THIRD EYE – A MOBILE APPLICATION FOR VISUALLY IMPAIRED PEOPLE TO ASSIST WITH DAILY TASKS

22_23-J 83

Project Proposal Report

M.C.J Costa – IT17088138

B.Sc. (Hons) Degree in Information Technology specializing in Information Technology

Department of Computer Science and Software Engineering

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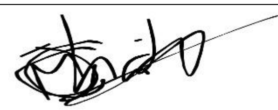
DECLARATION

We declare that this is our own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Name	Student ID	Signature
M.C.J Costa	IT17088138	

The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

Uthpala Samarakoon (Signed)	14th October 2022
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Signature of the supervisor:	Date:

Abstraction

The eye is one of the major organs of a living being out of five sensory organs. Losing sight causes a person to become partially deactivated in his or her daily activities by sitting in a corner of the room for the whole day without knowing the shapes or colors of the world. Because of a few medical factors, visually impairment can happen. While some situations can be cured and treated, some incidents can't be recovered. Due to the busyness of today's people, allocating a separate time for a visually impaired person is much more difficult while balancing their time as well. Thanks to the varied development of today's technology, there are so many smart systems and products for visually impaired people to do their own tasks by themselves, beyond the traditional techniques like white canes, guide dogs, trained human assistants, smart glasses, and so on. But the disadvantage of modern techniques is that the products are considerably more expensive than a normal person can afford. So, despite the fact that solutions exist, visually impaired people must continue to live without changing their daily routines.

This project focuses on a mobile application that a blind or color-blind person can easily handle via simple actions like finger taps, voice commands, or swiping the screen to accomplish small orders, and also with the help of voice assistants and read-aloud techniques. The primary goal of developing this "Third Eye" mobile application is to assist visually impaired people with navigation, object recognition, text reading, and color blindness. Because this project mainly depends on the mobile phone camera, the user doesn't need to worry about wearing external equipment or the lateness of receiving particular details. Even though there are hundreds of existing systems, using modern technology to add new features and meet multiple needs from a single free application increases the uniqueness of this concept rather than them.

Contents

LIST OF ABBREVIATIONS

Abbreviation	Description
AI	Artificial Intelligence
API	Application Programming Interface
BVI	Blind-Visually Impaired
CCTV	Closed-Circuit Television
CRUD	Create Read Update Delete
CV	Computer Vision
DB	Database
GPU	Graphical Processing Unit
MP	Mega Pixel
OS	Operating System
RFID	Radio Frequency Identification
SQL	Structured Query Language
TPU	Tensor Processing Unit
UI	User Interface
UX	User Experience
WHO	World Health Organization
QoL	Quality of Life

1. Introduction

1.1 Background & Literature Survey

Color blindness is an abnormal condition characterized by the inability to clearly distinguish colors of the spectrum [1]. Colorblindness (vision deficiency) is a common condition where around 8% of men and 0.4% of women being affected from birth [2]. What we see is less than what meets our eye. Especially for those who have colorblindness. More than 14 percent of men cannot distinguish reds from green colors. Some may have this affected where they lack either red- or green-sensitive cone pigments or when at least one of these three types have color pigments where the visual pigments doesn't work. Many aspects of day to day activates face problems when a person have this vision deficiency, things that require accurate color vision. From color-coded maps and graphs, to electronic wiring & components, to signaling & communication and even reading text set in a colored background [3]. This will effect on the persons quality of life (QoL).

	Component		
Items	**Health & Lifestyle**	**Emotions**	**Work**
Not noticing change in colour of skin due to sunburn	.810		
Difficulty choosing groceries due to colour	.766		
Not noticing change in colour of mole on skin	.763		
Can't tell when food is cooked due to colour	.755		
Difficulty choosing or buying clothes	.749		
Being confused about colour of pills or other medication due to colour-coding	.733		
Not noticing blood in stools (faeces)	.718		
Difficulty knowing when fruit is ripe due to colour	.711		
Difficulty reading maps (e.g. London Underground map)	.707		
Not noticing a change in colour of urine	.679		
Problems playing sports (e.g. colours of team clothing, colours of snooker balls etc)	.630		
Feeling anxious because of issues caused by problems seeing colours		.880	
Feeling depressed because of issues caused by problems seeing colours		.846	
Feeling unconfident because of issues caused by problems seeing colours		.820	
Feeling embarrassed or humiliated because of CB issues		.816	
Feeling low self esteem because of issues caused by problems seeing colours		.778	
Feeling anxious because you might not realise when you can't see a colour properly		.767	
Feeling different to other people because of issues caused by problems seeing colours		.720	
Felt that had let down self or others due to problems seeing colours		.692	
Avoiding conversations where colours are discussed		.627	
Being limited in choice of work or career			.754
Difficulty performing work or other activities (e.g. charts)			.658
Accomplishing less than would like at work or in career			.621

Table 1.1 Principal components analysis of CBQoL items

In BMC Ophthalmology as they mention in their literature review areas that a person mostly get affected are Health, Work & Emotions where all this will affect life and careers. To further support the people in need to help them spend a normal life with higher quality of life responses. As they mention CBQoL (Colorblind Quality of Life) can be somewhat increased with reduced number of problems related to CB for example supporting the person through smartphone. Starting from an adolescent child to early adulthood a person goes through color coded objects and signals (Colored chalk on blackboard, Driving safety, Taking medications, Reading charts or a simple thing as to know when meat is cooked).

All these existing research studies focuses on evaluating the QoL and gather responses using Likert scales (Scale from 1 to 6 with been a severe problem to no problem) where a table of record is been implemented. (Table 1.2) This shows that a person may be affected with problems regarding emotions, career or health. Identifying and giving support is the main focus area of our research using the most common device known to mankind nowadays the smartphone. To get the idea how many types of colorblindness and the causes to them and the tests that need to evaluate the types are the next thing that need to be evaluated in order to suggest a proposed solution.

In human vision there are two types of photoreceptors (specialized neurons found in the retina that convert light into electrical signals that stimulate physiological processes): rods and cones. Rods are sensitive to light while cones are sensitive to colors. Cones have three types that help to identify colors: L-cones (Sensitive to long wavelength – red), M-cones which are sensitive to middle wavelength (Known as green) and S-cones which are sensitive to short wavelength (Known as blue). According to these 3 types of cones, there are 3 types of colorblindness. Monochromy, which no cones or only one come type exists, Dichromacy, which one cone type is missing which can be of the three types: Protanopia, which L-cones are missing, Duteranopia where M-cones are missing, and Tritanopia where S-cones are missing. Last type of color blindness is Anomalous Trichromacy, in which there is a resuction in the sensitivity to a particular color, which can be of three types: Protanomaly corresponds to a reduced sensitivity to red light, Dueteranomaly correspons to a reduced senstivitity to green light. And Tritanomaly corresponds to reduced sensitivity to blue light. Protanopia and Duteranopia are the two types of red-green color blindness and Tritanopia is known to be blue-yellow color blindness. Below table summarizes the above said causes and effects.

