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

22_23-J 83

Project Proposal Report

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

Department of Computer Science and Software Engineering

Sri Lanka Institute of Information Technology

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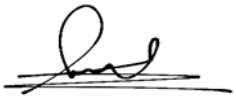
DECLARATION

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
A.M.N.D. Aththanayake	IT19981918	

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:

ABSTRACT

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.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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

1. INTRODUCTION

1.1 Background & Literature Survey

The eye is one of the main sensory organs of a living being. From birth to death, every living being, including both humans and animals, learns so many things through what they see. Memory is primarily based on what the eye sees, rather than what the ears hear, what the nose smells, what the tongue tastes, and what the skin feels [1]. So, losing one's vision is equivalent to losing one's desire to live. But unfortunately, a considerable number of people in this world have already lost this happiness because of being visually impaired. Around the world, there are 39 million people suffering from blindness [2]. Another 300 million of the total population are estimated as colorblind. According to the WHO statistics of 2021, it is an average of 6.34% of the world population [3][4]. Cataracts, age-related macular degeneration, glaucoma, diabetes, and gene factors can cause the visually impaired to be visually impaired, especially blind [5][6]. It is possible to say that 60% of the blindness in the world can be cured, and another 20% can be prevented. Unluckily, the remaining 20% can't be cured or there are no specific treatments for them. So approximately 1.5% of the population has to die, even without notifying the shapes and colors of the world [2].

But according to today's technology, there are now so many opportunities for BVI people to get rid of their monotonous lives. They are specifically designed to meet the major needs of visually impaired people, such as navigation, obstacle detection, text readers, and many others [7][8]. When considering the requirements of BVIs, the main need is that they want to travel anywhere as they like. But the main problem here is encountering obstacles along the way because every route is not as clear as a runway. Not only in the outdoors, but also within their own homes, blind people face numerous difficulties when moving from one room to another due to various types of obstacles [9][10]. Most blind people use a traditional white cane (white stick) to stop being injured when navigating. However, the white stick is not always successful because it does not recognize objects in higher levels. So, even though the blind person could be protected from the obstacles on the ground level, there's no shield to protect their heads until they hit something [11][12].

Usually, both navigation and detecting obstacles happen in parallel [13]. Normally, most blind people use different types of devices to accomplish these navigation and detection purposes. To gather details regarding this point, in 2018, a survey group in Saudi Arabia conducted a digital survey for a selected sample group, which is the age group between 18-

65. The below bar graph describes the common equipment that 164 respondents used to carry to fulfil the above requirements [14].

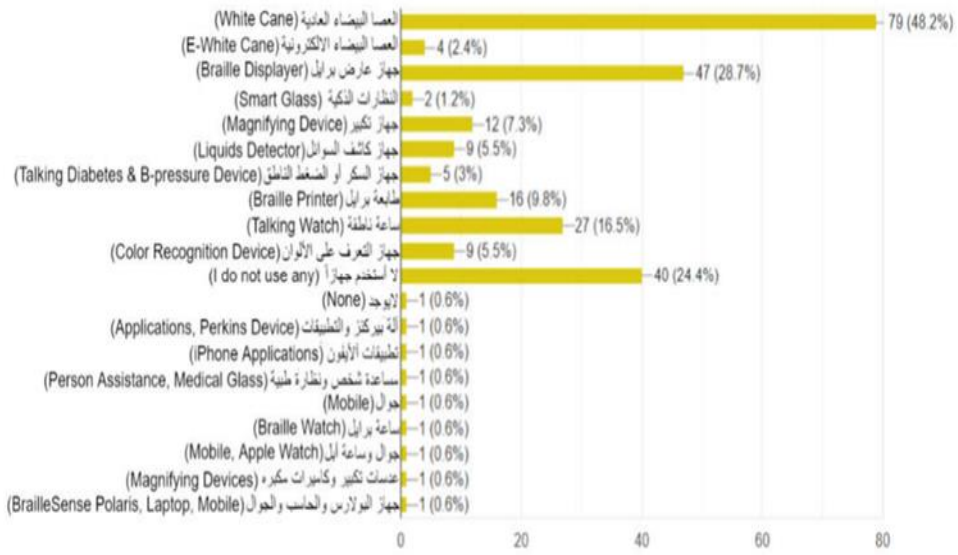

Figure 1.1: The use of different assistive technology by the survey participants in Saudi Arabia (number and the percentage)

As it shows, 48.2% of participants use white cane. It is mainly because the white cane is simply affordable, easy to handle, requires no instructions to follow and is also the symbol of blinds. Rather than the other techniques, the white cane can be used primarily for the purpose because it is inexpensive, easy to handle, does not require any instructions to follow, and is also the symbol of blinds [12][15]. Rather than the other techniques, the white can be used mainly for obstacles' identification purposes. Moving here and there, most objects on the ground level can be identified. Even though they are not mentioned here, sometimes a trained dog can also do the same thing. These guide dogs are specially trained to guide their blind master to avoid obstacles [16]. Not only that, nowadays, some smart equipment is also designed for BVIs to detect objects. The smart white cane is one of them [17]. It uses ultrasound waves or RFIDs [18]. The bat also uses this technique to detect objects. Bats produce echolocation by emitting high-frequency sound pulses through their mouths or noses and listening to the echo. They can then detect where the particular objects are [19]. Likewise, this smart white can also send out waves as the user walks on the road, then the cane detects the obstacles and vibrates according to how far they are. An ultrasonic sensor detects objects at body or head level and gives a warning vibration [17]. The user can use this cane with their smartphones and then use the cane’s touchpad to access features like voice assistants or navigation. The advantage here is that not only the obstacles at ground level but even those at high level can be detected. But the disadvantage

is that this smart product costs up to $500, an expensive price that normal people can't afford. And also, it is hard to protect this device because digital and sensitive circuits are not water or dust proof [17][20].

