SMART BLIND STICK

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This report is submitted in partial fulfillment of the requirements for the Bachelor of [Computer Science (Software Development)] with Honours.

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2024

DECLARATION

I hereby declare that this project report entitled

[SMART BLIND STICK]

is written by me and is my own effort and that no part has been plagiarized

without citations.

STUDENT : *KKISHORE* Date : 27 August 2024

(KISHORE A/L KANUN)

I hereby declare that I have read this project report and found

this project report is sufficient in term of the scope and quality for the award of

Bachelor of [Computer Science (Software Development)] with Honours.

SUPERVISOR : Date : 28 August 2024

([NAME OF THE SUPERVISOR])

DEDICATION

First and foremost, I would like to make a dedication to my main pillars, my parents, Umadevi A/P Ramasamy and Kanun A/L Nadassan for guiding and giving me their full support through the whole process of completing this project. A huge part of this project could not have happened without the help of my beloved supervisor, Ts. Dr. Lizawati binti Salahuddin who supported and guided me from the first day till today. To my fellow friends who always stood by my side with a valuable amount of emotional support and also provided me with guidelines and knowledge to help me through the difficult part of conducting this project, thank you so much. Without all of these people, this project could not have been done in the time given.

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I want to thank my supervisor, Ts. Dr. Lizawati binti Salahuddin for giving assistance in completing this project successfully. I have been struggling to complete this project and have been facing difficulties with it, she is the one who gave me enough guidance and advice throughout the end of this project. I would also like to thank my beloved parents and friends who have been giving me support and motivation throughout my project. I would say that I will cherish our relationship till my last breath and if one day the situation turns the other way around, I will be there by your side at any cause. Thank you.

ABSTRACT

The Smart Blind Stick project addresses the mobility challenges faced by blind and visually impaired individuals by providing a technologically advanced solution to enhance their navigation and safety. Traditional mobility aids, such as white canes, lack the capability for real-time obstacle detection, immediate alerts, and effective guardian monitoring. This project aims to solve these issues by developing a smart blind stick coupled with a mobile application. The solution integrates advanced technologies to offer real-time obstacle detection, timely alerts, and efficient emergency response mechanisms. The research process involves designing and developing both the hardware and software components, ensuring they work seamlessly to provide accurate and reliable assistance. The methodology used for this project is the Agile development methodology which facilitated iterative design, development, and testing. The hardware used includes NodeMCU Lua WiFi ESP8266 module, ultrasonic sensors, GPS NEO-6M module, Buzzer module and GSM SIM 900A module integrated to enhance the functionality of the Smart Blind Stick. The mobile application was developed using Android Studio with real-time data synchronization managed via Firebase Realtime Database and Firestore. The testing strategy involved comprehensive dynamic testing to validate the obstacle detection, location tracking, and emergency alert systems alongside User Acceptance Testing (UAT) conducted with visually impaired individuals and their guardians. The modules developed include User Authentication, Profile Management, Obstacle Detection and Alerts, GPS Location Tracking, and Emergency Alert System. The tests confirmed that the system meets the required functional and non-functional specifications ensuring the device is reliable and user-friendly. The expected outcomes include improved user confidence, increased independence and enhanced safety for visually impaired users. This project represents a significant advancement in assistive technology, offering a comprehensive and user-friendly solution that positively impacts the lives of visually impaired individuals and their guardians.