Color blind type	Cause	Effect
Monochromacy	No cones or only one cone type exist.	Inability to see any color (see the world in grey shades)
Dichromacy	One cone type is missing, three types: 1) Protanopia: L-cones are missing 2) Duteranopia: M-cones are missing 3) Tritanopia: S-cones are missing	Inability to see the color corresponding to the missed cone type. Inability to see Red color (Red Blind) Inability to see Green color (Green Blind) Inability to see Blue color (Blue Blind)
Anomalous Trichromacy	All cone types are exist, but they are not aligned, three types: 1) Protanomaly: L-cones are not aligned 2) Dueteranomaly: M-cones are not aligned 3) Tritanomaly: S-cones are not aligned	Reduction in the sensitivity to a particular color Less sensitivity to Red color (Red week) Less sensitivity to Green color (Green week) Less sensitivity to Blue color (Blue week)

Table 1.1 Colorblindness types and effects

At the time of the observations there are some developed applications for mobile as well as desktop platform. There are some use cases that some apps cover only one type and some supports just a filter for a type without evaluating which kind of a colorblindness type the user falls under. Some of the applications are below and descriptions about them are as follow,

1. Color Blind Pal

Color Blind Pal is an application which allows users to see through the eye of a colorblind person. How they see the world and at the same time help colorblind people to see the color corrections as a static image and the user have to manipulate the color filter in order to see the correct colors. Inspecting colors real-time is also available in a given image. Available for both iOS and Android.

2. Color Identifier

Take a picture from the application or select an image from gallery and click on the color that wants to be identified and the name. Also add filters to the image is possible

3. Colorblind Helper

Users can use the tool to pick colors and get to know the name of the color. It is created to improve the visual accuracy of people with color blindness by giving them information such as the name, Color composition in RGB or hexadecimal value of the selected image. Available for android at the time.

4. Chromatic Glass

This app helps people with difficulties recognizing specific colors or perceiving differences between specific color pairs due to a color vision deficiency. Congenital color vision deficiency can be classified into three major types: Protanope / Protanomal, Deuteranope / Deuteranomal and Tritanope / Tritanomal. People with different types of color vision deficiency perceive colors differently.

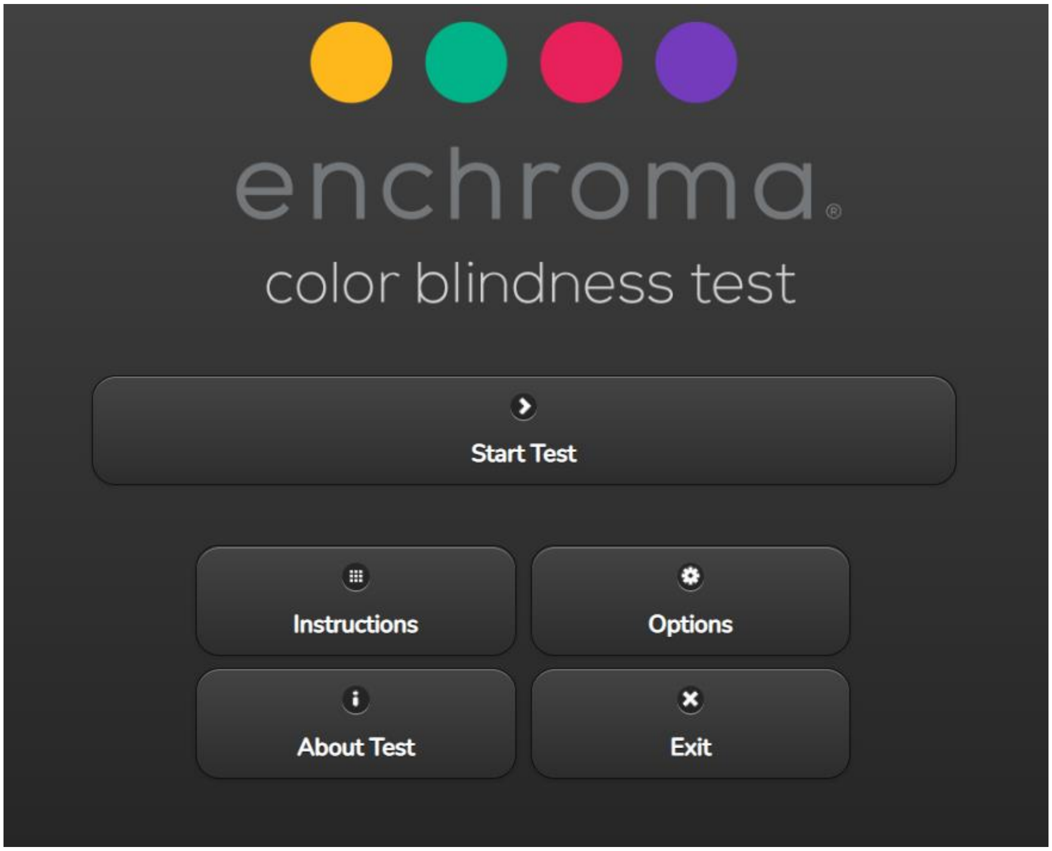
The colors which can be recognized or distinguished by color deficient persons are different from color normal persons. In addition, such conditions may occur owing to an acquired illness.

"Chromatic Glass" helps users to recognize and distinguish such colors by making a special modified color image based on scientific theoretical methods in real-time and displaying it and the original image alternately. Available for iOS only.

5. Color blindness correction

This app is a correction application with an augmented reality based one which enhances images to make areas confused by color-blind people visibly.

6. Enchroma



Enchroma is a desktop application that supports users to take online tests for color blindness type diagnosis through number of ishihara test diagrams. Accurate results most of the time due to the website can’t control the lighting of the test since brightness control is hard to implement in a web application.

Even though these applications exist, there are number of bad reviews and problem which the end users faced. All of these are listed as below.

System	Compatibility
Color Blind Pal	This app is good for someone who defiantly know what kind of a color blindness they have. But to confirm if the said type is the type the person is having is not evaluated. Some types were ignored at the time of the referencing. Types like “Protanopia” are ignored. (Red color blindness)
Color Identifier	Reviews says that the app doesn’t support accurate color description. Doesn’t support color blindness people even though it is categorized under color blindness.
Colorblind Helper	This app only reads out the color value through a database and says the name. Not helpful for a non-technical person and as the reviews suggested naming of the colors are unnecessary.
Chromatic Glass	This application shows an alternate image for a taken image and applied a certain filter by making the user to use a filter. Not suitable for non-technical user and hard to use as per the reviews.

Color blindness correction	App works as it advertised but the augmentation of the color isn’t been implemented as for the expectations of the end users as per the reviews. Color names are just been displayed as a pop-up.
Enchroma	This desktop application does a good job when diagnosing a color blindness type through ishihara tests but since the application can’t adjust the lighting of the screen the test cases are not accurate as per online blogs suggested.

