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

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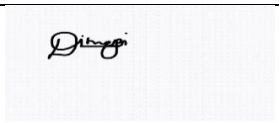
DECLARATION

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
K.D.J Jayasekara	IT19103600	

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.

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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

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Introduction

1.1Background & Literature Survey

Vision is one of the key sources to gather information about the surrounding to a human being. Vision facilitates our movement and development of everyday tasks to control activities efficiently. Blind people face great difficulties when moving and doing their day today tasks accurately, especially in unknown environments which reduces their self-confidence and puts individuals at risk mistakes and accidents.[4]

Table 3

Quality of life of the respondents in five domains (visual function, self-care, social interaction, mobility, and mental status)

QOL domains	Poor, n (%)	Good, n (%)	Total, n (%)
Visual function	241 (64.2)	134 (35.8)	375 (100)
Self-care	17 (4.5)	358 (95.5)	375 (100)
Mobility	161 (42.9)	214 (57.1)	375 (100)
Social interaction	191 (50.9)	184 (49.1)	375 (100)
Mental health	177 (47.2)	198 (52.8)	375 (100)

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Abbreviation: QOL, quality of life.

Figure 1.1- Summary of responses from a sample 375 of visually impaired in related to quality of life as per 5 domains

[5] The above figure shows how quality of life decreases or increases in related to 5 main domains. Two hundred and forty-one patients were found to have a poor quality of life in the domain Visual function while 134 of them said of having a good quality of life. 17 in the domain self crae,161 in the domain mobility ,191 in the domain social interaction and 177 on the domain

were also found to have a poor quality of in the respective domain while the rest on sample says of having a good quality of life.

According to the World Health Organization, in 2002 the estimated number of people with visual impairment was more than 161 million, of which 37 million were blind and 124 million had low vision, 85% of the visually impaired lived in Third World countries. Worldwide, more than 82% of blind people are aged 50 years and older, the proportion rise in the aging population means that by the year 2020, the number of visually impaired people will have will increased by 46.8% which has caused a significant limitation in visual capability in many

Quality of Life Rating	Non-visually Impaired	Visually Impaired	TOTAL
Very Poor	0 (0.0%)	0 (0.0%)	0 (0.0%)
Poor	0 (0.0%)	6 (7.0%)	6 (2.0%)
Neither Poor nor Good	16 (7.7%)	32 (37.2%)	48 (16.3%)
Good	140 (67.3%)	46 (53.5%)	186 (63.3%)
Very Good	52 (25.0%)	2 (2.3%)	54 (18.4%)
TOTAL	208 (100.0%)	86 (100.0%)	294 (100.0%)

Figure 1.2-Quality of life rating among participants

In the above figure The World Health Organization Quality Of Life (WHOQOL-Bref) which assesses quality of life in four main domains was administered to two hundred and ninety four (294) patients who visited the low vision center of the Eastern Regional Hospital, for various eye services. Interviewing the participants revealed a quality-of-life rating between “poor” to “very good”. Approximately 54% of the visually impaired rated their quality of life as “good” whiles » 17% rated their quality as “poor”.[8]

Advanced New technology have increased development of systems to assist the daily lives of the visually impaired people. Most of these systems help by providing the necessary details of the surrounding to the user by ultimately using them to automatically capture he recognized text and signs in the environment and assist people to navigate by mainly using computer vision to process and interpret the visual world to the user to recognize signs text-based signs, letters, and symbols and to reconstruct sentences and covert them to speech [1].

Another one of the main difficulties faced by visually impaired is when grocery shopping for essentials. Grocery shopping fulfills the basic needs of everyday supplies for visually impaired as

well as visually unimpaired human beings. The ability to not be able to shop independently is a major disadvantage for visually impaired people, shopping becomes extremely challenging when one is not able to identify labelled text on objects to obtain the desired item, to read the value of money notes to buy the necessary product, to read and to be aware of occasional promotions. By using this advanced technology with the aid of computer vision to visually see, observe and identify letters and characters on labeled items on shopping shelves and on monetary items a visually impaired can overcome the above-mentioned discomforts faced when shopping for basic needs.

Computer vision is one of the emerging technologies that can be used to aid visually impaired people for navigation (both indoor and outdoor). By recognizing text and symbols from scene images effectively using computer vision technology and to covert recognized text into speech so that it can be incorporated to a system to aid visually impaired people [2].

Weather forecast also is essential to assist blind people to predict the weather, thereby a system can be implemented to predict weather-based om parameters such as temperature, humidity and wind and communicated with user by giving the weather report [3].

With the advancement of new technologies many applications have been implemented to aid visually impaired in many forms to enhance the quality of their life by making the capable and with time many have been successful and unsuccessful as well. The main aim of these applications was to build any device, product, or software to make them more capable, independent, and self-sufficient.[6]

- Be my eyes is one of the applications built as per the need of visual impaired, it is a free smartphone app for iOS and Android app that helps blind or low vision people with visual assistance via a live video connection. These applications assist users with 180 languages by connecting volunteers to visually impaired people in need of help with small, everyday tasks. This app was found by Hans Jorgen a visually impaired himself who saw the technology of video calls as a visual assistance to blind people using a network of volunteers to help them to demonstrate what the blind person is showing by filming with a video camera in the smartphone. Be my eyes have helped many visually impaired people’s lives easier and more flexible while giving a great opportunity to volunteers to aid individual in need of help [7].