ABSTRAK

Projek Smart Blind Stick menangani cabaran mobiliti yang dihadapi oleh individu buta dan cacat penglihatan dengan menyediakan penyelesaian teknologi yang canggih untuk meningkatkan navigasi dan keselamatan mereka. Alat bantu mobiliti tradisional, seperti tongkat putih, tidak mempunyai keupayaan untuk pengesanan halangan masa nyata, amaran segera, dan pemantauan yang berkesan. Projek ini bertujuan untuk menyelesaikan isu-isu ini dengan membangunkan Smart Blind Stick yang dipadankan dengan aplikasi mudah alih. Penyelesaian ini menggabungkan teknologi canggih untuk menawarkan pengesanan halangan masa nyata, amaran tepat waktu, dan mekanisme tindak balas kecemasan yang berkesan. Proses penyelidikan melibatkan reka bentuk dan pembangunan kedua-dua komponen perkakasan dan perisian, memastikan ia berfungsi dengan lancar untuk menyediakan bantuan yang tepat dan boleh dipercayai. Metodologi yang digunakan untuk projek ini adalah metodologi pembangunan Agile yang memudahkan reka bentuk, pembangunan, dan pengujian secara iteratif. Perkakasan yang digunakan termasuk modul NodeMCU Lua WiFi ESP8266, sensor ultrasonik, modul GPS NEO-6M, modul Buzzer, dan modul GSM SIM 900A. Aplikasi mudah alih dibangunkan menggunakan Android Studio dengan penyelarasan data masa nyata yang diuruskan melalui Firebase Realtime Database dan Firestore. Strategi pengujian melibatkan ujian dinamik yang komprehensif untuk mengesahkan pengesanan halangan, penjejakan lokasi, dan sistem amaran kecemasan, serta Ujian Penerimaan Pengguna (UAT) yang dijalankan bersama individu cacat penglihatan dan penjaga. Modul yang dibangunkan, Pengesahan Pengguna, Pengurusan Profil, Pengesanan dan Amaran Halangan, Penjejakan Lokasi GPS, dan Sistem Amaran Kecemasan. Ujian mengesahkan bahawa sistem memenuhi spesifikasi fungsional dan bukan fungsional yang diperlukan, memastikan peranti ini boleh dipercayai dan mesra pengguna. Hasil yang dijangkakan termasuk peningkatan keyakinan, kebebasan, dan keselamatan bagi pengguna cacat penglihatan. Projek ini mewakili kemajuan yang signifikan dalam teknologi bantuan, menawarkan penyelesaian yang komprehensif dan mesra pengguna yang memberi impak positif kepada kehidupan individu cacat penglihatan dan penjaga mereka.

TABLE OF CONTENTS

PAGE

LIST OF TABLES

PAGE

LIST OF FIGURES

PAGE

LIST OF ABBREVIATIONS

FYP	**-**	**Final Year Project**
UAT	**-**	**User AcceptanceTesting**

LIST OF ATTACHMENTS

PAGE

CHAPTER 1: INTRODUCTION

1.1 Introduction

The Smart Blind Stick project helps people who are blind or visually impaired move around safely and independently. The main goal is to create a device that can detect obstacles, send alerts, and help with emergency communication, making it easier and safer for users to navigate their surroundings.

Recent technological advances make it possible to develop new assistive devices that improve the lives of people with disabilities. The Smart Blind Stick connects the physical components with a mobile application to offer a complete solution. This project uses a GPS module to track location, ultrasonic sensors to detect obstacles, a NodeMCU Lua WiFi ESP8266 module, and a GSM module to send emergency notifications. Together, these components create a smart walking stick that not only detects obstacles but also sends important information to the user's guardian.

The mobile application is developed with Android Studio and integrated with Firebase Realtime Database and Firestore, acts as an interface for both the user and their guardian. It provides real-time updates on the user's location, gives voice command when obstacles are detected, and stores the history of emergency alerts. This way, the user is always aware of their surroundings, and the guardian can monitor the user’s safety and respond quickly in emergencies.

The aim of this project is to provide a dependable and easy-to-use assistive device that addresses the mobility challenges faced by visually impaired individuals. The Smart Blind Stick represents a step forward in technology, offering more freedom and security for those with visual impairments.

1.2 Problem Statements

Firstly, blind and visually impaired individuals often experience significant challenges in navigating their environments safely and independently. Traditional mobility aids, such as white canes, offer basic assistance by providing tactile feedback when an obstacle is encountered. However, these methods are limited as they do not detect obstacles at a distance or provide real-time alerts. This limitation affects the user's confidence and freedom of movement, often leading to a greater dependence to others. The inability to move independently can significantly impact their quality of life, hence making it crucial to develop a more advanced solution.

Another major issue is the limitation of real-time obstacle detection. Blind and visually impaired individuals frequently encounter unexpected obstacles that can lead to accidents and injuries. Traditional aids do not offer real-time feedback about obstacles, making it difficult for users to react quickly to avoid them. This lack of immediate information increases the risk of falls and collisions, thereby affecting the user's safety and well-being. Real-time obstacle detection and alert systems are essential to mitigate these risks and enhance the overall safety of visually impaired individuals.