1.2 Research Gap

As the literature study suggests there are countless number of applications to support colorblindness only downside is that they are not user friendly because we need to develop the application targeting the end user who is not a tech person. The biggest downside is that neither of these applications doesn’t evaluate the user by the system. The main variables that need to consider are,

- Type of colorblindness the user is having
- Correct augmentation filters to let the user to see colors correctly according to the evaluation

Many applications consists of,

- Color of the object display
- Let the user to adjust the filter with a RGB slider to manually add a filter
- Take an image and add the filter. (No dynamic or real-time support)

As these points that mentioned above the available features of support systems doesn’t have a consistency of support as well as confusing to navigate and troublesome for a non-tech person to follow. All of these research focuses on helping the user without evaluating so that the results or expectations of the users are different because colorblind people aims and thinks that these applications would help them as they expect at least the things that would make their Quality of Life would be consistent.

The table below (3.1) shows the tabularized format of the above said explanation.

Product	Tests	Filters	AR Support	Additional Info
Research A	x	✓	x	x
Research B	x	x	x	✓
Research C	✓	✓	x	x
Third Eye	✓	✓	✓	✓

Table 3.1- Comparison of former researches

1.3 Research Problem

According to information described so far the background and research gaps these applications have lot of gaps that may make the user feel uncomfortable or worse an injury. So as solutions the proposed fix would be a system to determine and evaluate an accurate application. To make the things clear there are tests and methods to consider.

			Colour vision category			χ^2
			CB (N = 65)	Borderline (N = 22)	Normal vision (N = 332)	
Sex	Male		57 (88%)	6 (27%)	65 (20%)	118.984[a]
	Female		8 (12%)	16 (73%)	267 (80%)	
	SEC	Managerial	38 (65%)	10 (56%)	183 (68%)	4.328[b]
		Intermediate	5 (9%)	0 (0%)	24 (9%)	
		Manual	15 (26%)	8 (44%)	63 (23%)	

Table 3.2 BMC Ophthalmology: Description of the color vision of the participants by sex (128 men and 291 women)

As the above figure describes, these are the areas of a colorblind person struggles of. For that to consider this support system must consist of an Augmented Reality component with accurate low latency result output.

- **Testing: Ishihara Pseudoisochromatic Plate**

  Total number of 24 color plates has to be considered when to get an accurate evaluation when using ishihara diagrams. Below will be some plate screenshots that were captured through an iPhone 6s plus as a screenshot.

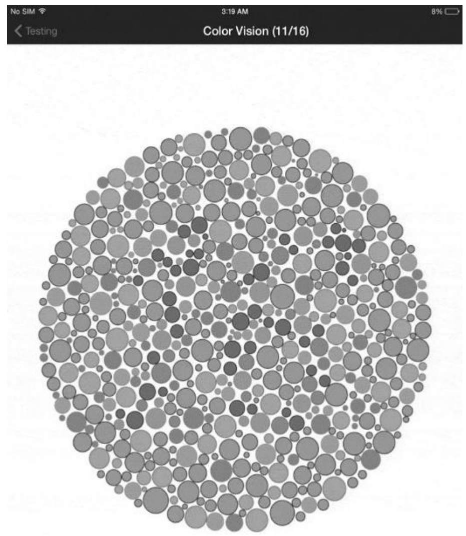


Table 4.1 Screenshot of 32 bit-greyscale of Plate 11 in Eye Handbook. The correct number 16 is visible to the observer despite the lack of color information, indicating that the image is testing contrast sensitivity rather than perception of color.

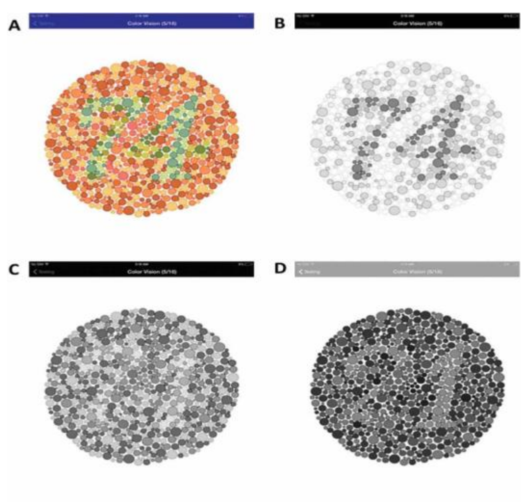


Table 4.2 Split RGB Channel of Plate 5 in Eye Handbook. The number 74 is visible in (A) Normal Plate and can be discerned in (B) Red channel and (C) Green channel. In contrast, the Blue channel (D), which simulates red-green color blindness, reveals the number 21.

Unprocessed images with all three color channels preserved simulated normal color vision. 32 bit-greyscale images are hypothesized to simulate total color vision loss and blue channel images under split RBG are hypothesized to simulate R-G deficiencies. Each color plate (unprocessed and processed photos) from EHB and Ishihara was analyzed independently by two reviewers with normal color vision by standard Ishihara testing. For each plate, the numeral (or absence of numeral) seen under three different conditions was recorded.

The first part of the study compared results from the processed photographs of the Ishihara color plates to the original answer key provided by Ishihara booklet (Table 4.3) to evaluate the validity of this image processing method in simulating R-G deficiencies and total color blindness. The second part of the study compared results from the EHB (The Eye Handbook) to the Ishihara test.

Answers to each plate

<table>
<tr><th>Plate</th><th>Normal Person</th><th colspan="4">Person with Red-Green Deficiencies</th><th>Person with Total Color Blindness and Weakness</th></tr>
<tr><td>1</td><td>12</td><td colspan="4">12</td><td>12</td></tr>
<tr><td>2</td><td>8</td><td colspan="4">3</td><td>X</td></tr>
<tr><td>3</td><td>29</td><td colspan="4">70</td><td>X</td></tr>
<tr><td>4</td><td>5</td><td colspan="4">2</td><td>X</td></tr>
<tr><td>5</td><td>3</td><td colspan="4">5</td><td>X</td></tr>
<tr><td>6</td><td>15</td><td colspan="4">17</td><td>X</td></tr>
<tr><td>7</td><td>74</td><td colspan="4">21</td><td>X</td></tr>
<tr><td>8</td><td>6</td><td colspan="4">X</td><td>X</td></tr>
<tr><td>9</td><td>45</td><td colspan="4">X</td><td>X</td></tr>
<tr><td>10</td><td>5</td><td colspan="4">X</td><td>X</td></tr>
<tr><td>11</td><td>7</td><td colspan="4">X</td><td>X</td></tr>
<tr><td>12</td><td>16</td><td colspan="4">X</td><td>X</td></tr>
<tr><td>13</td><td>73</td><td colspan="4">X</td><td>X</td></tr>
<tr><td>14</td><td>X</td><td colspan="4">5</td><td>X</td></tr>
<tr><td>15</td><td>X</td><td colspan="4">45</td><td>X</td></tr>
<tr><td colspan="2" rowspan="2"></td><td colspan="2">Protan</td><td colspan="2">Deutan</td><td rowspan="4"></td></tr>
<tr><td>Strong</td><td>Mild</td><td>Strong</td><td>Mild</td></tr>
<tr><td>16</td><td>26</td><td>6</td><td>(2) 6</td><td>2</td><td>2 (6)</td></tr>
<tr><td>17</td><td>42</td><td>2</td><td>(4) 2</td><td>4</td><td>4 (2)</td></tr>
</table>

The mark X shows that the plate cannot be read. Blank spce denotes that the reading is indefinite. The numerals in parenthesis show that they can be read but they are comparatively unclear.