- Sullivan plus is another visual-aid app by TUAT Co., Ltd to enhance the accessibility of the visually impaired and low vision users. Sullivan plus app mainly focuses AI mode to capture documents, images Text Recognition to identify texts and to tell user by sound, Image descriptions to identify objects and describe them to the user, color recognition to tell the user the color of the center of the screen and a magnifier glass function mainly towards low vision people to enlarge or reduce objects or texts. This app has been

identified as very useful for people with reading difficulties, particularly as the text is read aloud automatically.

- Seeing AI is an artificial intelligence application developed Microsoft for IOS. Seeing AI uses the device camera to identify people and objects, and the app audible those objects for with visual impairment describe short text, documents, products, people, currency scenery, colors, handwriting and light. Seeing AI mainly uses Facial recognition which can match image or a video frame against a database of faces that helps to authenticate users. Seeing AI app can scan barcode to describe a product and uses sounds to assist the user in focusing on the barcode. The app also describes and estimates person's age, gender, and emotional status.

- Supersense is the smartest assistive app that helps blind and visually impaired users to read, find objects, and explore places independently. It aids to visually impaired to make the physical world more accessible them.
  Supersense uses the power of AI to solve problems for blind and visually impaired as well. Supersense helps users to read texts, photos and documents using an auto camara guidance system, locates objects by scanning the environment with the camera.
  Supersense was developed to bring solutions using AI technology for people with visual disabilities

1.2 Research Gap

As I have mentioned above application made to aid visually impaired plays a major role in increasing the quality of their lives, but due few defects/issues faced by users when using the applications also puts individuals in very doubtful situations. As for an example according to a research done with 256 participants with visual impairments by Nora Griffin-Shirley professor who coordinates the Orientation and Mobility Specialist Program and few other researchers found that many individuals would like improvements and new apps by saying that Developers of apps for individuals with visual impairment needs to refine and test the existing apps and that Practitioners need to be knowledgeable about app usage so they can provide effective instruction to their students or clients. [9]

Therefor even though apps seem useful they also have drawback when used concurrently Below are some of issues found commonly found in few applications.

System	Drawbacks
 Be my eyes	Be my eyes is an apps developed to connect bling users and volunteers who's willing to give real time visual assistance to the blind or low vision user. The main issues found in this are, • A blind user cannot user a particular volunteer according to his/her preference, volunteers are filtered based on the user's language and time zone only. • This app is to be used at your own risks because a user is totally dependent on the volunteer present to fulfill his/her requirement, thereby a volunteer can be a fraud volunteering to fulfill their own needs which eventually becomes a trust issue to the user
 Sullivan plus	Sullivan plus is a free easy to use app which recognizes texts and describe people and objects around you while detecting colors and light brightness and has a magnifying glass function. • No weather prediction implementation in the application to help the visually impaired. • No currency recognizing to allow people with visual impairment or blindness to identify and count bills and notes
	Seeing AI is an application to provide audio descriptions of the world to people with visual impairments. Users point their phone's camera and turn the visual world into an audible

 Seeing AI	experience with descriptions of people, text, and objects, using the power of Artificial Intelligence (AI). • Text reading is not always accurate and reliable, have difficulties when reading nonlinear texts. • No weather prediction implementation in the application to help the visually impaired. • General scanning is not always correct, object scanning gives false results sometimes
 Supersense	Supersense is the smartest and simplest scanner application for the blind and the visually impaired. It is fueled by unique AI technology and a super-accessible user interface. • No weather prediction implementation in the application to help the visually impaired • Reported issues when reading texts using a camera guidance, does not read the text entirely • Safety issues

Table 1.1 Existing applications with Drawbacks

1.3 Research Problem

According to the problems and gaps mentioned above the application have potential to seek out and build a new guidance method. So as a solution the proposed application is considered to be created. To make things clear let's take each function separately,

- **Text recognition**

For text recognition there are multiple ways to capture texts from images and objects. Some of the methods that the system considers are as follow,

- **Optical Character Recognition (OCR)**

OCR is a technology that allows users to convert text or documents in images captured by an input device into an editable, searchable, and reusable data type for further image processing. This technology enables a machine to recognize the characters automatically through an optical mechanism just like a human being use eyes to see an object in the world. At the early stage of introducing OCR, this technology encountered several problems such as limitations in terms of the quantity and complexity of the hardware and the algorithm. An OCR system is a combination of several subsystems, and each of the subsystem itself is dedicated to solve certain problems and perform different roles in image processing. Although there are numerous algorithms available out there, most still follow the core steps which are discussed below,