Finally, there is the problem of insufficient guardian monitoring capabilities. Guardians of blind and visually impaired individuals often face difficulties in ensuring their safety and tracking their location. Current mobility aids lack the ability to provide real-time location tracking and do not collect data on users' movements and emergency incidents. This gap can lead to uncertainty about the user's well-being, especially in unfamiliar or potentially dangerous environments. The ability for guardians to monitor the location and safety of visually impaired individuals in real-time is crucial for prompt emergency response and peace of mind.

1.3 Objectives

- To design a solution to facilitate blind or visually impaired individual and their guardians to monitor the user's movements and ensure their safety.
- To develop a mobile application for obstacle detection and quick responses during emergencies.
- To test the functionality and user acceptance of the developed application.

1.4 Scopes

1.4.1 Modules to be developed.

- User Authentication:
  Includes login, registration, forgot password, and change password functionalities to ensure secure access to the application.
- Profile Management:
  Allows users to view and edit profile information, ensuring that both the user and guardian details are up-to-date.
- Obstacle Detection and Alerts:
  Provides real-time voice commands of text-to-speech functionality to notify users of detected obstacles.
- Emergency Alert System:
  Sends automatic text message alerts in case of emergencies.
- GPS Location Tracking:
  Provide the location of smart blind stick in real-time.

- Historical Data Logging:
  Maintains a history of emergency alerts for reference and safety assessments.

1.4.2 Target Users

- Blind and Visually Impaired Individuals:
  The primary users of the smart blind stick, who will benefit from enhanced mobility and safety features. The device is designed to assist in navigating surroundings independently without the reliance on others.

- Guardians:
  Secondary users who will use the mobile application to monitor the safety and location of the primary users.The application offers features of real-time alerts and location tracking, ensuring that guardians can respond immediately in case of emergencies.

1.5 Project Significance

The Smart Blind Stick project benefits blind and visually impaired individuals by enhancing their mobility and confidence through real-time obstacle detection and auditory alerts which helps to improve their quality of life. Guardians gain peace of mind with the ability to monitor the user's location and receive emergency alerts in real-time. The project advances the field of assistive technology by integrating modern components such as ultrasonic sensors, GPS modules, and GSM communication, offering innovative solutions that set new standards for mobility aids. Additionally, it provides a foundation for further research and development, encouraging continued innovation in assistive devices.

1.6 Expected Output

The Smart Blind Stick project is expected to significantly enhance the mobility and safety of visually impaired individuals by providing real-time obstacle detection and auditory alerts, ensuring immediate awareness of surroundings. It will feature an emergency alert system that sends automatic text messages and GPS locations to guardians in case of a fall, enabling swift emergency responses. The user-friendly mobile application will include secure login, registration, profile management, and text-to-speech functionality, making it accessible and tailored to the needs of visually impaired users. Additionally, the app will maintain a history of emergency alerts for reference, providing peace of mind for guardians and improving the overall quality of life for users.

1.7 Conclusion

In conclusion, the Smart Blind Stick project aims to significantly improve the lives of blind and visually impaired individuals by enhancing their mobility and safety. Through the integration of advanced technologies such as ultrasonic sensors, GPS tracking, and GSM communication, the device provides real-time obstacle detection, emergency alerts, and location monitoring. The user-friendly mobile application ensures seamless interaction for both users and guardians, offering features tailored to their specific needs. By addressing the limitations of traditional mobility aids and incorporating modern technological solutions, the Smart Blind Stick stands as a comprehensive and innovative assistive device, promising greater independence and security for visually impaired individuals.

CHAPTER 2: LITERATURE REVIEW AND PROJECT METHODOLOGY

2.1 Introduction

The Smart Blind Stick project involves advanced technological components to help blind and visually impaired individuals in navigating their surroundings to increase safety and independence. This chapter briefs the literature review and project methodology which provides a thorough understanding of this project's theoretical foundation and the systematic approach used to achieve its objectives.

The literature review examines recent findings and developments intechnology related to assistive devices for blind and impaired individuals. It highlights key developments in obstacle detection, real-time alert systems, GPS tracking, and emergency communication technologies. The review highlights the difference in current solutions and illustrates the necessity and innovation of the Smart Blind Stick project by examining past research and current developments.