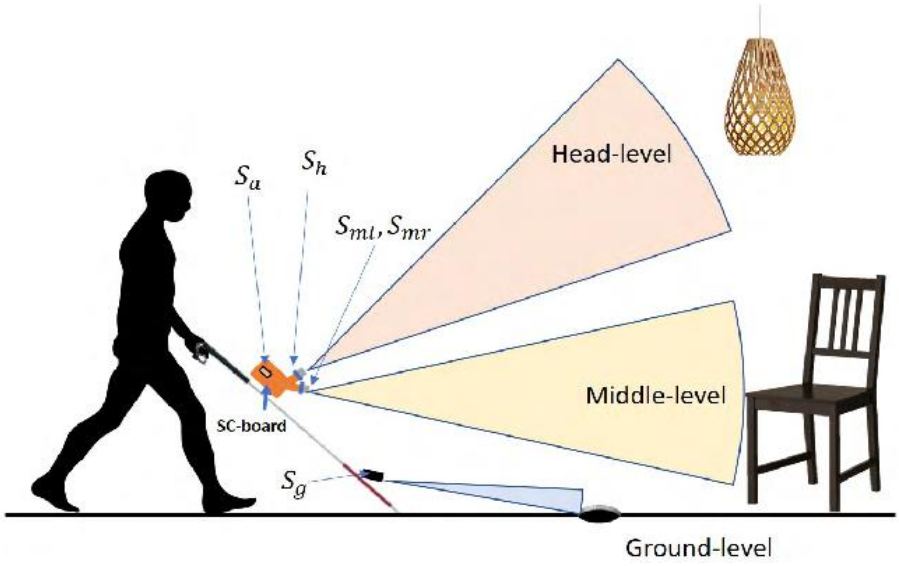

Figure 1.2: The area which the smart cane covers to detect the obstacles

However, the main usage of assistive devices for BVIs is to recognize obstacles while navigating to somewhere. The below pie chart confirms this detail. The highest number of participants' (39.6%) response was that assistive devices are mainly needed for navigation and detecting obstacles. Again, the fourth majority of responses are for objects' recognition.

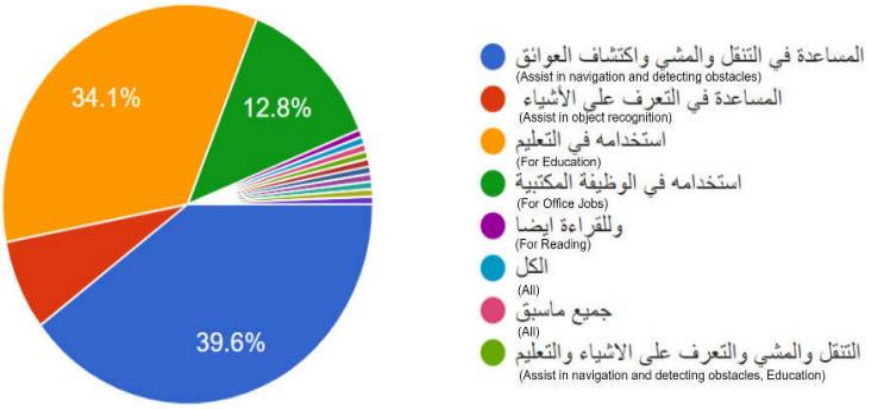

Figure 1.3: The purpose of assistive devices according to the survey participants

An important point discovered here is that, even though how developed the technology is, the traditional or smart products couldn't satisfy the BVIs by fulfilling their requirements when identifying obstacles. Due to the fact that assistive devices can't detect every object in the navigation paths, some participants are used to using mobile applications for visually

impaired people to detect obstacles. In order to decide the importance of obstacles' identification, the below survey results would be useful.

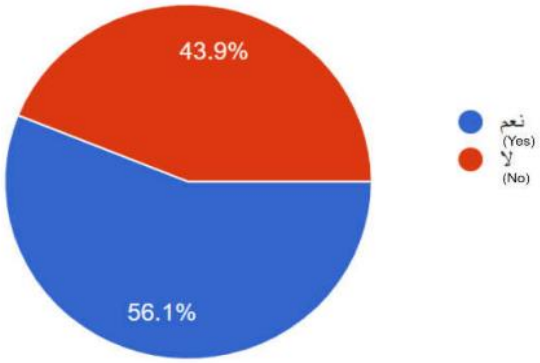

Figure 1.4: The distribution of survey participants using object recognition applications

More than half of participants (56.1%) use any of the object recognition applications. The remaining 44% said they do not use any kind of object recognition apps. Finding solutions to the problems of existing object identification mobile applications is the purpose of this survey. So, it is needed to check what these mobile applications are and what the drawbacks are. The below figure indicates what the most commonly used mobile applications for object recognition are.

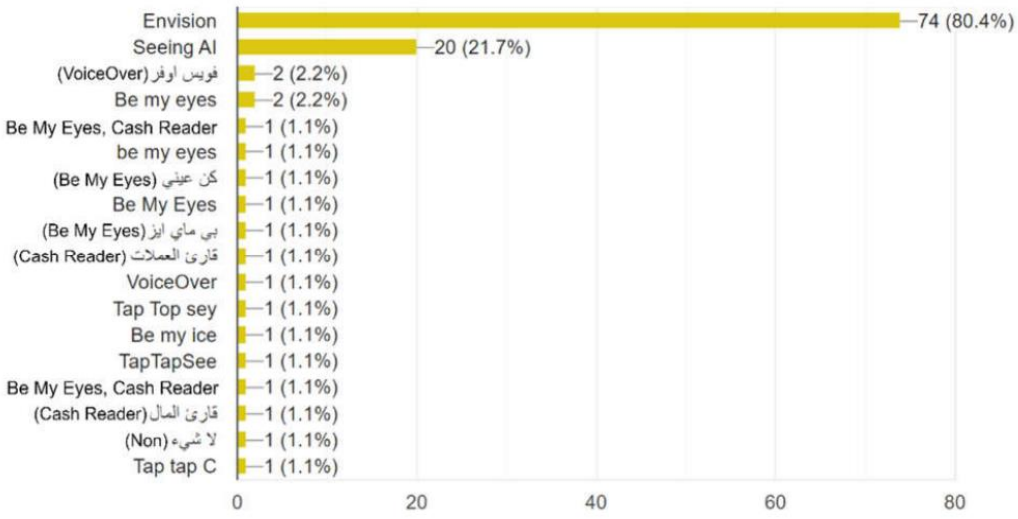

Figure 1.5: Popular object recognition apps used by the survey participants

Above bar graph shows that “Envision” represents the most used object recognition app on mobiles (80%), second comes “Seeing AI”. Envision app helps the blind and the visually impaired to read text and documents, recognize faces, and find objects. Seeing AI is the

second most popular object recognition app (22%), and that is mainly because it is only available on iOS, whereas “Envision” is available on both iOS and Android [21].

