4 present the survey results, including relevant questions aimed at assessing the functionality and user experience of WARNA. The test group comprised seven male and four female users, with the majority being twenty-two years old. Out of the eleven testers, only five individuals were identified as having color blindness.

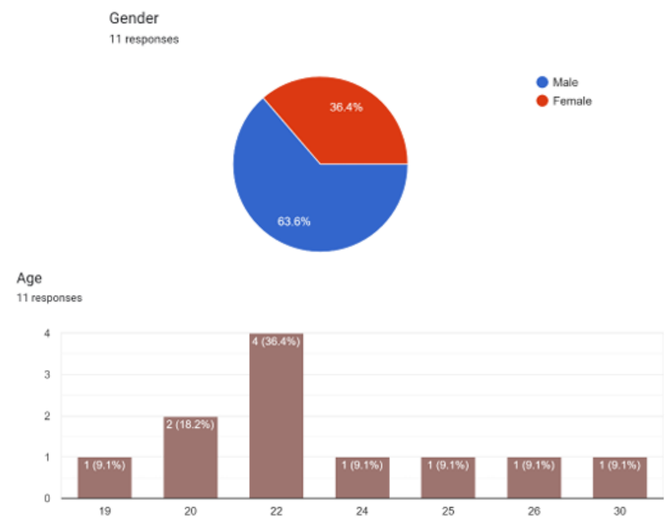
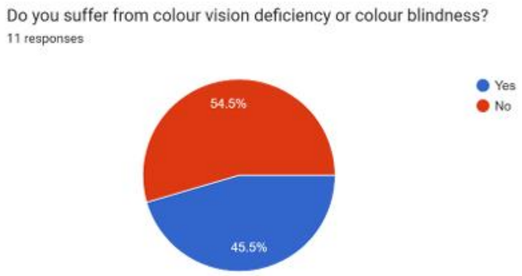
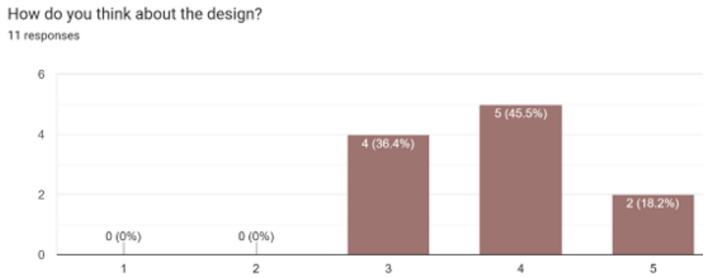
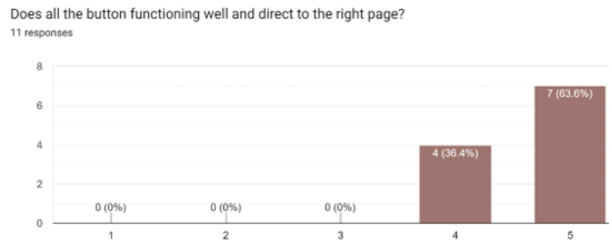


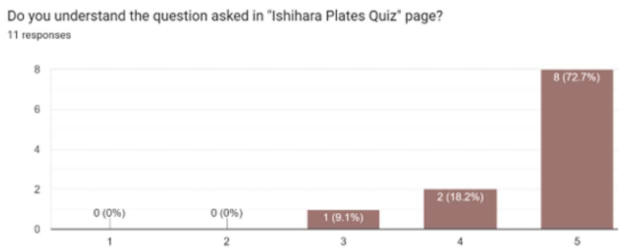
Figure 3. Gender and age involve in a questionnaire survey



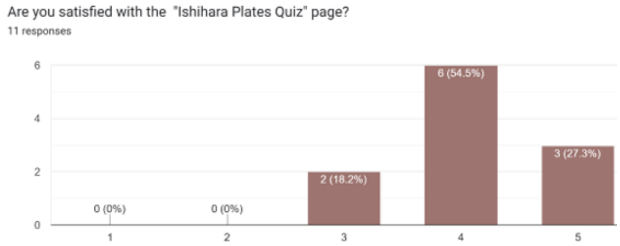


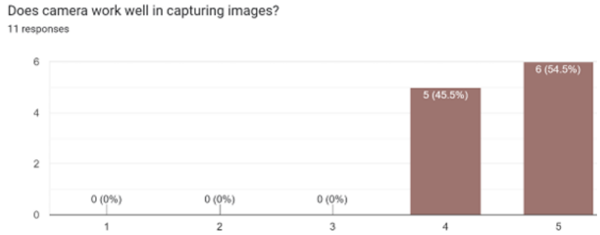
Question 1 Question 2



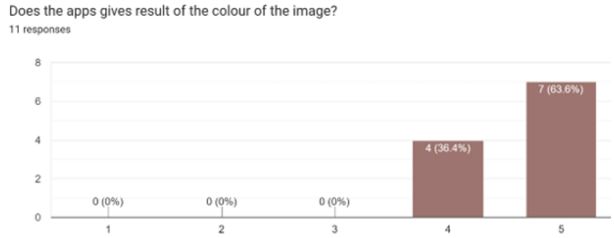


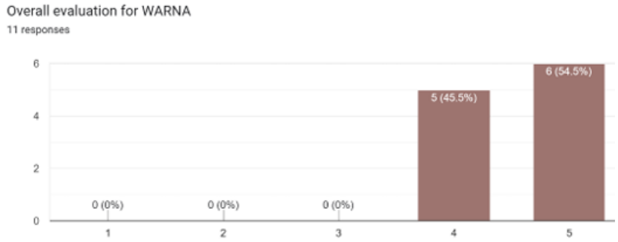
Question 3 Question 4





Question 5 Question 6





Question 7 Question 8

Figure 4. Result of survey with relevant questions to evaluate the functionality and experience of the users towards WARNA.

Conclusion

The mobile application "WARNA" has been developed for Android devices and aims to assist individuals with colour blindness in identifying the actual colours of images. While the application does not cure colour blindness, it serves to aid users in recognizing and acknowledging the true colours of objects in their surroundings. "WARNA" is designed with two main sections: a colour blindness test comprising ten image-based questions, and real-time colour identification using the device's camera.

The development of "WARNA" took more than two months to complete, and user feedback indicates satisfaction with the design, functionality, and flexibility of the application. Despite its successful completion and meeting user requirements and expectations, "WARNA" still has some weaknesses. To improve the accuracy and reliability of the colour identification feature, future iterations of "WARNA" could benefit from incorporating advanced colour recognition algorithms and leveraging the capabilities of modern smartphone cameras. Additionally, the colour blindness test could be expanded to cover a wider range of images and scenarios to provide a more comprehensive assessment of users' colour perception. In conclusion, while "WARNA" has successfully achieved its objectives in aiding individuals with colour blindness, there is potential for further enhancements to address its current weaknesses and provide an even more effective and user-friendly experience.

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