The project methodology outlines the structured approach adopted to design, develop, and implement the Smart Blind Stick. This section details the selection and integration of hardware components, software development processes, and data synchronization techniques. It also explains the design considerations, testing procedures, and evaluation metrics used to ensure the project's effectiveness and reliability. This process offers a transparent road map for converting the conceptual design into a useful and easy-to-use assistive technology.

2.2 Facts and Findings

The technique of gathering facts and findings in the development of the Smart Blind Stick involved a systematic approach following the System Development Life Cycle (SDLC). Initially, comprehensive research was conducted on existing assistive technologies, highlighting their limitations in real-time obstacle detection and emergency alerts. Observations of blind and visually impaired individuals using traditional aids shows the critical insights into their mobility challenges. Interviews and questionnaires with users and experts provided essential requirements and design considerations. During the design phase, prototypes were created and tested in various environments, with user feedback driving improvements. The implementation phase involved integrating NodeMCU ESP8266, ultrasonic sensors, GPS modules, and GSM modules, and developing a mobile application using Android Studio with Firebase for real-time updates. Thorough testing ensured each component and the overall system functioned correctly. Finally, the deployment phase included user training and continuous feedback collection, ensuring the device met user needs and maintained reliability. These systematic facts and findings enabled the development of a comprehensive and effective Smart Blind Stick.

2.2.1 Domain

The domain related to the Smart Blind Stick project is Assistive Technology for the visually impaired. This domain includes a range of technologies and devices designed to support individuals with the blind and visual impairments by enhancing their ability to perform daily activities independently and safely. Example of assistive technology are screen readers, braille displays, electronic canes, and other navigation aids. The focus is on integrating modern technological advancements, such as sensors, GPS, GSM communication, and mobile applications, to create innovative solutions that improve the quality of life for blind and visually impaired individuals.

2.2.2 Existing System

In developing the Smart Blind Stick, several approaches and past research studies were considered to ensure the project is grounded in sound principles and practices. The primary approach involved integrating various technologies, including ultrasonic sensors for obstacle detection, GPS modules for location tracking, GSM modules for emergency alerts, and a mobile application for real-time monitoring and interaction.

2.2.2.1 Smart Blind Stick Using Arduino and Ultrasonic Sensor

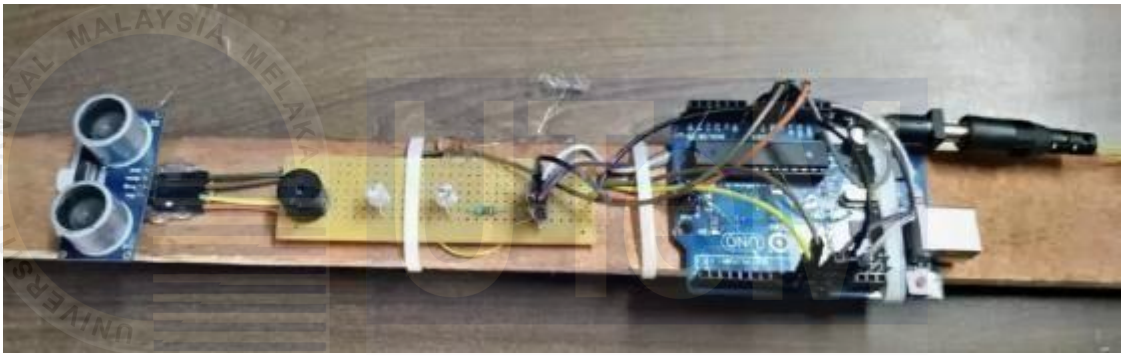

Figure 2.1 Smart Blind Stick Using Arduino and Ultrasonic Sensor

Figure 2.1 shows the development of a smart blind stick that integrates an Arduino board with ultrasonic sensors to aid visually impaired individuals in obstacle detection. The sensor produces ultrasonic waves and calculates the distance of obstacles based on the time taken for the waves to return. When an obstacle is detected within a certain range, the buzzer alerts the user. This system aims to provide a low-cost, efficient solution for obstacle detection, enhancing the mobility and independence of visually impaired users (Techatronic, 2021) .