When considering about the satisfactory level of these mobile applications, most of the respondents are not satisfied with the object recognition apps they are using (59.8%). While 40.2% were neutral and the rest were satisfied. The unsatisfied participants said that the app helps them depend on themselves when navigating indoors and outdoors.

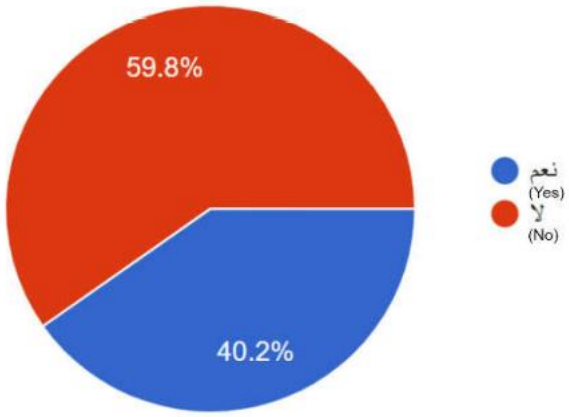

Figure 1.6: The satisfaction level of object recognition mobile applications

There are so many problems that can be identified in these object detection applications: mismatches of the final results; complexity of usage; latency of processing data; not recognizing the object; sometimes the light is not enough to detect the object [22]. Another thing is that most users don’t like to hold the phone the whole day to capture the objects. They want to keep their hands free to do other tasks [23]. These are the main reasons for receiving negative feedback on the above survey. These details will be discussed in more detail in upcoming pages. As already said in the above, both the detection of objects and navigation are parallel tasks. So, to succeed in navigation apps, obstacle detection also needs to work properly. And also, it gives the user a safe and smooth journey until they reach their destination.

In this component, the main focus is on implementing a mobile application for visually impaired people to identify obstacles. Besides some assistive physical devices that are now existing, it is much easier to do this process via a mobile application because, in today’s world, the mobile phone is the most used piece of equipment to do day-to-day tasks. So, let’s have a look at whether the "Third Eye" mobile application would be able to accomplish these drawbacks.

1.2 Research Gap

In order to understand the research, first it is needed to check what traditional techniques are used for object detection and identification. As discussed above, the traditional white cane and guide dog are the most common and easiest ways of identifying obstacles. But they can only detect objects at ground level [13][16]. To overcome this problem, the smart or e-white cane was introduced. Like it is shown in Figure 1.2, the smart cane can cover the higher areas using ultrasound. Rather than that, ultrasonic vision-based smart caps and smart glasses have been introduced. These devices are designed to connect with smartphones. As soon as the object is detected by these devices, the voice assistant lets the user know about it via a connected hand free or a headset [24]. But approximately, these devices can cost around $500 and above, which a normal person can't afford [25].

Figure 1.7: White cane

Figure 1.8: Guide dog

Figure 1.9: Smart cap

Figure 1.10: Smart white cane

Now let's have a comparison between existing mobile applications and the proposed product. The below table shows the most popular object detection and recognition mobile applications with their functionalities.

Mobile application	Logo / Icon	Functionalities
TapTapSee		Double-tap the right side of the screen to take a picture or double-tap the left side of the screen to take a video. TapTapSee can accurately analyze and identify any two- or three-dimensional object at any angle within seconds. The device's VoiceOver then speaks the identification aloud.
Seeing Eye GPS		The app can identify objects, text, and even people. Simply navigate to the Scene Preview channel. Once the user ready, double tap the "Take Photo" button. The app will describe the surroundings. At the top of the screen is a "Close" button.
Be My Eyes		Be My Eyes uses live video chat to communicate with the volunteer at the other end, whilst other apps will require you to take a photo. The person who's blind connects to people with sight, points the smartphone camera at things and gets help seeing what they are.
Lookout By Google		By using your smartphone's rear-facing camera, Lookout identifies important items in your environment and reports the information it believes is relevant. This might include things like exit signs, the location of a bathroom, people, or objects nearby, and even text in a book.

Supersense		The app's Object Explorer mode uses streaming video from your smartphone camera. No need to take photos and wait for images to be uploaded and analyzed. Slowly pan the phone and the app will identify and speak the names of furnishings: sofas, chairs, lamps, picture frames and such. Again, the identification happens in real time

Table 1.1: Existing obstacle detection mobile applications which popular among BVIs

Almost all the applications provide the facility to take a photo of the particular image, and then the system says what the object is [26]. These apps better familiarize the blind user with identifying home equipment and furniture. But in this research area, the main focus is going to be on detecting and identifying objects while navigating to get away from them. So, the system should be able to calculate the distance between the object and the person by considering the user's walking speed, the dimensions of the object, the user's height, and the time to reach the object. And also, another important point is that most of the above mobile applications fail to recognize objects when light is not enough to capture them. Another important aspect of this point is that the app should be able to identify whether the bulb is on or off [27]. This point is needed when the user's camera captures the color lights in a pedestrian crossing. If the system is unable to say which status the color lights are in now, it can be a threat to the user's life. So much research has already been done in this area. Most of the time, in navigation and object detection applications, blinds only give alerts when they detect objects. Sometimes the voice assistant doesn't inform the user how far the object is. It only does warnings and gives instructions to not collide. According to the surveys done for BVIs, they want to know about everything around them in detail [28]. So, they prefer to know what the object is and what its other dimensions are. The below table indicates the areas that have been discovered in previous research and which areas should be considered more. The "Third Eye" mobile application aims to provide solutions for these uncovered areas.