Table 4.3 Ishihara instruction demonstrating the number that should be identified by normal person, person with red-green deficiency and person with total color blindness.

Results: Ishihara(Example)

Tables 4.4 and 4.5 summaries findings from the EHB color vision and Ishihara test. Plate 1 of both the EHB and Ishihara is a control plate with the number 12, which can be correctly identified by both persons with normal color vision and those with color deficiencies. For each table, column 1 states the plate number, column 2 shows the number or the design that is identified by persons with normal color vision, while columns 3 and 4 state the result identified under blue channel and 32 bit-greyscale, respectively.

Plate	Number or design on the plate	Blue Channel	32 bit-Greyscale
1	12	12	-
2	8	3	-
3	29	70	-
4	5	5	-
5	3	5	-
6	15	15	-
7	74	21	-
8	6	-	6
9	45	-	-
10	5	-	-
11	7	-	-
12	16	-	-
13	73	-	-
14	Wiggly line	5	-
15	Wiggly line	45	-

Table 4.4 *Results of Ishihara test, showing numeral that is visible under blue channel and 32 bit-greyscale. (-) means no numeral was detected.*

Plate	Number or design on the plate	Blue Channel	32 bit-Greyscale
1	12	12	12
2	8	-	-
3	5	8	-
4	29	29	29
5	74	21	-
6	7	-	16
7	45	-	-
8	2	-	-
9	Wiggly line	-	-
10	Wiggly line	-	-
11	16	-	16
12	Wiggly line	-	-
13	35	-	5
14	96	-	-
15	26	-	26

Table 4.5 Results of Eye Handbook, showing numeral that is visible under blue channel and 32 bit-greyscale. (-) means no numeral was detected.

There was a high correspondence across the two reviewers interpreting images with 100% inter rater correlation.

In plates 2 through 15 of the Ishihara test, both reviewers correctly identified the answer in 12.5 out of 14 plates under simulated R-G deficiency and 13/14 plates under simulated total color blindness (Table 4.4).

As you can see the tests are important for the evaluation of the filter we need to consider. Means that how the real-time capture has to be filtered after considering the colorblind type after the test phase is done. Example of the said plates has to work and compared to two types of colorblindness how it should work.

Three algorithms to color correction techniques,

1. LMS Daltonization algorithm
2. color contrast enhancement
3. LAB color adjustment.

- **LMS Daltonization Algorithm** use the information lost in the simulation of color blindness and use LMS color space to compensate colors missing in each group/type of cones, long (L), medium (M), and short (S) in order to be predictable to the viewer and provide accurate results.
- **Color Contrast Enhancement Algorithm** refers to the sharpening of image features to remove the noisy feature such as edges and contrast boundaries. Contrast Enhancement Algorithms aim to improve the perception of the image by human eye.
- **LAB Color Adjustment,** It uses three values (L, a, and b) to specify colors. RGB and CMYK color spaces specify a color by telling a device how much of each color is needed. Lab Color works more like the human eye. It specifies a color using a 3-axis system. The a-axis (green to red), b-axis (blue to yellow) and Lightness axis.

2. Objectives

Main objective of the whole “Third Eye” mobile application:

Implement an application that can guide and assist blind people and visually troubled individuals. They can have support in which areas they have difficulties. Their difficulties can be overcome by this system which is fully automated with a built-in voice assistant and utilities that can support each of these said groups.

2.1 Main Objectives

Main objective of this component:

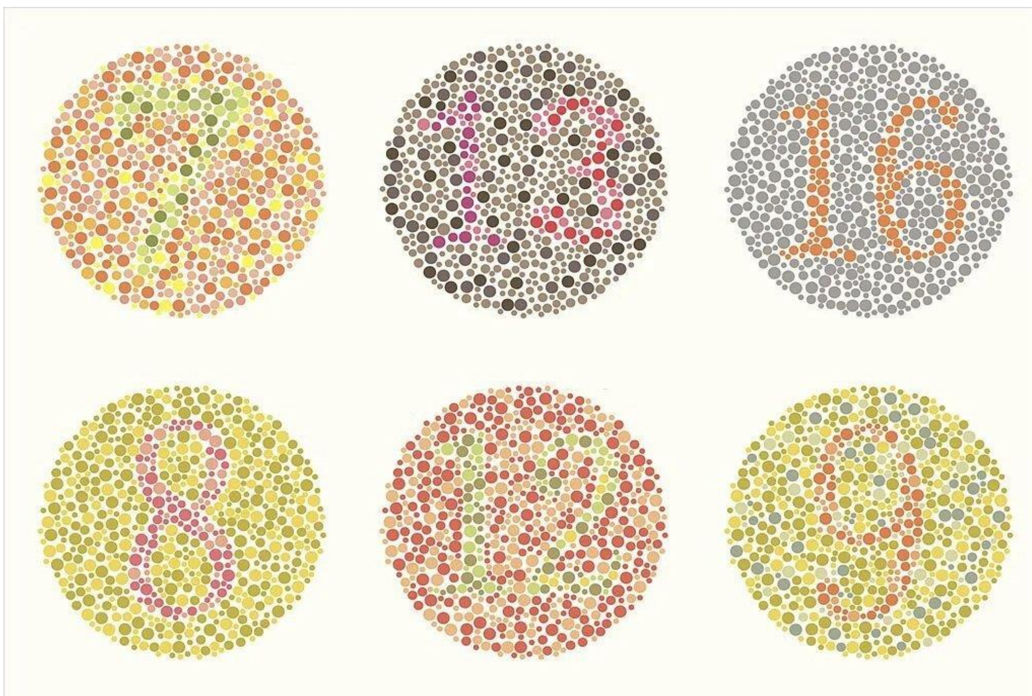
Implement real time augmented reality supported application which helps the colorblind people to get the QoL by using the smartphone accurately.

As discovered in the research problem section, a mobile application should be implemented for visually impaired people to navigate both indoor and outdoor locations, even if the app is offline. For that objective, live data should be captured and processed, reducing the time delay as much as possible. To be effective on offline platforms, the app should store frequently used actions in an offline database. If the user doesn’t have an exact idea about anything related to (as an example, **Ref. Table 1.1**), Application should be triggered quickly for the actions to be more effective.