1. **Image Capturing and Preprocessing**

Firstly, images are captured in this phase by a camera on real-time. Extraction of scanned images with a white background and black character foregrounds are easy to be detected but the camera captured images may contain noise because of the environmental reasons and low brightness of the images. Therefore, there are some techniques like image enhancement, binarization and noise reduction to be done in the preprocessing phase to increase the performance and accuracy of a character recognition system. Therefore, when a blind person's smartphone is constantly capturing objects and reading them even the objects are not clear this way the captured image can be sharpened and readable for the system. Also the system can use sensors of the device to further improve and support binarization

Figure 1.3 Image Binarization Example

2. Text Segmentation

Extraction of correct character boundaries is very important for recognizing a character. The segmentation of a binary image in a regular sequence can be categorized into lines, words and characters. There are many well-known segmentation methods available which are projection, region growing and tracing contour etc.

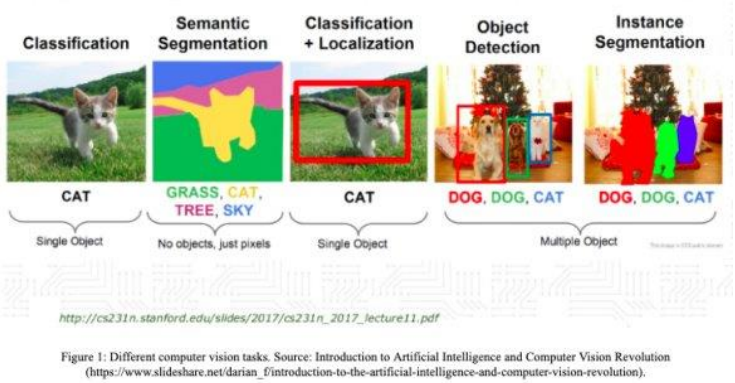

Figure 1: Different computer vision tasks. Source: Introduction to Artificial Intelligence and Computer Vision Revolution (https://www.slideshare.net/darian_f/introduction-to-the-artificial-intelligence-and-computer-vision-revolution).

Figure 1.4 Text Segmentation

3. Text Recognition

In the recognition phase, after the character is segmented, they are normalized by removing noise. Lastly, OCR extracts the character and recognizes it.

Although OCR is useful, it is not perfect without any issues. Researchers have discovered problems such as light condition, text skew, and perception distortion, misalignment of text, blur and difficulty in recognizing handwritten document. So these are the challenges for that the algorithms we implement must have and which will make the system more comprehensive and easy to be used by the target group.

With the evolving and remarkable technology in mobile device, mobile phones are now capable to capture high resolution images with at least 3088 × 1440 pixels, which are more compatible and have higher chances to be detected with OCR. Implementing OCR application on a mobile device could be realistic as there are many ongoing research in this field. However, modern mobile phones have a number of advantages like higher RAM and a larger capacity of battery. Since these advancements running an OCR will not be a challenge.

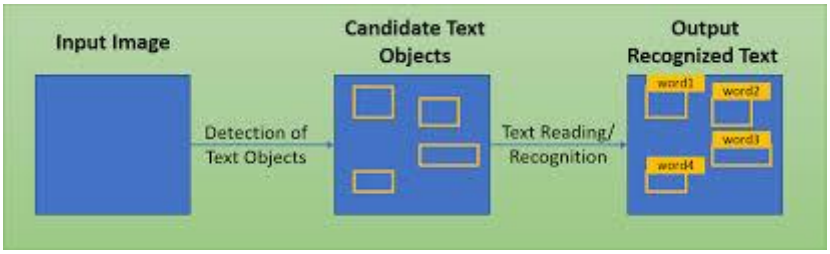

Figure 1.5 Text Recognition

- **Language Translator**

Most of the language translator engines are available on the web-based application compared to mobile based. However, there are translation engines provided in mobile environment with limited number of supported languages. As research conducted, there are 3 different algorithms of how a translator engine can be performed. They are based on crowdsourcing, where the OCR resulted character will be sent to a group of human workers to carry out translation task, an online translation service, where character extracted will be delivered to Google Translator to do the actual text to text translation, and lastly real time translator, which integrates a translator engine and dictionary on mobile phone to do the translation.

Crowdsourcing translation requires too many human resources. The translations made sometimes are not reliable and slow because of translating word by word sequentially. Another issue might be faced that if the translation is done word by word, the meaning of the original sentences might be affected and may lead to a different meaning. On the other hand, online translation service provides more reliable translation to requester, and it only requires a small amount of data package to be embedded at the backend of the smartphone. Internet connection is required to update the translator on need basis to ensure more accurate translation. It is useful to access the right information instead of getting wrong information.

Real time translator is considerable effective. Where the processing power of modern devices comes into play. Since we cater the needs for blind people, we need to have a real-time translator and read aloud at the same time while the option to work online or offline by saving frequent

words and objects that consist of texts (nutritional value of a food item, content of a food item. etc.)