Research	Object detection	Object identification	Illumination condition	Distance calculation
Research A	Yes	No	No	Yes
Research B	No	Yes	Yes	No
Research C	Yes	No	No	No
Third Eye (proposed system)	Yes	Yes	Yes	Yes

Table 1.2: Comparison between previous research and the proposed product

Here, most of the research focuses on either object detection or object identification. These are two different terms; while detection means capturing that there is an object, identification means recognizing what the captured object is. Most of the time, for this recognizing task, the background light is very important. That is what "illumination condition" means [29]. In another research, it was mentioned that what are the types of obstacles that can be found in the environment [30].

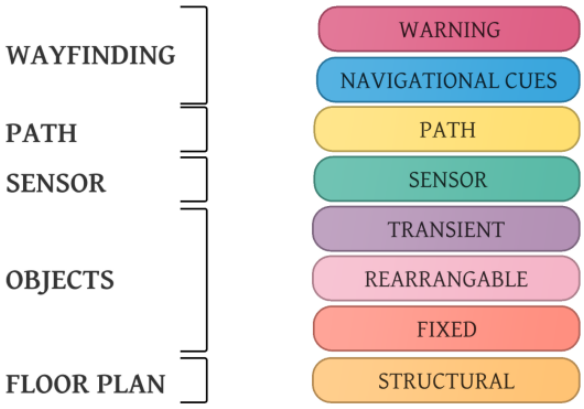

Figure 1.11: Classification of obstacles

Among them, except transient, all other obstacle types are considered in this research part. To detect a self-moving object, more data should be trained within a given period while considering the other implementations. And also, it can be more difficult to both detect and recognize a moving object because the speed of each object can vary. Even though it is a bit easy to detect a slowly moving object, the fast-moving object's time won't be enough to capture and process data [31][32].

Way finding	Navigational cues and warning information	Warning	Warning markers and information about hazards that could happen to visually impaired people such as sharped edges, stairs and escalators, slippery surface, holes, drop-offs, glass doors and automatic sliding doors.
		Navigational cues	The cues that can be used to promote the indoor navigation by BVIs people such as objects like edges and corners, intersection, landmarks. The transition spaces stairs: tread width, riser height, and depth width.
Path	Walkable areas and paths	Path	The walkable areas (hallways) and restriction areas (emergency exit)
Sensor	Camera, Wi-Fi, RFID, and others	Sensor	Lighting, smoke detector, Wi-Fi, RFID, camera or CCTV, door, switch sensor, and others.
Objects	Fixed, Transient and Rearrangeable objects	Transient	The objects that can be rearrangeable, but last for a short period of time, for instance self-moving objects (people, pet, and robots) and also used in terms of measuring indoor traffic, detecting objects.
		Rearrangeable	The objects can be rearranged like furniture (table, chairs, waste bins) or other objects that remain in their position for a medium to

			long period of time, depending on a movability factor
		Fixed	The fixed objects that permanently installed inside the buildings (furniture) and transition objects like doors, stairs, escalators, and lifts. And also, drop-offs, curbs, events, and restriction areas (construction and renovation areas).
Floor plan	Relationships of rooms, spaces, entrances	Structural	The relationships between rooms and transition spaces (doors) for each floor inside the buildings, where each floor can be linked to other floor by the transition spaces (stairs, escalators, lifts). And also, about dimension, size, wall type, etc.

Table 1.3: Objects classification

1.3 Research Problem

According to the information discovered in previous sections so far, a few major issues can be identified in blind obstacle identification. Despite the significant progress in this field and the great ability of computer vision, the detection of objects is a complex process, for the implementation of which it is required to go through certain challenges [30][33].

Viewpoint variation – An object viewed from different angles may look completely different. For example, the images of the cakes that can see differ from each other because they show the object from different sides. Thus, the goal of detectors is to recognize objects from different viewpoints.

Deformation - The subject of computer vision analysis is not only a solid object but also bodies that can be deformed and change their shapes, which provides additional complexity for object detection.

Occlusion - Sometimes objects can be obscured by other things, which makes it difficult to read the signs and identify these objects. For example, in the first below image, a cup is covered by the hand of the person holding this cup. In the second image, a person is also holding a mobile phone in such a way that the hands are occluding the object. Such situations create additional difficulties for determining the subject.

Figure 1.12: Occlusion of objects

Illumination conditions - Lighting has a very large influence on the definition of objects. The same objects will look different depending on the lighting conditions.

Cluttered or textured background - Objects that need to be identified may blend into the background, making it difficult to identify them. For example, the below picture shows a lot of items, the location of which is confusing when identifying scissors or other items of interest. In such cases, the object detector will encounter detection problems.

Figure 1.13: Clustered background

Variety - The same object can have completely different shapes and sizes. Computer vision needs to do a lot of research to read an object and understand what it means.

Speed - When it comes to video, detectors need to be trained to perform analysis in an ever-changing environment. It means that object detection algorithms must not only accurately classify important objects but also be incredibly fast during prediction to be able to identify objects that are in motion.

Due to this component's main focus being on identifying obstacles in outdoor navigation, some of these issues can be ignored, because there are so many obstacles that can be found in normal surroundings. Training data to capture almost all of these things can be a kind of tedious task. So, here the target is to give more accurate data about obstacles that can be found in normal outdoor navigation paths, such as holes, fences, parked vehicles, poles, trees, color lights, buildings, houses, edges, pedestrian crossings, bus halts, and so on. To train on this data, the system should also be implemented with a higher accuracy. However, now let’s have a look at what the drawbacks are in obstacle detection and recognition mobile applications.

- Both indoor and outdoor navigation is hard due to the obstacles in the way.
- Most apps support detecting objects at lower levels.
- Sensor devices are needed to detect objects. Most of them are external wearable devices and are also expensive.
- Even though most apps support the detection, recognizing it is a minimum requirement. And also, to recognize that photos should be taken of the particular object. Sometimes it gives an accurate result after a few attempts.

- The users don’t know about the distance, dimensions, or even the name of the object. Most applications, instead of a voice assistant giving specific information, use a "beep" sound or a vibration to notify the user.
- Recognizing is directly affected by lighting conditions. Most apps are unable to detect an object in dark environments.
- Most datasets have been trained to identify a limited number of obstacles.
- Not supportive to identify restricted areas, slippery places, wet floors, construction areas, and so on.
- The latency of data processing due to network issues.
- Most apps rely on the user’s demands and preferences and have imitations, such as some apps that are only available on iOS [34]. To activate new features, the premium versions should be bought.