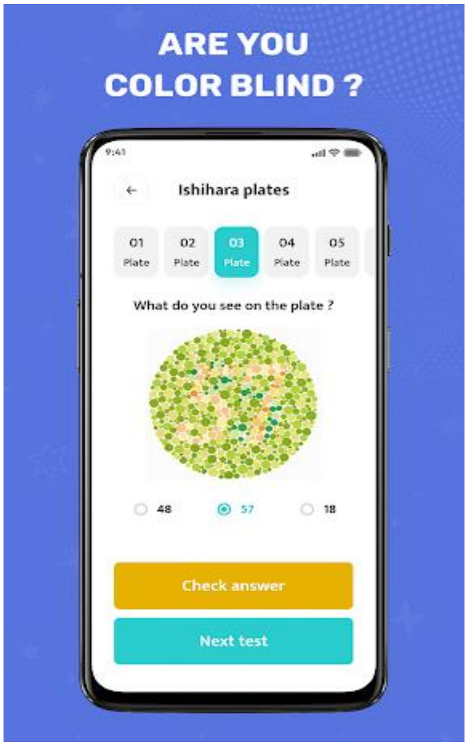
2.1 Specific Objectives

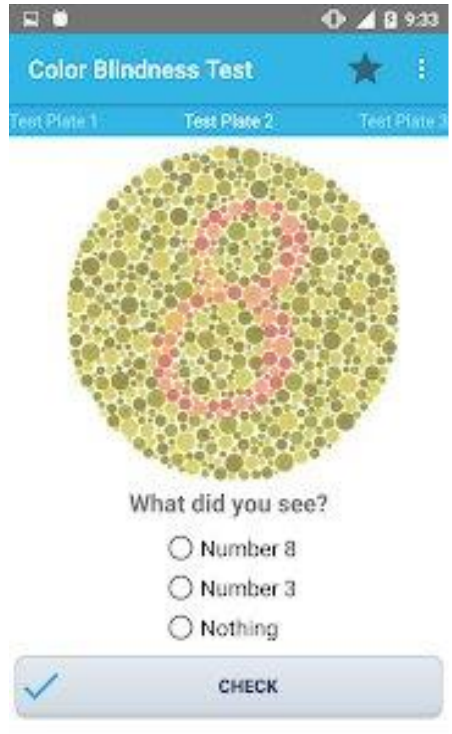
In order to reach the main objective of the app, the specific objectives that needs to be attained are as follow,

1. To evaluate the type of colorblindness create "Ishihara" tests
   When the colorblind user initially runs the application it will send the prompt to the user stating that the evaluation needs to be done in order to continue using. This evaluations can be handled offline since connectivity in Sri Lanka is currently at a poor point and these tests has to be done in a given time for each 24 or 17 ishihara plates to achieve accurate scores. After the initial tests the system/app will reconfigure and set the screen for the support.



Example 1.1 – Ishihara Test





Example 1.2 – Ishihara Test

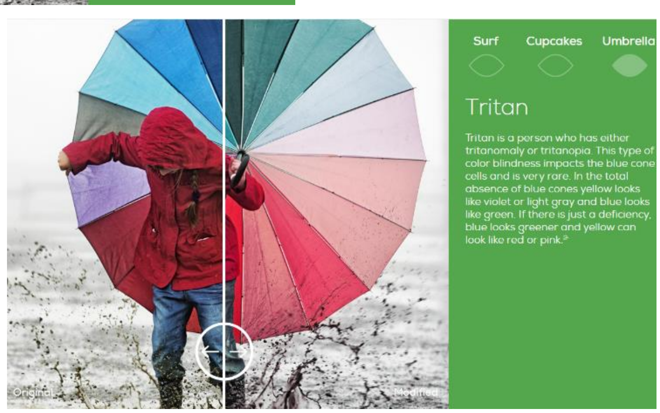
Example 1.3 – Ishihara Test

2. Add a display filter depending on the evaluated result

   After the ishihara tests the evaluated result will be what type of colorblindness the user have therefore from that moment as stated above we can use an algorithm to flip the RGB value and a filter will be added to the system.

Example 3.1 Deutan Type

Example 3.2 Protan Type



Example 4.3 Deutan Type

3. Guide user with Augmented Reality

Since some aspects of QoL of a colorblind person (Refer **Table 1.1**) needs guidance in real-time AR will help and guide when that sort of support is needed through the filtered display of the smartphone. Assistant support will be available when unreachable actions or unclear actions occur.

3. Methodology

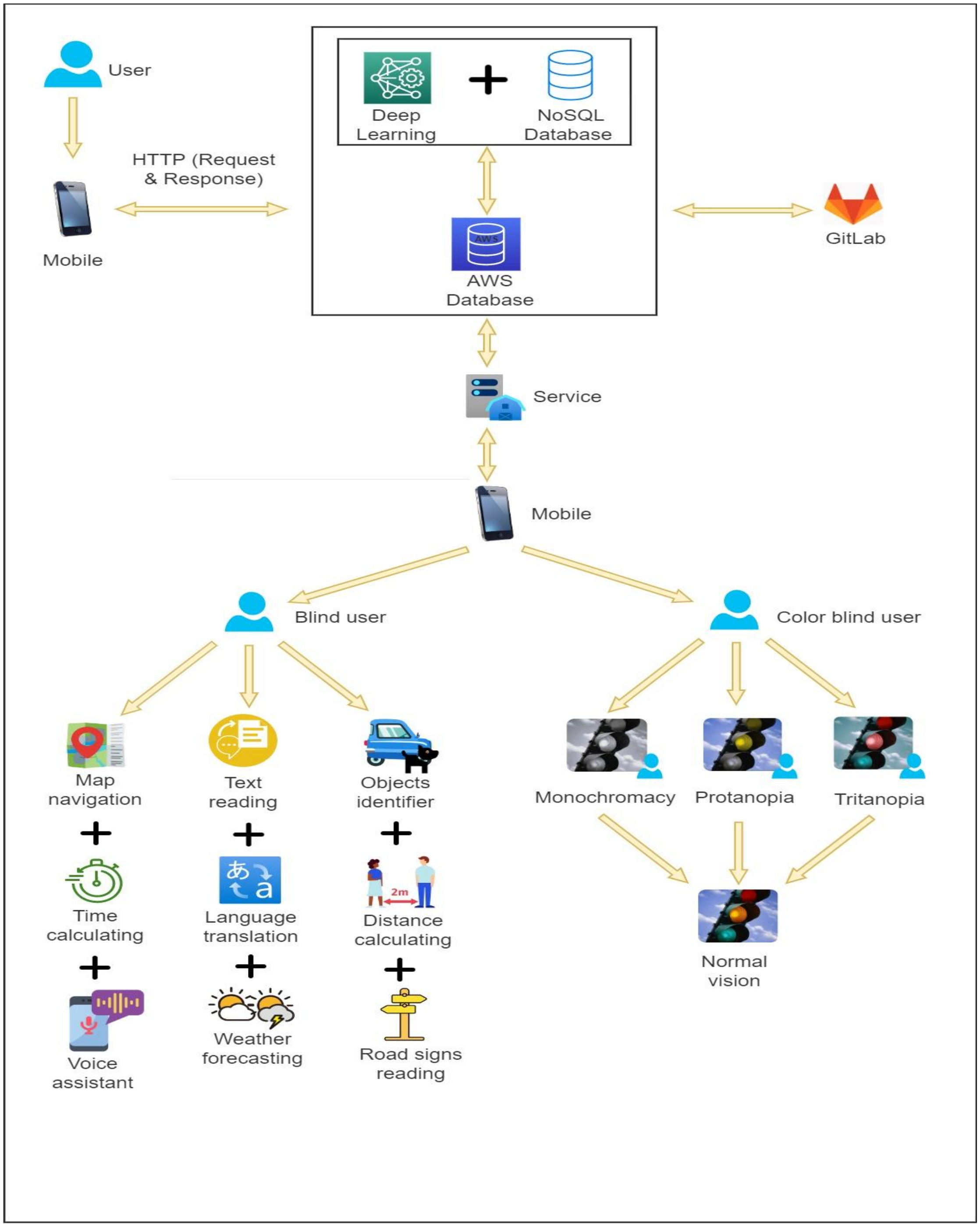
In order to implement the colorblind supportive functions, the below requirements should be correctly developed. And also described in objectives, all specific objectives are connected with each other to achieve the main objective. So, depending on the accuracy and effectiveness of them, issues with existing navigation apps for colorblind people will be solved.