- **Weather Forecasting**

When the system is been used at the first point when the map navigation is triggered the system should let the user to know the weather forecast and by each and every weather changes system should update the user about the changes. Weather forecasting can be achieved through services like Google Weather or AccuWeather. Every user of internet knows that to retrieve data from a cloud or a service it takes time. That latency can affect a blind person more since our system is working as a eye for him. Latency of even 3ms can become a danger. So getting data from services is not feasible. Therefore, we can use sensors in a smartphone. There are various number of sensors in a modern smartphone. Our target is to user 3 types of sensors which will take environmental changes accurately.

- Motion sensors

These sensors measure acceleration forces and rotational forces along three axes. This category includes accelerometers, gravity sensors, gyroscopes, and rotational vector sensors.

- Environmental sensors

These sensors measure various environmental parameters, such as ambient air temperature and pressure, illumination, and humidity. This category includes barometers, photometers, and thermometers.

- Position sensors

These sensors measure the physical position of a device. This category includes orientation sensors and magnetometers.

From these sensors for weather forecasting we will use Environmental sensors. Let’s say that a blind person is navigating through a route with the guidance of our system. Sudden weather change can render the user and the system useless. Therefore, barometers can detect changes in temperature and air pressure. Which will help to identify changes around the user more accurately. Same as barometers, photometers and thermometers can make real time data gathering and alert the user

Distinct types of sensors are embedded in modern smartphones. These sensors enable the implementation of new apps across various domains including healthcare, transportation, environmental monitoring, and safety [3]. The smartphone sensors can be classified as inertial, positioning, and ambient sensors [10]. Inertial sensors can measure the physical motion of a solid object such as accelerometers and gyroscopes. Positioning sensors can sense the user's location and presence of entities in her proximity

Using technology such as Bluetooth, WI-Fi, Global System for Mobile Communications (GSM), and Global Positioning System (GPS). On the other hand, ambient sensors such as a camera, magnetometer, or microphone are used for sensing the surroundings of a user.

Smartphone sensors at least have ten types of sensors namely accelerometer, ambient temperature sensor, gravity sensor, light sensor, linear acceleration, magnetometer, barometer, proximity sensor, humidity sensor, and gyroscope. On the other hand, another review also specified ten types of sensors that are classified into five categories namely optical, thermal, acoustics, magnetic, and mechanical. The sensors include a camera and video camera, barometer, gyroscope, proximity, digital compass, temperature, microphone, red-green-blue (RGB) light, accelerometer, and GPS.

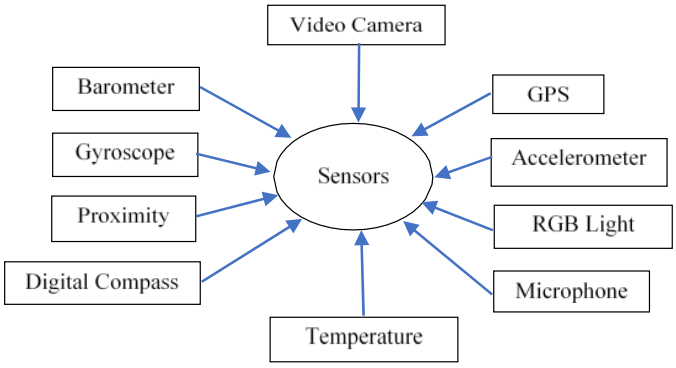

Figure 1.6 Smartphone Sensor

Below table will describe about more in-depth details about the sensors and their functionalities.

Sensors	Function(s)
Video camera	A sensor that recognizes and capture image for various purposes including image recognition, augmented reality, and indoor positioning.
Barometer	A sensor that measures air pressure and can be applied in vehicle states detection.
Proximity	A sensor that detects the presence of nearby objects and used to detect the presence of ears during a phone conversation for turning off the touch screen and brightness.
Digital compass (Magnetometer)	A sensor that detects orientation in relation to the Earth's magnetic field. It is used by compass-based apps.
Temperature	A sensor that can read the surrounding temperature.
Microphone	A sensor that can recognize sound and audio in our daily life activities such as coughing, eating, and emotions.
RGB Light	A sensor that measures illumination and it is used by default to adjust the screen dis- play brightness.
Accelerometer	A sensor used for activity and gesture recognition such as fall detection. By de- fault, the sensor is used for automatic orientation of the smartphone screen and camera.
Gyroscope	A sensor used for motion recognition that can provide the direction of orientation such as identification of driving style.
GPS	A sensor that detects the current location mainly used for positioning and location- based service (LBS).

Table 1.2 Built-in sensors in modern smartphones.

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 a real time application to assists visually impaired to identify and understand text and road signs with a real- aloud capability and trained assistance to forecast and predict weather

According to the facts and issues gathered above our main intention is to implement an application that recognizes a text on labels, symbols, and numbers using a front of a camera Then read the text using the read-aloud technique that speaks text instantly without and delay to the user thereby the user instantly identify the text and efficiently complete the task. Our main objective is to give assistance to user to identify objects in the market by capturing the texts represented. Our application also has the capability to recognize currency notes and aid the visual impaired to do their daily transaction smoothly and efficiently also by using a camera. Another functionality that we intend to implement is a weather forecasting voice assistance to inform the user about the weather before starting their day, so that can be prepared for difficulties faced by sudden weather or climate changes.