This component aims to provide solutions for most of the above-mentioned problems. As the main objective here is to implement a mobile application for visually impaired people to navigate in the outdoors (and selected indoors) while detecting and identifying obstacles, the system should be more accurate, fast, effective, and reliable.

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 Objective

Main objective of this component:
Implement object identifying when navigating through the journey to assist with obstacles as well as distances calculating to forecast collision detection.

To accomplish this main objective only detecting obstacles in not enough. The system should know their names, distance, and dimensions. Because some objects can be useful things such as bus halt, pedestrian crossing, traffic lights while other objects act as barriers. Main purpose is, avoid collisions, so even in the dark not only in the light, but the system should also be able to detect object. Instead of alerting techniques, a voice assistant is used to give warnings. This voice assistant shouldn’t fussy and troublesome. From the starting to the destination, the app should be more supportive to the user to accomplish the navigation purpose while detecting and recognizing the obstacles on the way.

2.2 Specific Objectives

In order to reach the main objectives, the specific objectives that needs to be achieved is follows,

1. To detect and recognize the objects
   As discussed earlier, detecting every object in the world is a kind of tedious task for a human-made system. In the research gap section, the table shows the classification of objects, and capturing all these objects in a real-time video is very difficult when both implementing the system and adapting the visually impaired person to the system. To reduce this problem, some static objects like buildings and houses are already detected

and saved from the Google Maps Street View. Other objects that meet at that particular moment are detected by the real-time video from which the camera captures.

2. To calculate distance between the user and obstacle

   In this part, a few formulas are needed to calculate the distance and location of the object. The measurements of the camera angle, the height, the length and the width of the object, the height of the phone's camera from the ground, and the user's walking speed are needed. This system should have a trained dataset to detect an object as soon as possible. Because the data should be captured from real-time data, the system should have a proper understanding of the 3D view of the object.

3. To work properly in every background conditions

   As discussed earlier, the app should be supportive in different lightning conditions. If the light is not enough, the app recommends turning on the flasher. Because of the other sensors that are not used in this system, the phone camera should work properly in every condition. Not only should the illumination conditions be met, but the data should also be processed quickly, even on online and offline platforms. In the signal-weakened areas, the offline database can be able to provide the necessary information. With parallel map navigation, data should be refreshed. Because it is useless when the warning comes after the user has collided with the object.

4. To be effective, clear, and accurate when the voice assistant guides the user

   The voice assistant's duty takes a main place in this part. It is the one who gives correct instructions regarding how to avoid the object. So, it should be triggered quickly when the system detects the user's path is not smooth any longer. But it shouldn't confuse the user by providing almost all the details including unnecessary facts. It should guide the user calmly until the user make sure they have passed the object without any threat.

3. METHODOLOGY

In order to satisfy the main objective, the sub objectives should be implemented correctly. Not only detecting the object, but it should also fulfil the background factors such as illumination condition, stabilizing, accuracy, and dimensions. Below mentioned are the features of obstacle detection component to be implemented.

- The app should be supportive for both obstacle detection and identification
- Measurements for the distance calculation, should be correctly done considering the relevant dimensions.
- The system should be able to identify what are the supportive objects and what obstacles act as barriers.
- Output data should receive to the user on time.
- Live data or stored route data can be used for object detecting purpose.
- Should work properly in both online and offline platforms.
- Should be work in different lighting conditions.
- The app should be flexible for user's needs and should be triggered in necessary conditions.
- The voice assistant's instructions should be clear and supportive.

3.1 Overall System Architecture

This "Third Eye" mobile phone app is composed of four main sections. One of them is targeted at people who have color blindness. The users of such a feature should be able to view live videos and photographs in their natural color, just like a healthy person can. For those who are completely blind, there are three additional sections. As already mentioned, this part focuses on obstacle identification. To be supportive of this section, another part is focusing on map navigation for both indoors and outdoors. It provides similar location suggestions and a customized voice assistant in order to be more effective. The last part is detecting texts and reading aloud techniques. To increase the uniqueness of this part, additional text translation and weather forecasting techniques have also been included. The weather forecasting part helps the user to get a better understanding of the day's weather so they can be prepared to bring an umbrella or not before they go out of the home.