- They can be used both indoors and outdoors, even if the app is offline.
- The live view should be when the user needed.
- The output should be modified with AR.
- AR should be accurate.
- Displayed filter should be the same as the colorblind type of the test output.
- Ishihara tests should be high res and the timer for each test should be consistent.

To get a clear idea about how this component works, let's look at the architectural view and technological possibilities.

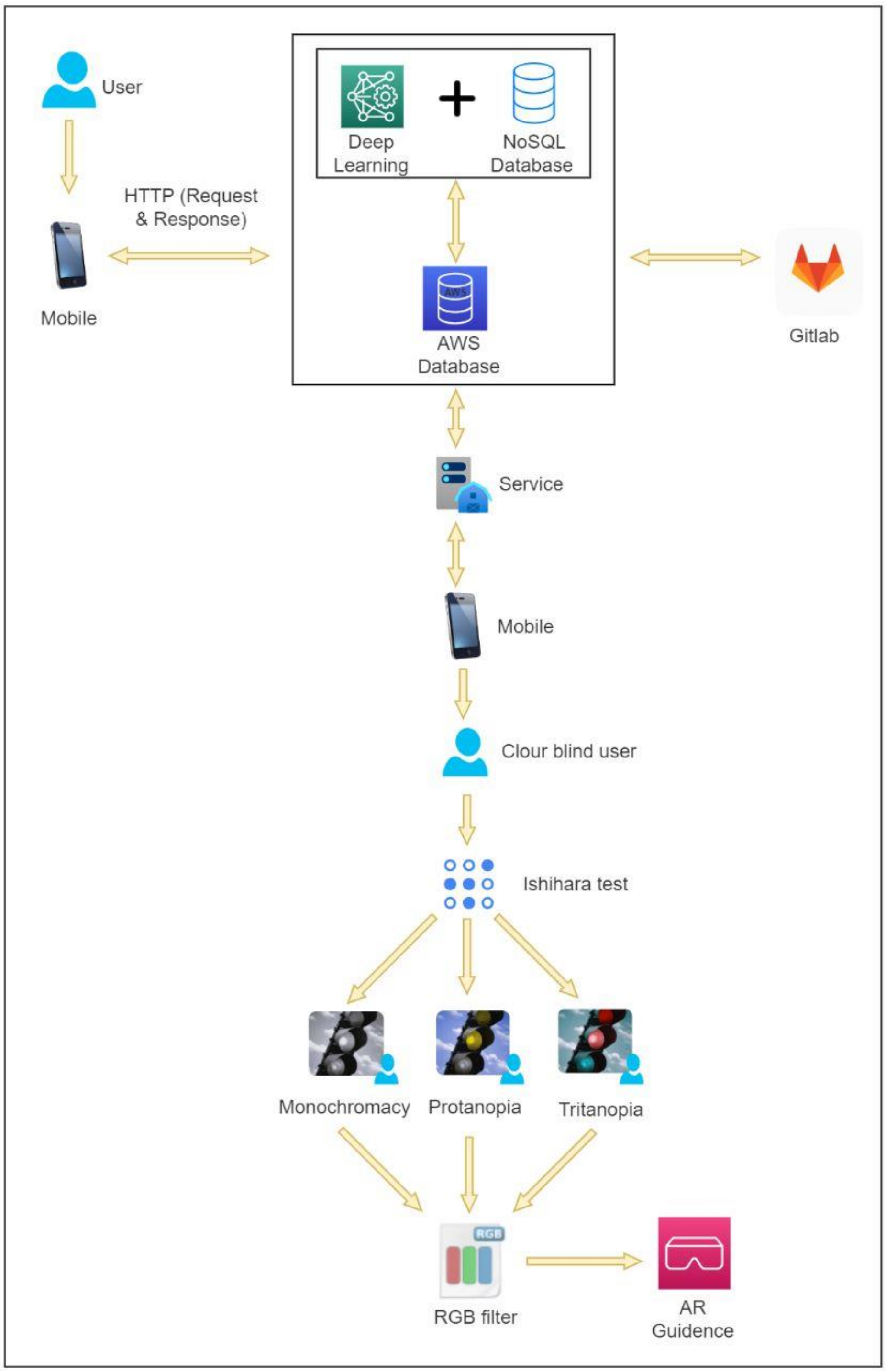
3.1 Overall System Architecture

The "Third Eye" mobile application consists of four major components. One of them is for people who are suffering from color blindness. In that function, a filtering option is implemented as the users should be able to see the actual colors of images and also in live videos like a healthy person sees. The other three components are for people who are totally blind. As described so far, this part focuses on navigation. Parallelly, the voice assistant and time-calculating parts should be worked on. Another member is implementing the obstacles and road sign identification part. The voice assistant’s assistance is needed for this part as well. And also, here the distance to the particular object is calculated considering the phone camera angle and the height of the object. It helps blind users have a safe journey by avoiding objects in their route. Another member is implementing text reading and read aloud functionalities. Also, text translation techniques as well. This app provides the facilities for users to be notified about the weather forecast. Here too, the voice assistant says something about the captured texts and also the weather condition.



Example 3.1: Overall system architecture diagram

3.2 Component System Architecture



3.3 Hardware Solution

When considering the usability of this application, it gives the user a hands-free experience. The app totally relies on the phone’s back camera. The user has to keep the phone at least above the stomach level. The user can use a code to hang the phone around their neck or keep it in their shirt pocket (this solution is better for men). This app totally depends on the data capture through the phone camera, so it is a must to keep it where the data can be gathered easily. The user can directly listen to the phone's speakers to hear what the voice assistant says, and also the user can directly speak to the phone’s microphone to give voice commands. But it is recommended to use a hand free, or a headset, to be more convenient, especially in crowded and noisy places. They can be both wired and wireless (Bluetooth). These are the only pieces of hardware that the user should have when using this mobile application. It gives the user a cheap, hands-free, easy experience.