2.2 Specific Objectives

To reach the above-mentioned main objective of the app, the specific objectives that needs to be attained are as follow,

1.Implement a voice assistance to identify text quickly and accurately via a camera.

By using Optical character recognition (OPR) to recognize existing characters in text format for the voice assistance to be able to convert it to speech and real aloud any text regardless of its origin. This voice assistant needs capture the text without any delay and gives the output to the user instantly. This helps improve the quality of life for people with low vision or blind by aiding them to read text when needed. The rate of vision impairment can vary in everyone with low vision, thereby this technology become very useful in fulfilling their day today tasks. user should be easily using this voice assistance without having to ask for help from others and they can utilize this capability for academic and intelligence ability.

2.A reliable and accurate weather forecasting system.

For many of us, checking the weather forecast is a regular part of our morning routine. A quick look at the weather report lets us know if we need a jacket, an umbrella, or sunglasses for the day. But climate data is not only useful for planning your outfit or commute; it is a vital resource for blind to be prepared for any unexpected changes in the surroundings. Access to current weather information becomes makes life very easily and convenient to the blind. Thereby. From a real time sensor via a barometer inside the user phone environmental changes will be detected and notified the user about any weather change instantly

3.Implementation of an automatic real time and an accurate language translator

Visually impaired faces numerous difficulties when understating unclear texts or text in other languages therefore our intention is to help the user by implementing a translator to real time capture the text via computer vision methodology and through a translator module convert the text to and understandable format and give the out via the voice assistance system implemented in out

application This system captures texts real time as input and gives the translated output as speech to blind user. Having done a text -to -text conversion by translating the text to an understandable format or language for the user. The accuracy of the translation needs in a high level without a delay.

Figure 2.1-Process of an automatic language translator

3. Methodology

In order to implement the above-mentioned objectives, below requirements should be clearly developed. And 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 assistive application for visually impaired will be solved.

- They can be used both indoors and outdoors, even if the app is offline.
- The voice assistance should be clear and accurate.
- The live text capturing via a camera should be able to accurately identify text on labels, symbols, and numbers.
- The live view should be when the user needed.
- The translator needs to translate the texts immediately without any latency

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.