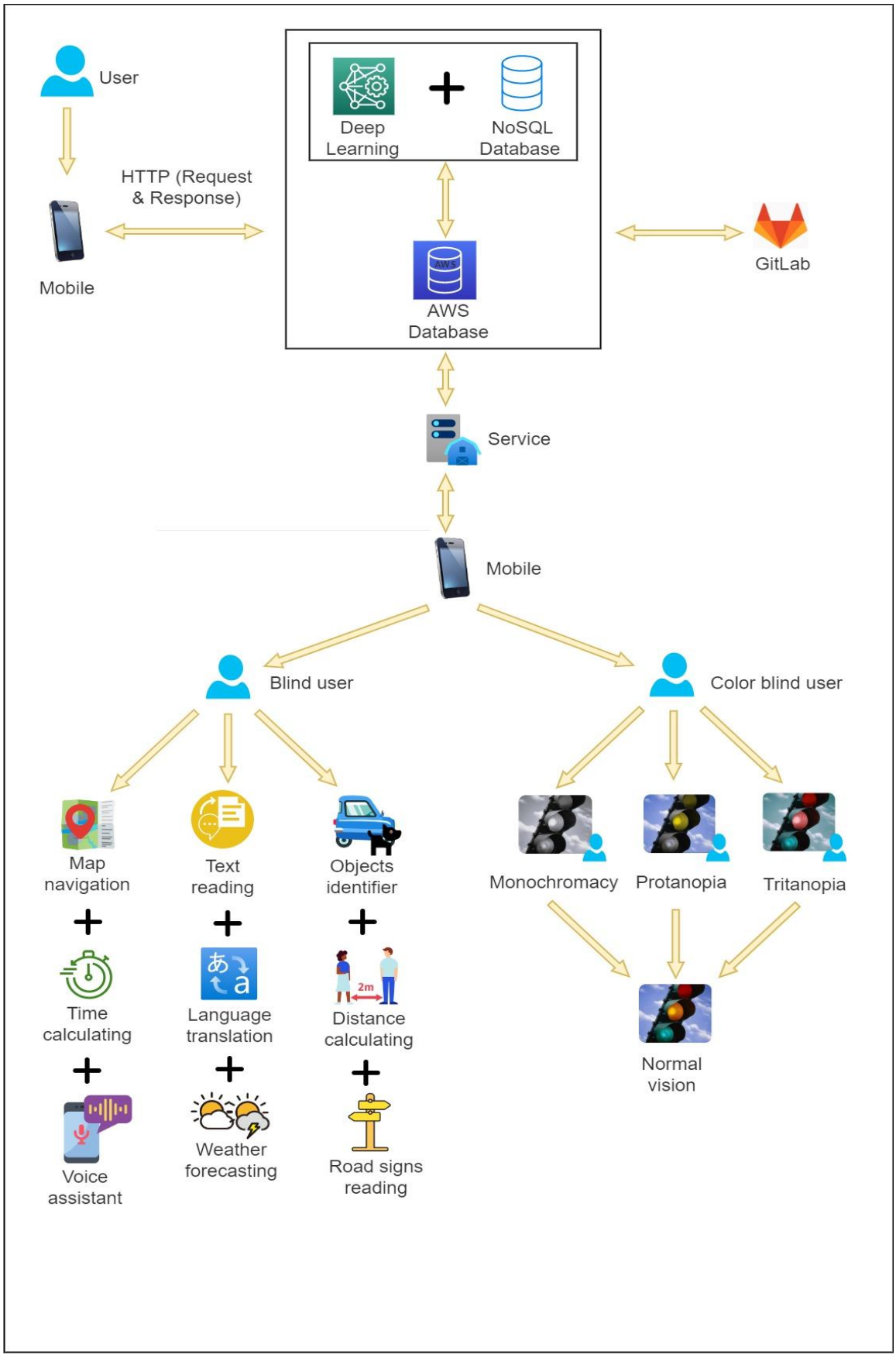

Figure 3.1: Overall system architecture diagram

3.2 Component System Architecture

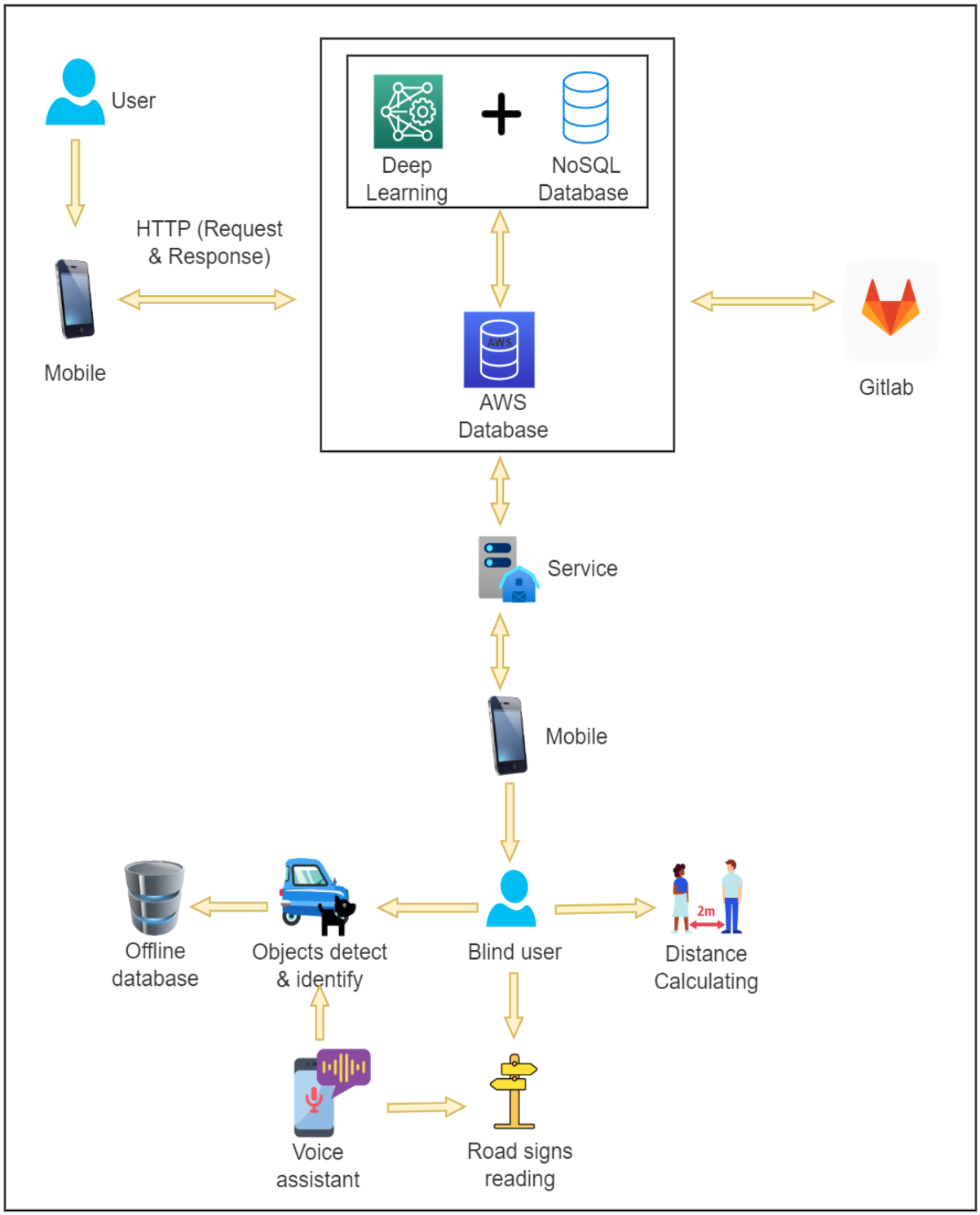

Figure 3.2: Component architecture diagram

3.3 Hardware Solution

This application's usability emphasizes the hands-free experience it offers the user. The back camera of the phone is wholly reliant on the app. The user must maintain the phone at least above the level of their stomach. The user can use a code to keep the phone in their shirt pocket or slung around their neck (this solution is better for men). This app completely relies on data collection through the phone camera, so it must be kept at a location where data collection is simple.