Example 4.1 Hang on the phone using a code

Example 4.2 the phone in the shirt pocket

3.4 Software Solution

Agile is an iterative approach to project management and software development that helps teams deliver value to their customers faster and with fewer headaches. Instead of betting everything on a "big bang" launch, an agile team delivers work in small, but consumable, increments. Requirements, plans, and results are evaluated continuously so teams have a natural mechanism for responding to change quickly. Whereas the traditional "waterfall" approach has one discipline contribute to the project, then "throw it over the wall" to the next contributor, agile calls for collaborative cross-functional teams. Open communication, collaboration, adaptation, and trust amongst team members are at the heart of agile. Although the project lead or product owner typically prioritizes the work to be delivered, the team takes the lead on deciding how the work will get done, self-organizing around granular tasks and assignments. Agile isn't defined by a set of ceremonies or specific development techniques. Rather, agile is a group of methodologies that demonstrate a commitment to tight feedback cycles and continuous improvement. Considering this concept, “Third Eye” mobile application is going to develop following agile methodology.

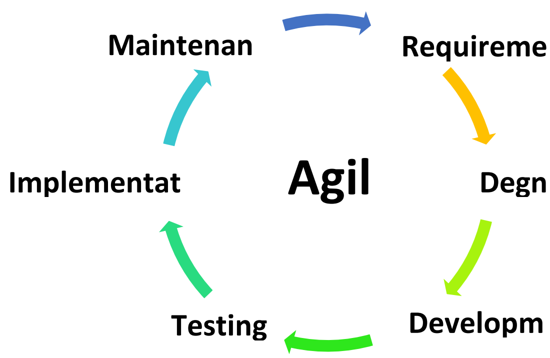


Figure 1: Agile Development Cycle

- **Requirements gathering and analyzing**

  To gather the requirements, people with colorblindness was selected. To reduce the conflicts or mismatches in their needs, it is better to collect at least 50 samples. The sample should consist of both male and female participants regardless of age. And also, to come up with this project proposal, survey results of colorblindness tests, which were conducted for the visually impaired people in some countries, were gathered. These details are already mentioned in the previous pages.

Schedule feasibility – This navigation component should develop within the given timeline because the other two functions are mainly dependent on its functionalities.

Economic feasibility – The cost should be calculated at the beginning of the planning. Some plugins, libraries, and tools for map navigation are not free to download from the internet. So, it is necessary to buy them for an affordable price. Because there's no external equipment to buy, this product can be implemented with less expenditure. However, it is unable to predict exactly what future expenditures will be. Therefore, it is safe to come up with a budget plan.

Technical feasibility - Selected tools and technologies should be supported to develop map navigation. It is needed to verify that this component can be implemented without having conflicts with other components. GPS, AR, openCV are the main things this function relies on. And also, this part should be adapted to work both on online and offline platforms. So, the network and technical feasibility should be of great concern.

- **Implementation**

The implementation phase complies with the development of the functionalities below,

  - Optimal data capturing and processing
  - Computer Vision
  - Analyze map locations and recommendations and accurate guidance
  - Guide using Voice Assistant with clear instructions
  - AR support for colorblind people.
  - Identify objects and traffic signals.
  - Translate and read texts as well as forecast weather with translations of texts to be read through computer vision.
  - Obstacle identification and avoidance with low latency feedback

The above functionalities will be implemented so that a view will be provided to the user using mobile application.

3.5 Requirements

3.5.1 User requirements

- User should be registered to the system.

- User’s data privacy should be protected and safe.
- The application should be easily handled by the user.
- The user have to take the test to determine the type of colorblindness.
- The app should be capable to detect an object through CV.
- It is desirable that the app could manage multiple object description through AR.
- The app should provide real-time information without any latency.
- User need to be able to use a smartphone by following the instructions provided.

3.5.2 System requirements

- System should be applicable for full blind and color-blind people.
- Smartphone should have at least a 20MP back camera which all of modern smartphone have these days.
- Proposed mobile application should work on both Android and iOS mobile operating systems.
- Android version 8 or above.
- iOS version 11 or above.
- GPS should be discreet and not too obvious after initial permission.
- Use of back camera has to be consistent and when uncertain events occur the system should be able to operate under the last point of failure.

3.5.3 Non-functional requirements

- Availability
- Reliability
- Security
- Speed
- Accuracy
- Maintainability
- Usability
- Performance

3.6 Tools and Technologies

- **Cross Mobile Platform Development**

  The final product contains both iOS and Android application to support cross mobile platform support. To achieve this using flutter is the best framework which supported by google. Which has an array of updating and a variety of UI library support which enables smooth UI/UX for users. Open source framework and the base OS of the framework is Dart which is not used that much for web development but since the time of flutter came to the mobile application development it became famous.

- **Database Handling**

  The application will generate thousands of data when the user is using or for processing. Best option is to use NoSQL database which lets handle big data. Amazons DynamoDB is the database we will use for the system. Handling CRUD operations as well as authorization operations will be easy to implement with a built in security by Amazon Web Services.

- **Version Controlling**

  When creating an application which handles a vast area of code bases and changes each and every day also improvements can be happening when an existing method can have a more simplistic and secure way to handle. When this happens versioning and keeping a track on code base is a must. For that Git is used.

- **Keras & Tensorflow**

  Keras is the high-level API of TensorFlow 2: an approachable, highly-productive interface for solving machine learning problems, with a focus on modern deep learning. It provides essential abstractions and building blocks for developing and shipping machine learning solutions with high iteration velocity.

  Keras empowers engineers and researchers to take full advantage of the scalability and cross-platform capabilities of TensorFlow 2: you can run Keras on TPU or on large clusters of GPUs, and you can export your Keras models to run in the browser or on a mobile device.

- **OpenCV**

  The library has more than 2500 optimized algorithms, which includes a comprehensive set of both classic and state-of-the-art computer vision and machine learning algorithms. These algorithms can be used to detect and recognize faces, identify objects, classify human actions in videos, track camera movements, track moving objects, extract 3D models of objects, produce 3D point clouds from stereo cameras, stitch images together to produce a high resolution image of an entire scene, find similar images from an image database, remove red eyes from images taken using flash, follow eye movements, recognize scenery and establish markers to overlay it with augmented reality, etc. This will help us when using camera of the mobile phone.