The Techatronic project serves as a foundational reference for our Smart Blind Stick project. As it effectively addresses obstacle detection, it lacks features such as real-time location tracking and emergency alert systems, which are critical for user safety. By using the GPS modules and GSM communication in our design, it aims to offer a more robust and versatile assistive device. This project builds upon the principles established by Techatronic, integrating advanced features to enhance functionality and user safety (Techatronic, 2021) .

2.2.2.2 Arduino Smart Blind Stick

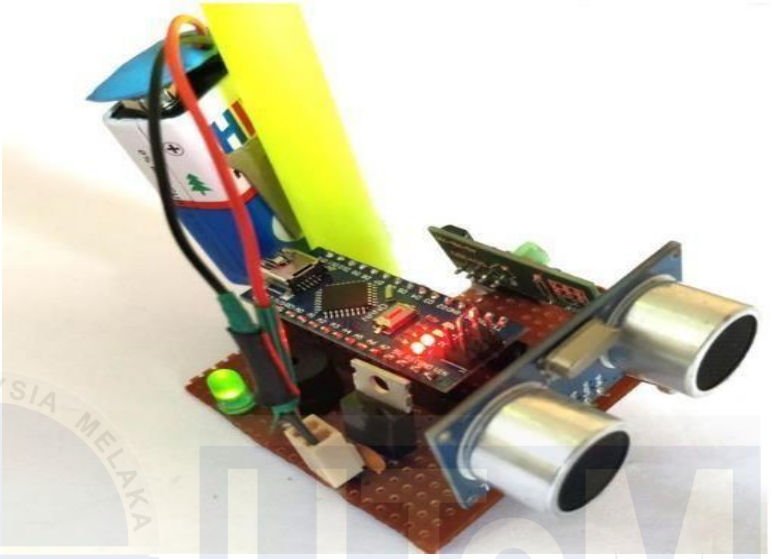

Figure 2.2 Arduino Smart Blind Stick

Figure 2.2 shows the utilization of an Arduino Uno and ultrasonic sensors to create an assistive device for the visually impaired. This stick uses the ultrasonic sensor to sense distance from any obstacle, LDR to sense lighting conditions and a RF remote using which the blind man could remotely locate his stick (Circuit Digest, 2021). The device sends vibration signals to the user via a motor, providing a discreet and effective alert mechanism. This project emphasizes the use of affordable and accessible components to enhance the daily lives of visually impaired individuals.

Building on the Circuit Digest project, our Smart Blind Stick aims to extend functionality by integrating voice commands and emergency alert features. Moreover, our project incorporates a buzzer and text-to-speech functions to offer more comprehensive alerts. Additionally, the integration of GPS for location tracking and GSM for emergency alerts addresses the limitations of existing solutions, ensuring users can receive timely assistance in emergencies. This evolution ensures a higher level of safety and convenience for the users and their guardians (Circuit Digest, 2021).

2.2.2.3 Smart Blind Stick Using Ultrasonic Sensor

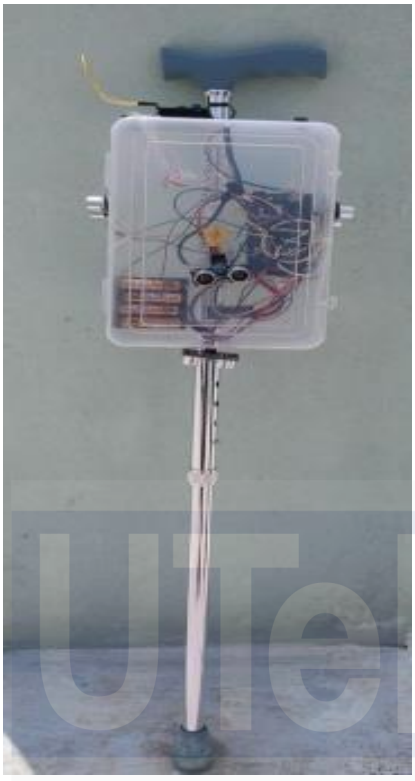

Figure 2.3 Smart Blind Stick Using Ultrasonic Sensor

This project focuses on designing a smart blind stick that integrates ultrasonic sensors and an Arduino Mega to detect obstacles and provide feedback to the user. The ultrasonic sensor detects obstacles and triggers an alert mechanism, which could be a vibration or another form of alert, indicating the presence of an obstacle. The primary objective of this research is to enhance the mobility and safety of visually impaired individuals by providing real-time obstacle detection (Talari Tirupal et al., 2021).