The user can directly talk into the phone's speaker to issue voice commands, as well as directly listen to the phone's speakers to hear what the voice assistant says. However, using a handfree or headset is advised in order to be more practical, particularly in crowded and noisy environments. They come in wired and wireless varieties (Bluetooth). The user should only have certain pieces of hardware in order to use this mobile application. The user enjoys an inexpensive, simple, and hands-free experience.

Figure 3.2: Hanging the phone around neck

Figure 3.3: The phone in a shirt's pocket

3.4 Software Solution

Agile is a methodology and framework that enables users to adjust and work more efficiently when developing and testing their products. As opposed to more traditional project management techniques like Waterfall, Agile approach allows a product to be built and tested simultaneously. This process necessitates meticulous planning both before and after any changes are made to the final output. Due to the extremely thorough project management technique, it is obvious that one modification can cause the entire project to go behind schedule and jeopardize the teams' ability to provide high-quality work.

Figure 3.4: Agile development cycle

One of the various Agile project management approaches is scrum, as was already noted. It is frequently employed, particularly when managing software development projects. In addition, unlike more conventional project management techniques, scrum encourages teams to make mistakes as they go rather than waiting for the plan to succeed or fail before having to go back and fix them. This idea will be considered as the "Third Eye" mobile application is created using Agile approach.

- Requirements gathering and analyzing

  The Rathmalana institution "The School for the Blind" was chosen to meet the standards. It is preferable to gather at least 50 samples in order to lessen the disputes or mismatches in their needs. Regardless of age, the sample should include both male and female participants. The findings of surveys on blind navigation that were undertaken for people who are visually impaired in some nations were also gathered in order to develop this project proposal. These specifics are already covered in the pages before this one.

  Schedule feasibility – This navigation component should develop within the given timeline because it takes a considerable time to train a huge amount of data sets of different obstacles.

  Economic feasibility – For this component, there’s no need for sensors or external devices. So, there’s no expenditure for the hardware equipment. But it can be costly when there’s need of buying the necessary software tools from the internet. As an example, the AWS cloud platform is needed for some implementations. In these kinds of services hire a charge if the free period is over.

Technical feasibility – This function mainly relies on the phone's camera quality. It is recommended to have a considerably good pixel to detect obstacles in both light and dark places. The phone's flasher should work properly when the light is not enough to detect an object. And also, this function should support the map navigation function in parallel by detecting the obstacles within the given time. There shouldn't be a delay between data capture, processing, and output. Network conditions will also be supportive for this part. But it is recommended to work on this part on both online and offline platforms. The user's walking pattern won't be a problem for the smoothness of capturing data. If it is, the stabilization settings can be used to increase the stability of the live video.

- Implementation

  The development of the functionalities listed below is in line with the implementation phase.

  - Implementation of the object detecting and recognizing.
  - Implementation of the distance calculation of the obstacles in front of the user.
  - Training objects using the stored route data of map navigation.
  - Implementation of the voice assistant.
  - Storing objects' data to the offline database.
  - Optimal data capturing and processing
  - Computer Vision

3.5 Requirements

3.5.1 User requirements

- A user should be a registered person.
- The system should be able to be handled by the user easily with simple and quick actions like voice commands and finger taps.
- The user should be able to know the particular object's details quickly and accurately.
- Users should be able to maintain trust in the accuracy of data.
- The system should be supportive according to the user's demands and requests.
- The app should be a secure place for user details and shouldn't violate user privacy.
- The voice assistant should be customized according to the language or speaking speed.

- The app should be supportive to the user in identifying objects even in the dark.

3.5.2 System requirements

- System should be applicable for full blind and color-blind people.
- Proposed mobile application should work on both Android and iOS mobile operating systems.
- The app should be supportive in both online and offline platforms.
- The phone flasher should work properly when the background light is not enough to detect an object.
- Smartphone should have at least a 20MP back camera which all of modern smartphone have these days.