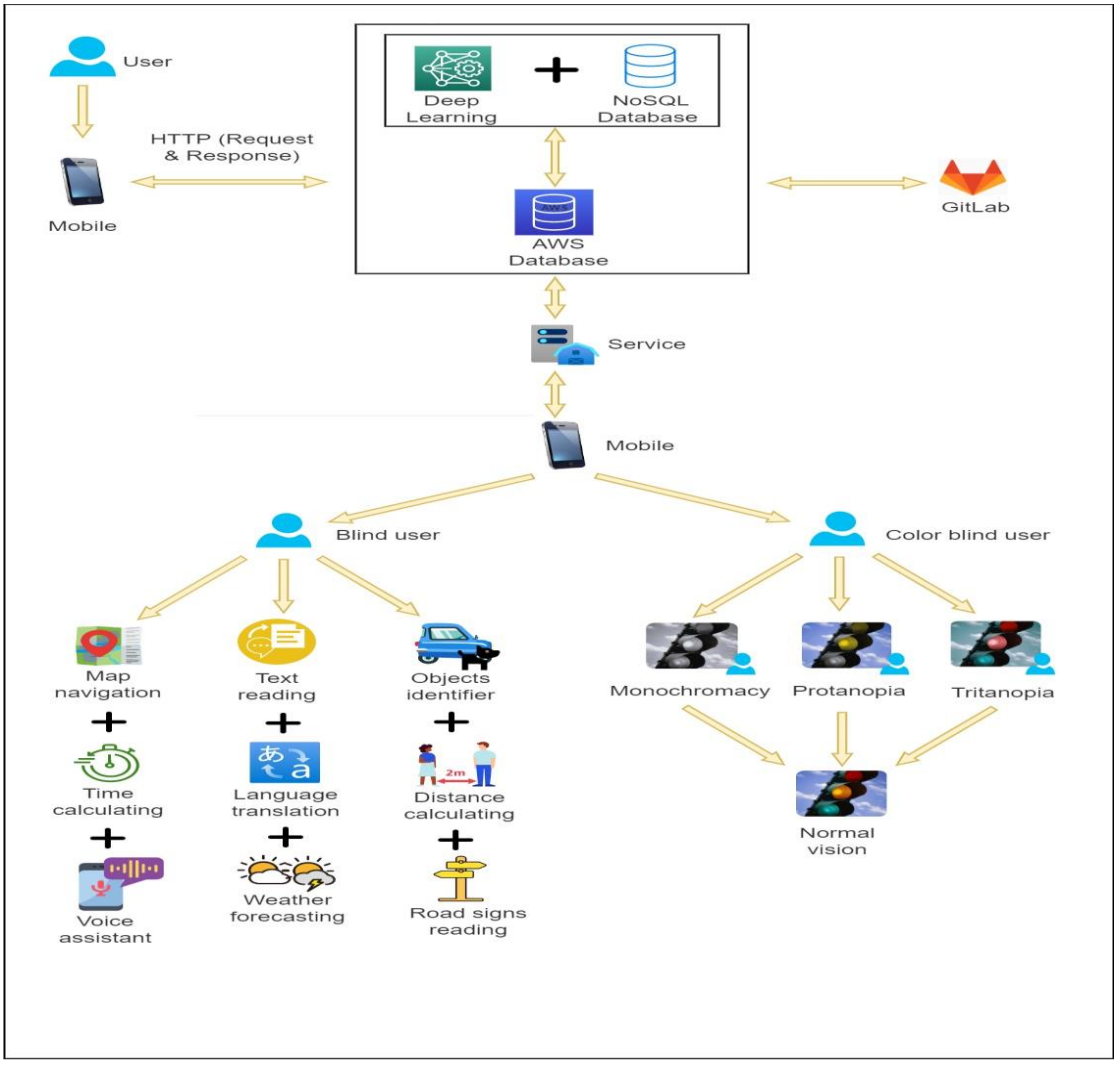

Figure 3.1 : Overall system architecture diagram

3.2 Component System Architecture

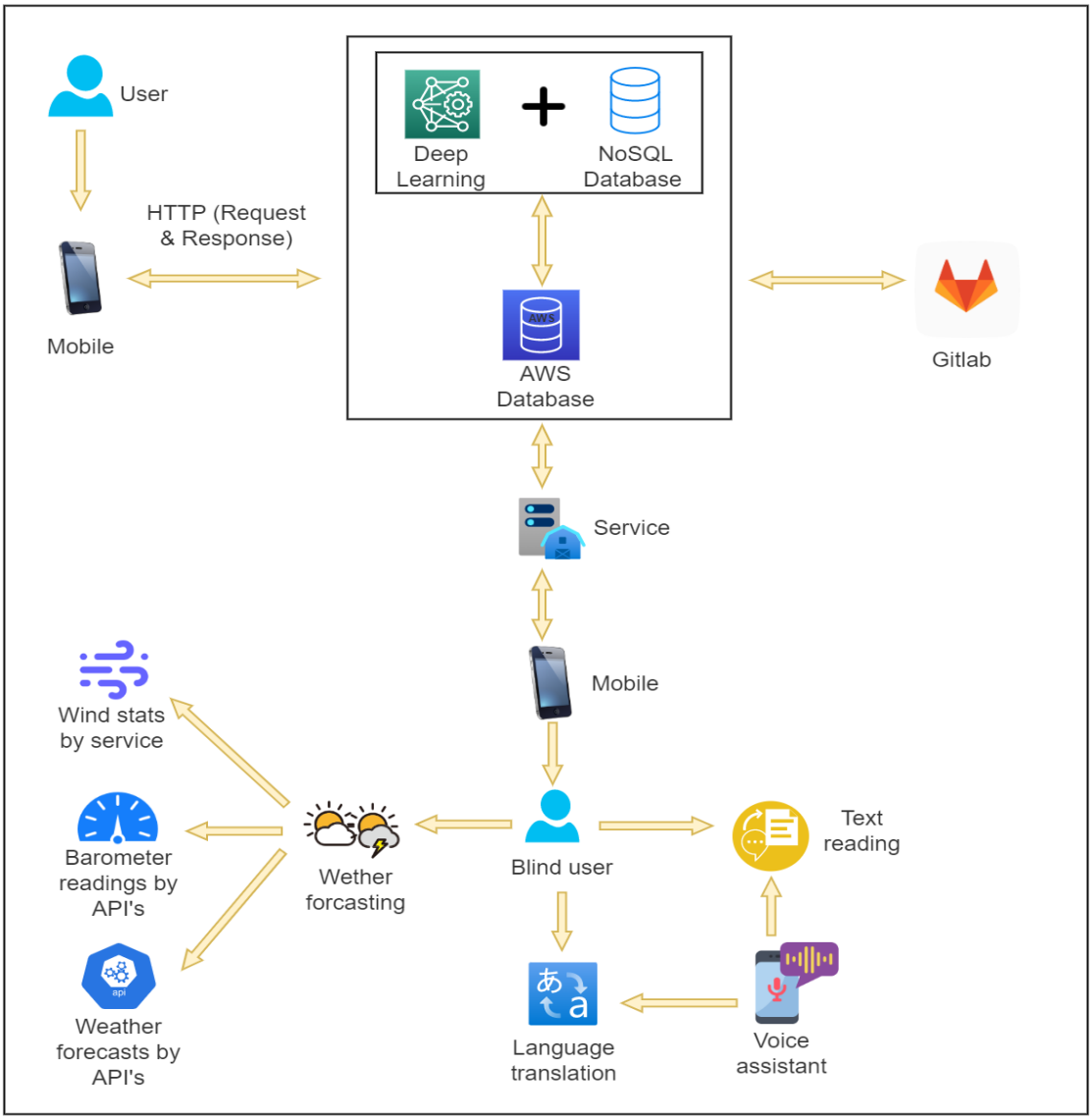

Figure 3.2 : Overall system architecture diagram

3.3 Hardware solutions

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.