This research forms a critical basis for the project, highlighting the importance of real-time obstacle detection and user feedback. However, the Smart Blind Stick project extends these functionalities by integrating GPS modules and GSM communication for real-time location tracking and emergency alerts. By incorporating these advanced features, the project aims to provide a more comprehensive solution that addresses the gaps identified in previous research, ensuring enhanced safety and independence for visually impaired users (Talari Tirupal et al., 2021).

2.2.2.4 Comparison Table between Existing and Propose System

Table 2.1 shows the comparison between the existing system and the proposed system.

Table 2.1 Comparison Table between Existing and Propose System

Feature	**Existing System**	**Proposed System (Smart Blind Stick)**
Obstacle Detection	Uses ultrasonic sensors for real-time obstacle detection through buzzer	Uses ultrasonic sensors for real-time obstacle detection
Emergency Alerts	None	GSM module sends SMS alerts to guardians in emergencies
Location Tracking	None	GPS module provides real-time location tracking
User Interface	Not applicable	Mobile application with a user-friendly interface
Data Logging	None	Logs history of emergency alerts in the mobile application
Voice Commands	None	Mobile application provides voice commands for obstacle detection
Guardian Monitoring	Manual	Allows guardians to monitor user's location and receive alerts
Real-time Updates	None	Real-time updates and data synchronization using Firebase
User and Guardian Profile Management	None	Includes login, registration, profile management

2.2.3 Technique

In developing the Smart Blind Stick project, there are plenty of approaches that could have been considered. Here are a few techniques that are chosen for this project along with the justification for choosing them:

i. Ultrasonic Sensors for Obstacle Detection:

- **Description**: Ultrasonic sensors are used to detect obstacles by emitting ultrasonic waves and measuring the time taken for the waves to bounce back from an obstacle. This allows for accurate distance measurement and real-time obstacle detection.
- **Reason for Choosing**: Ultrasonic sensors provide reliable and accurate measurements across various environmental conditions, unlike infrared sensors which can be affected by bright sunlight or reflective surfaces. The consistency and reliability of ultrasonic sensors make them an ideal choice for detecting obstacles in the user's path, ensuring better safety and navigation for visually impaired individuals.

ii. GSM Module for Emergency Communication:

- **Description**: The GSM module enables the smart blind stick to send text message alerts to guardians in case of an emergency. It provides long-range communication capabilities, ensuring that alerts can be sent regardless of the distance between the user and the guardian.
- **Reason for Choosing**: GSM technology allows for reliable communication over long distances, which is crucial for ensuring the user's safety in emergencies. Unlike Bluetooth, which has a limited range, GSM ensures that guardians can receive alerts and take appropriateactions regardless of their location.

iii. GPS Module for Real-Time Location Tracking:

- **Description**: The GPS module is used to track the real-time location of the smart blind stick. This information is sent to a cloud-based database and displayed on the mobile application, allowing guardians to monitor the user's location.
- **Reason for Choosing**: GPS technology provides accurate location tracking, which is essential for ensuring the safety of visually impaired individuals. Real-time location updates allow guardians to monitor the user's movements and respond quickly in case of emergencies. This feature significantly enhances the safety and independence of the user.

iv. Mobile Application for User and Guardian Interaction:

- **Description**: The mobile application serves as an interface for both the user and their guardian. It provides real-time updates on the user's location, sends voice commands when obstacles are detected, and stores the history of emergency alerts.
- **Reason for Choosing:** A mobile application offers a user-friendly interface that is accessible to both visually impaired users and their guardians. It leverages modern smartphone capabilities, such as text-to-speech and real-time data synchronization, to provide a comprehensive solution that enhances the overall user experience and safety.