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

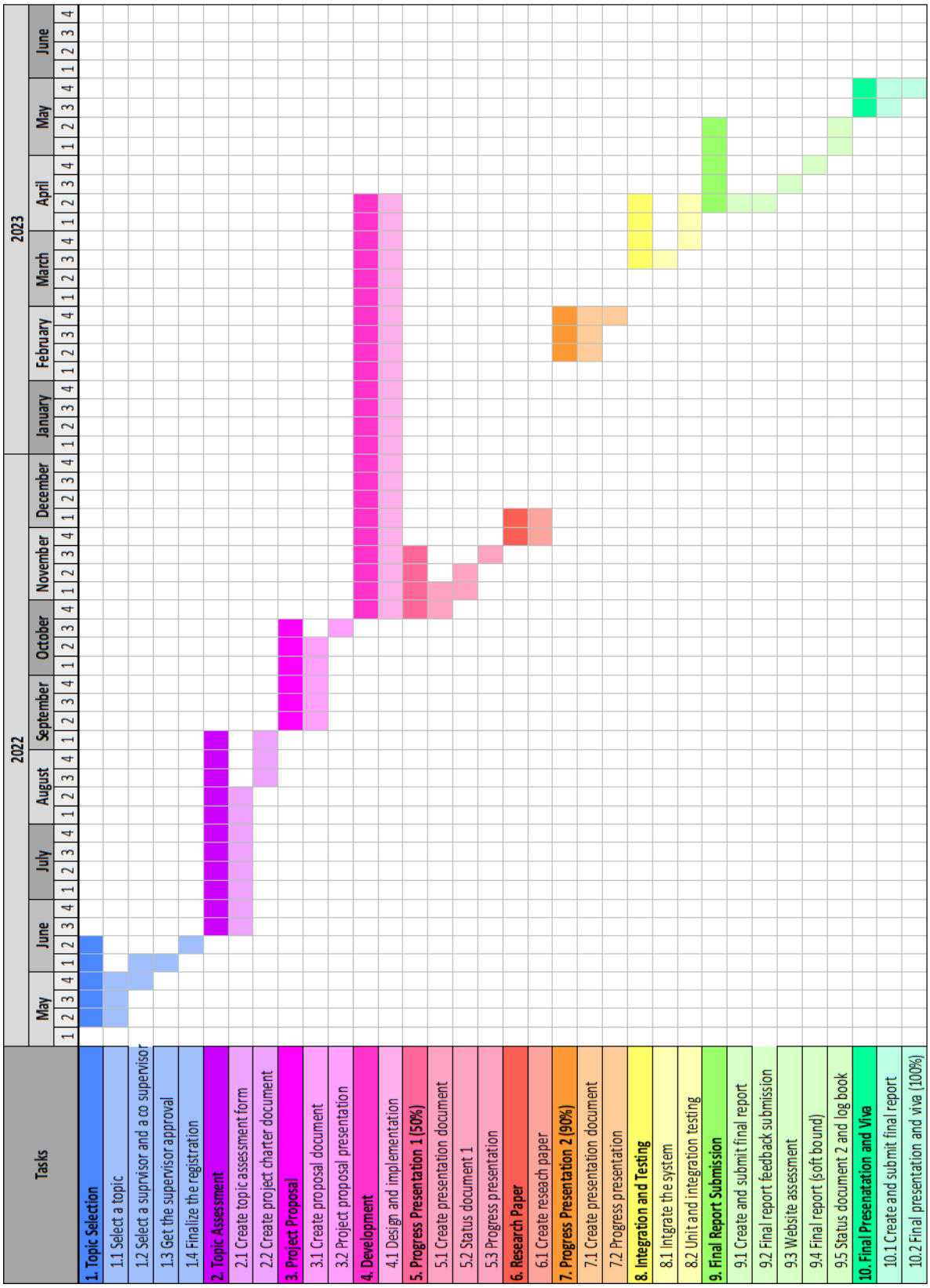

Figure 4.1: Gantt Chart

4.2 Work Breakdown Structure

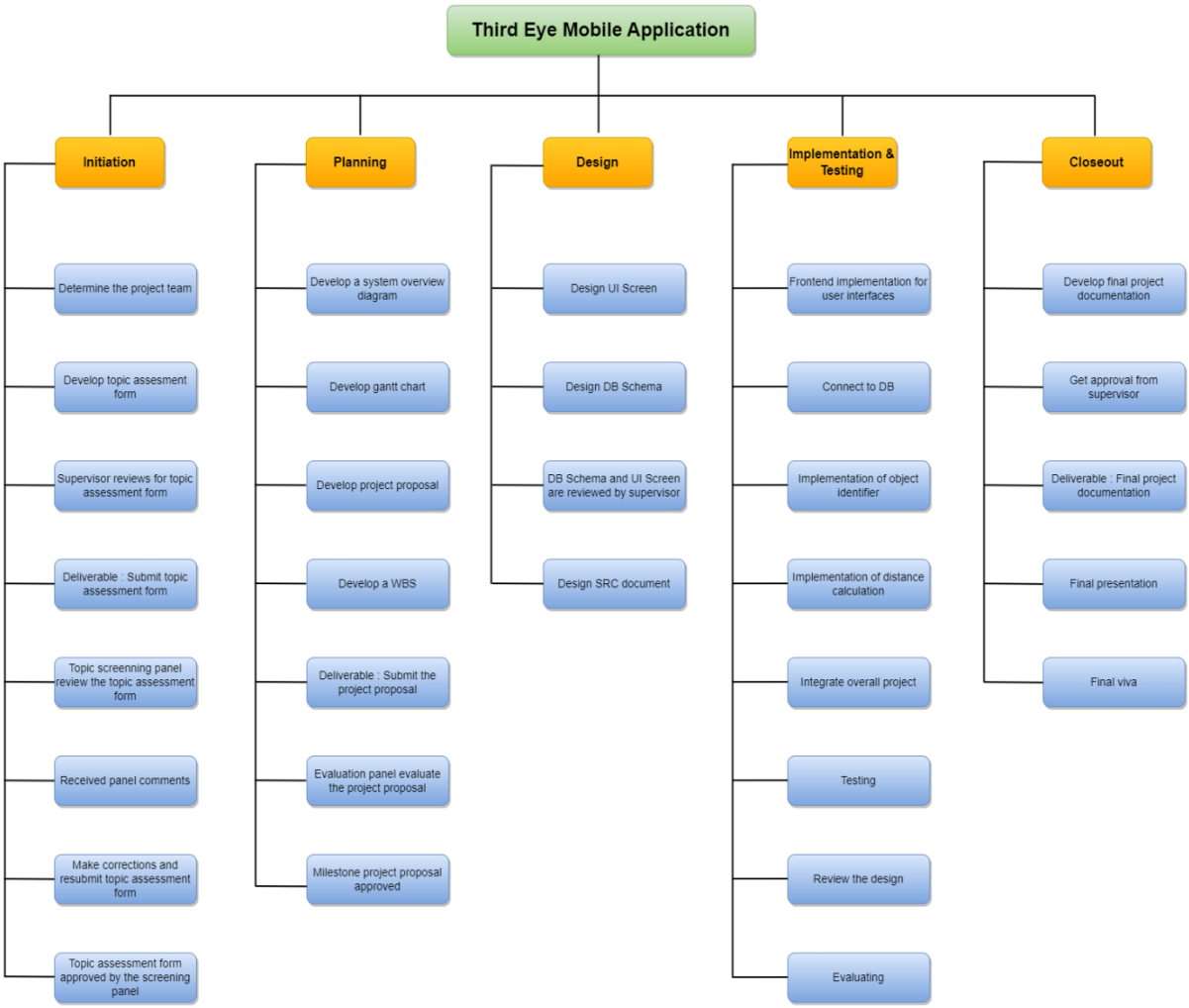

Figure 4.1: Work breakdown structure

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

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