4. EVALUATION CRITERIA

4.1 Gantt Chart

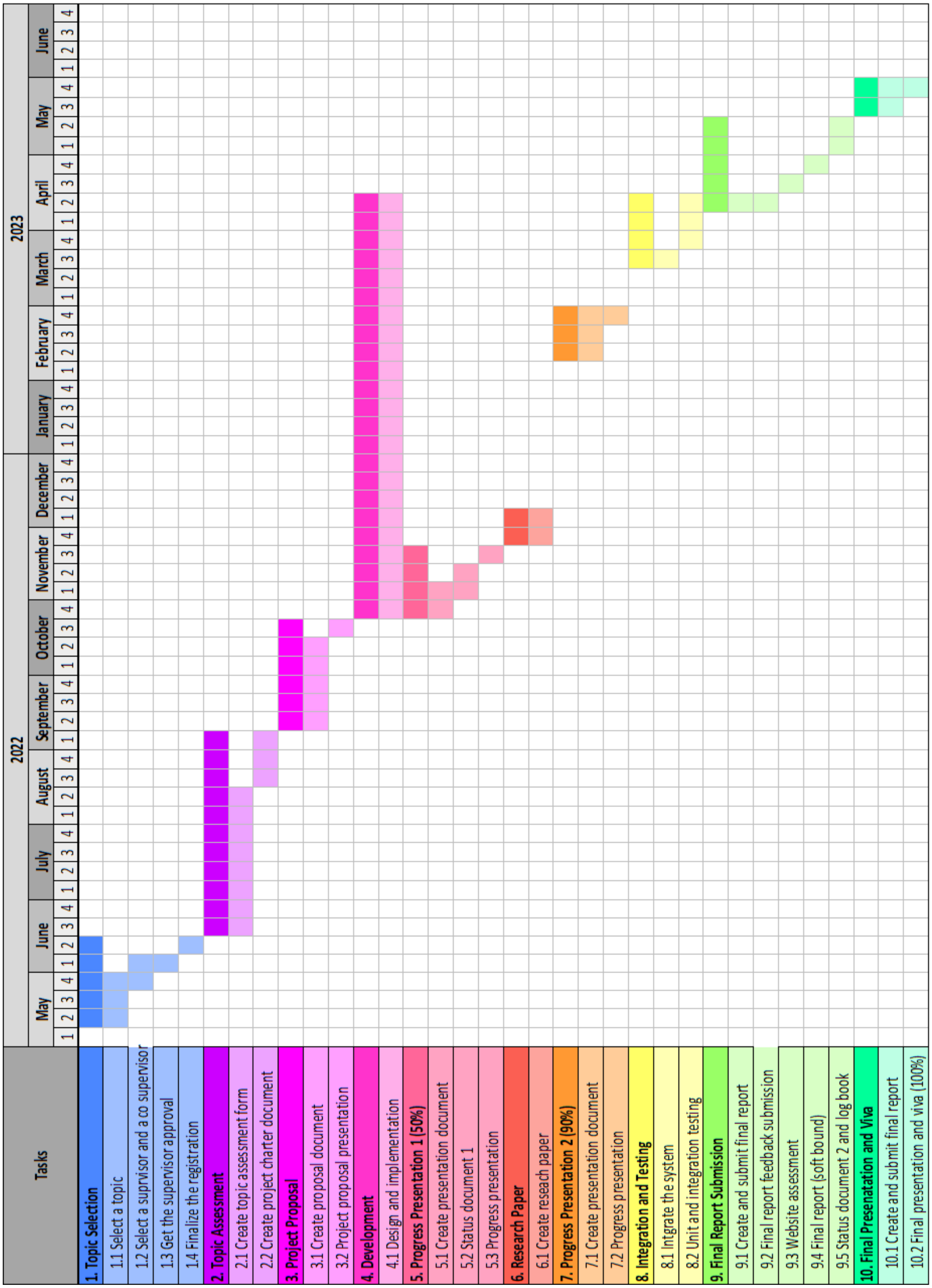


Figure 2.1: Gantt Chart

4.2 Work Breakdown Structure

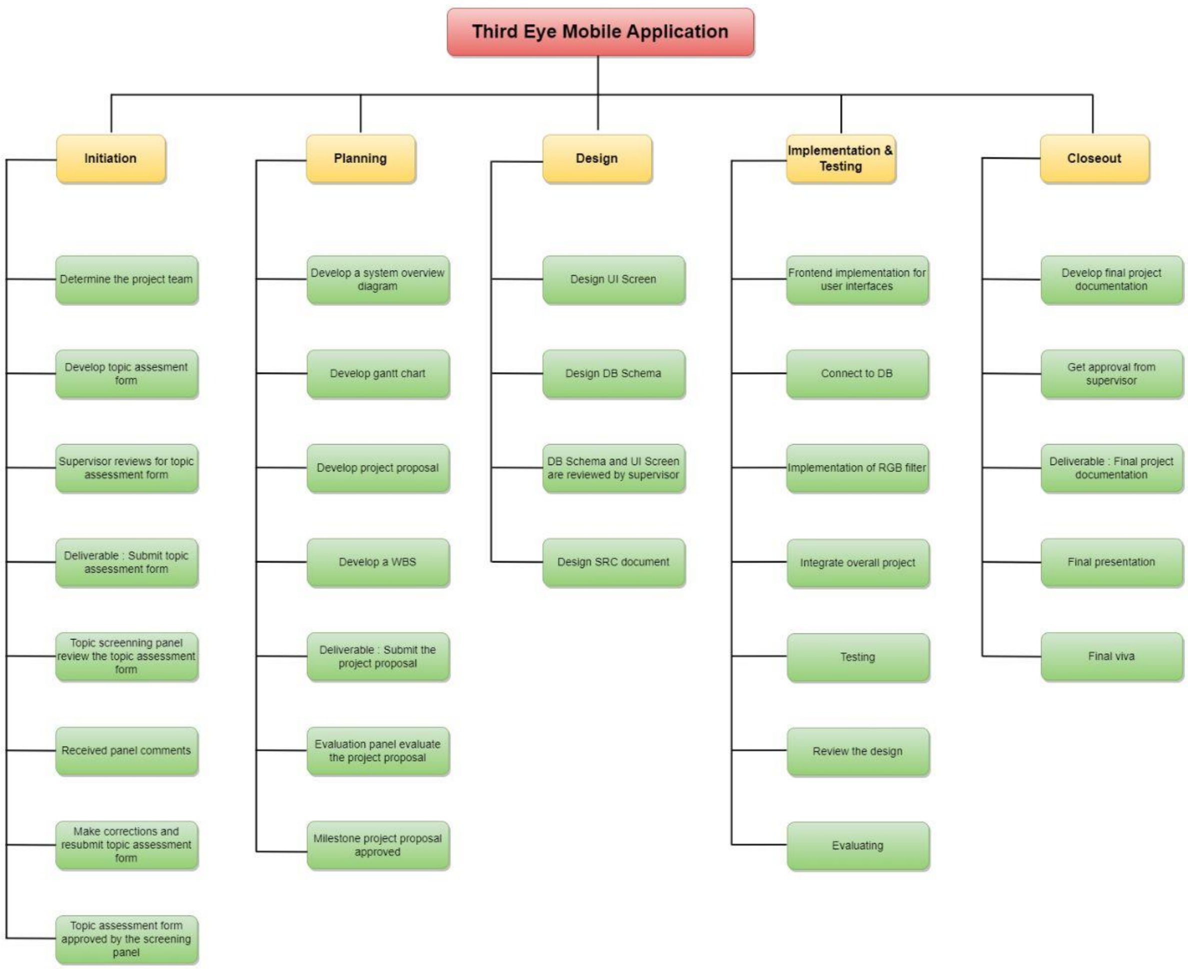


Figure 2.2: Work breakdown structure

5. BUDGET AND BUDGET JUSTIFICATION

Component	Amount (USD)	Amount (LKR)
DynamoDB ($24 per month)	288.00	110000.00
EC2 (PAYG for 750Hrs)	77.00	29000.00
Phone lanyard strap	3.00	750.00
Site visits and transport	9.00	3000.00
Document printing	28.00	10000.00
Total	**$ 405.00**	**Rs. 152750.00**

Table 5.1: Budget plan

6. REFERENCE LIST

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