Here are a few techniques that are also applicable and related, along with the justification for not choosing them:

i. Infrared Sensors for Obstacle Detection:

- **Description**: Infrared sensors can be used to detect obstacles by producing infrared light and measuring the reflection.
- **Reason for Not Choosing**: Infrared sensors can be less reliable in

detecting obstacles in certain environmental conditions, such as bright sunlight or highly reflective surfaces. Ultrasonic sensors provide more consistent and accurate measurements across various conditions, making them a more reliable choice for obstacle detection.

ii. Bluetooth for Communication:

- **Description**: Bluetooth technology could be used for short-range communication between the smart blind stick and a mobile device.
- **Reason for Not Choosing**: Bluetooth has a limited range compared to GSM and Wi-Fi. Since the project requires long-range communication capabilities to send emergency alerts and provide real-time location tracking to guardians who may not be nearby, GSM and Wi-Fi are more suitable technologies.

iii. Cloud-Based AI for Obstacle Recognition:

- **Description**: Utilizing cloud-based artificial intelligence (AI) to process images or sensor data for advanced obstacle recognition.
- **Reason for Not Choosing**: The complexity and cost of developing and maintaining such a system are higher compared to using local sensors and processing.

iv. Haptic Feedback for Alerts:

- **Description**: Haptic feedback uses vibrations to alert users about obstacles or emergencies.
- **Reason for Not Choosing**: While haptic feedback can be effective, it might not be as immediately noticeable or informative as audible alerts, especially for visually impaired users who rely heavily on auditory cues. The combination of a buzzer for immediate sound alerts and voice

commands through the mobile application provides a more robust and accessible notification system.

2.3 Project Methodology

In the development of the Smart Blind Stick project, the Agile methodology was chosen as the guiding approach. Agile emphasizes flexibility, continuous improvement, and rapid delivery of functional components, making it particularly suitable for complex projects that require frequent adjustments based on user feedback and evolving requirements. The Agile methodology consists of various stages, including brainstorming, design, development, quality assurance, and deployment. Each stage involves specific activities that contribute to the overall success of the project.

Figure 2.4 Agile Development Methodology

The first stage in the Agile methodology is requirement analysis. This is crucial as it sets the foundation for the entire project. During this phase, the team gathers detailed requirements from blind and visually impaired individuals and their guardians through interviews, questionnaires, and observations. The goal is to understand the challenges faced and the specific features needed for the Smart Blind Stick. These requirements are documented as user stories and prioritized based on

their importance for user safety and convenience. This approach aligns with Agile principles, which emphasize continuous collaboration and iterative improvement (Hewitt, 2013).

The second step is the design phase, which involves creating an architecture that supports the identified requirements. For the Smart Blind Stick, this phase focuses on integrating hardware components like ultrasonic sensors, GPS modules, and GSM modules with a NodeMCU ESP8266 microcontroller. Additionally, designing a mobile application using Android Studio and Firebase is essential. The Agile approach allows for iterative design where prototypes are developed and refined based on continuous feedback. Each iteration includes the development of specific features like obstacle detection, emergency alerts, and real-time location tracking.

In Agile methodology, continuous development and testing are emphasized. Development is carried out in short sprints, usually lasting two to four weeks. Each sprint focuses on implementing user stories and delivering a usable product increment. Testing is integral to each sprint, including unit tests for individual components and integration tests to ensure seamless functionality with the mobile application. User acceptance testing is performed at the end of each sprint to validate the system's functionality and usability with visually impaired users and their guardians.

The release phase involves deploying the product to users and ensuring it meets their needs. For the Smart Blind Stick, this includes distributing devices to visually impaired individuals and providing training on their usage. Maintenance is an ongoing process, where the team collects feedback from users, addresses issues, and implements enhancements through regular updates. This ensures the Smart Blind Stick remains reliable and effective in real-world scenarios.

User feedback is important in Agile methodology. Throughout the project, feedback from visually impaired users and their guardians is actively incorporated

into the development process. This continuous feedback loop ensures the Smart Blind Stick evolves to meet user needs and expectations. By using the Agile methodology, the project adapts to changing requirements, incorporates continuous user feedback, and delivers a reliable and effective assistive device for visually impaired individuals, enhancing their mobility and safety.

2.4 Project Requirement

2.4.1 Software Requirements

i. Arduino IDE:
For programming the NodeMCU and integrating various hardware components.

ii. Android Studio:
For developing the mobile application on Android devices.

iii. Firebase Realtime Database:
For real-time data synchronization between the smart blind stick and the mobile application.

iv. Google Maps API:
For implementing real-time location tracking in the mobile application.

v. NodeMCU Firmware:
To enable communication between the hardware components.

vi. Java Development Kit (JDK):
Required for Android application development.

vii. Text-to-Speech (TTS) Engine:
For implementing voice commands and accessibility features in the mobile application.

viii. GSM Library for Arduino:

For enabling GSM communication with the SIM 900A module.