Figure 3.3 Earphones

Figure3.4 Headset

Figure3.5 The phone in the shirt's pocket

3.6Hang on the phone using a code

3.4 Software solutions

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.

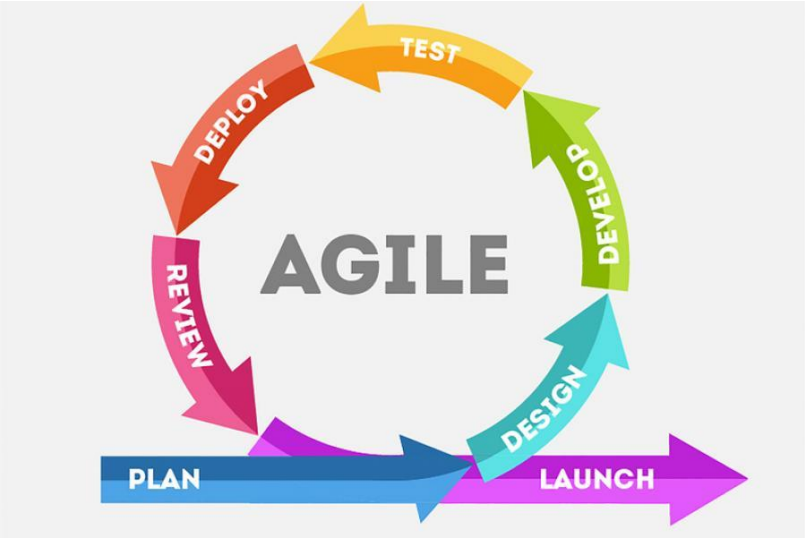

Figure 3.7 Agile Development Cycle

- **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 is the main thing this map navigation 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 app should provide real-time information without any latency.
- The BVIs should be able to set the destination on their own (the autonomy and independence of the BVIs is very important).
- As far as outdoor navigation is concerned, it would be desirable that the app provides a list of favorite destinations that the BVI can edit.
- The BVI should have the ability to dictate the destination address on the device.

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.

- In general, however, other applications (including the voice assistant) should be able to run in parallel with the navigation app.
- Any GPS device must refresh the information it provides at high frequency because some BVIs can move at a fast pace.
- Stored route and voice direction data should be work properly on offline status.

3.5.3 Non-functional requirements

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

3.6 Work Breakdown structure

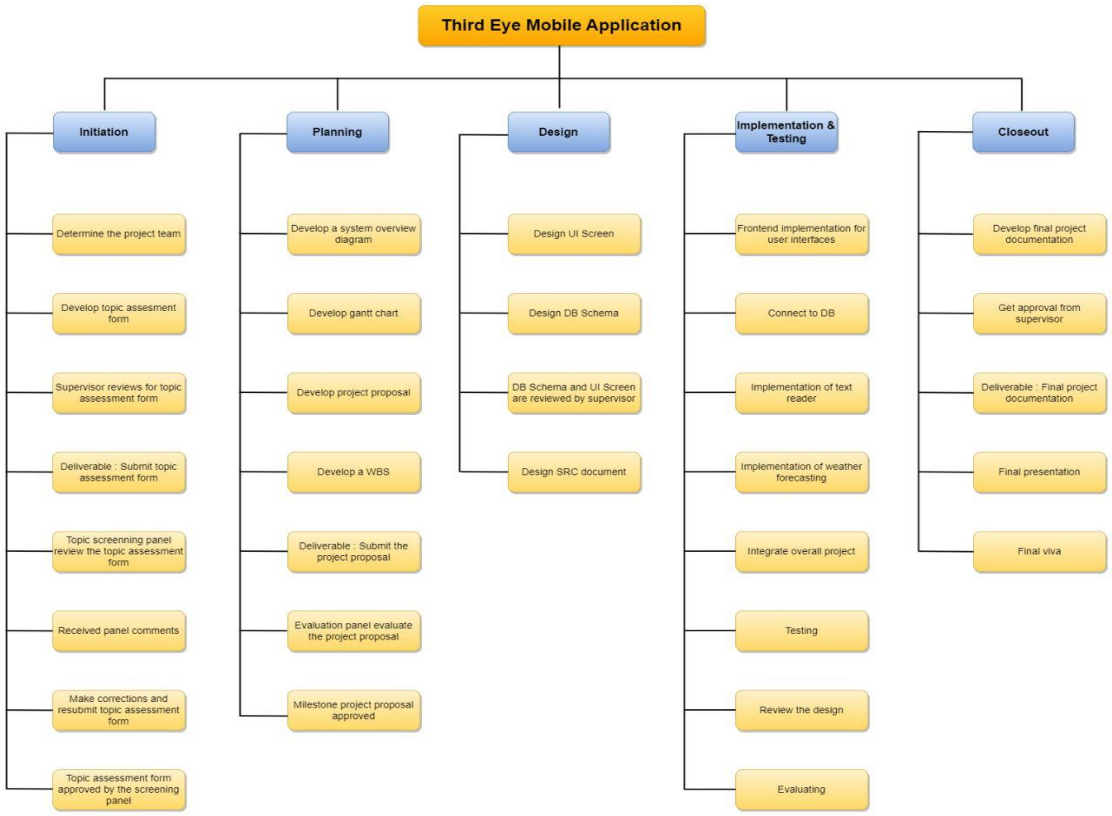

Figure 3.8 Work Breakdown Structure

3.7 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

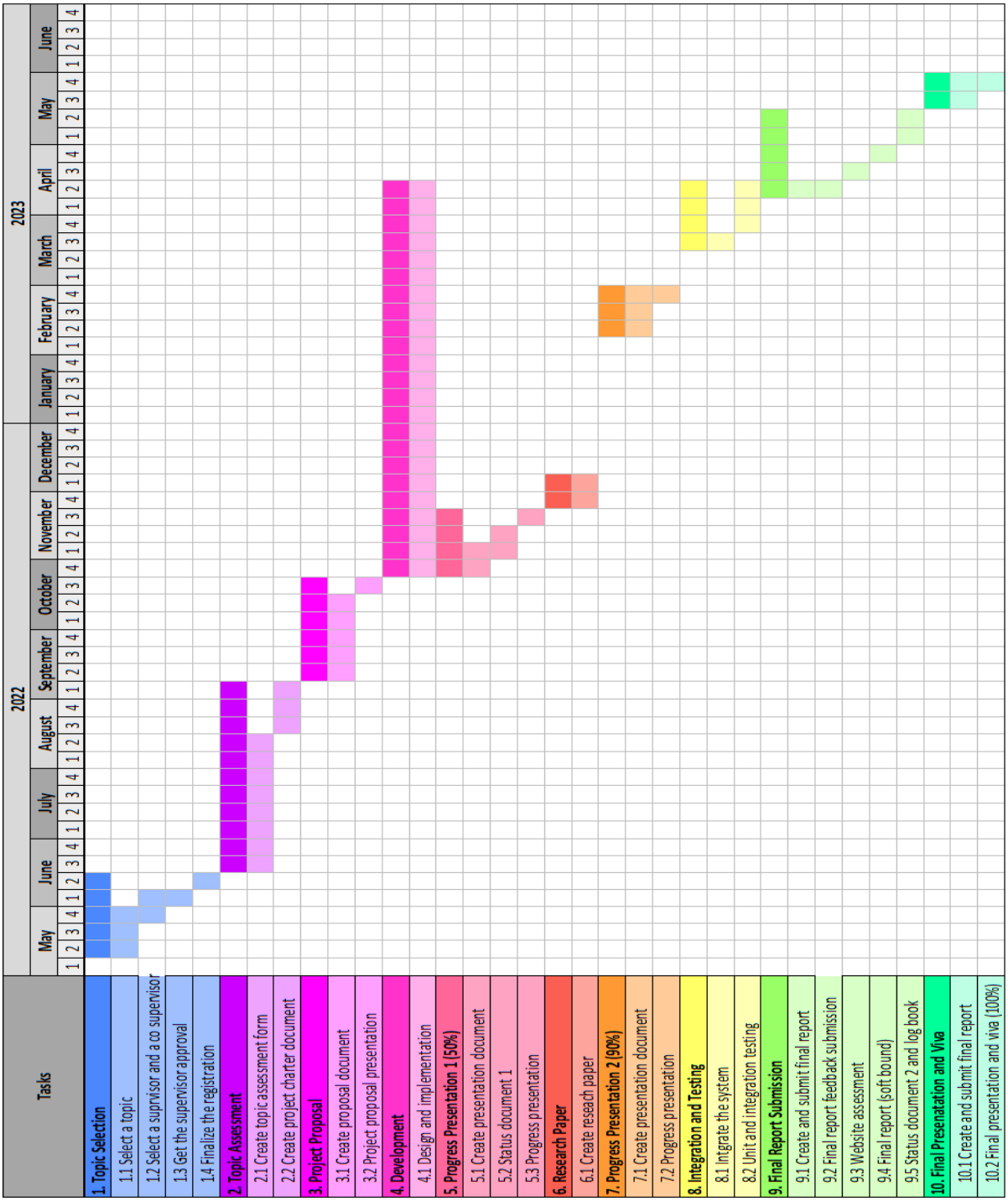

Figure 4.1: Gantt Chart

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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