2.4.2 Hardware Requirements

Table 2.2 List of Hardware Requirements

Hardware	**Description**
NodeMCU Lua WiFi ESP8266 Module V3	Main microcontroller for processing data and communication.
NodeMCU Base Expansion Board V3	For easier connections and power supply management.
GSM Module SIM Module 900A	For sending SMS alerts in case of emergency.
Ultrasonic Sensor	For obstacle detection.
GPS NEO-6M w/PPS	For tracking the location of the blind stick.
Buzzer DC5V	For providing sound alerts when obstacles are detected.
Breadboard and Jumper Wires	For prototyping and connecting components.
Power Supply	To power the NodeMCU and other components.
Smartphone	For running the mobile application and testing its features.
Laptop	For software development and programming the microcontroller.

2.5 Project Schedules and Milestones

A milestone is a particular point in a project's life cycle that is used to monitor progress made towards the end result. A project's start and finish dates, external reviews and input, budget checks, the submission of a major deliverable, etc. are all indicated by milestones in project management.

- **Planning Phase**: Weeks 1
  - Project Briefing
  - Identify Project
  - Proposal Submission

- **Requirement Phase**: Weeks 2
  - Survey of Current Project
  - Listing of Constraints

- **Design Phase (Progress 1)**: Weeks 3-5
  - Create System Architecture & Design Diagram
  - Develop Hardware & Software Specifications
  - Design User Interface

- **Implementation Phase (Progress 2)**: Weeks 6-11
  - Assemble and Integrate Hardware Components
  - Develop & Program Arduino Microcontroller
  - Develop Android Application
  - Set up the Firebase Database

- **Testing Phase**: Weeks 12-13
    - Perform Unit Testing on Components
    - Conduct Integration Testing
    - Execute System Testing
    - Conduct User Acceptance Testing

- **Deployment Phase**: Weeks 13-14
    - Deploy Hardware & Software in User Environment
    - Provide Training and Support to Users
    - Monitor Initial Usage and Address Issues

- **Maintenance and Evaluation**: Weeks 14
    - Provide Ongoing Support and Maintenance
    - Collect User Feedback
    - Conduct Final Presentation

This is the project schedule and milestones of developing Smart Blind Stick:

Planning	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15
Project Briefing	/														
Planning Phase - Identify Project	/														
Proposal Submission	/														
Requirement Phase		/													
Survey of Current Project		/													
Listing of Constraints		/													
Design Phase (Progress 1)			/	/	/										
Create System Architecture & Design Diagram			/	/	/										
Develop Hardware & Software Specification			/	/	/										
Design User Interface			/	/	/										
Implementation Phase (Progress 2)						/	/	/	/	/	/				
Assemble and Integrate Hardware Components						/	/	/	/	/	/				
Develop & Program Arduino Microcontroller						/	/	/	/	/	/				
Develop Android Application.						/	/	/	/	/	/				
Set up the Firebase Database						/	/	/	/	/	/				
Testing Phase												/	/		
Perform Unit Testing on Components												/	/		
Conduct Integration Technique												/	/		
Execute System Testing												/	/		
Conduct User Acceptance Testing												/	/		
Deployment Phase													/	/	
Deploy Hardware & Software User Environment													/	/	
Provide Training and Support to Users													/	/	
Monitor Initial Usage and Address Issues													/	/	
Maintenance and Evaluation														/	
Provide Ongoing Support and Maintenance														/	
Collect User Feedback														/	
Final Presentation															/
Full document & Project Submission															/
Final Report															/

Figure 2.5: Gantt Chart

2.6 Conclusion

This chapter provided an in-depth review of existing literature and outlined the project methodology employed for the Smart Blind Stick. The literature review highlighted the advancements and differences in current assistive technologies for visually impaired individuals. The chosen Agile methodology was detailed, showcasing its iterative and flexible approach, which facilitated continuous improvement through user feedback. The integration of various hardware and software components was systematically explained, ensuring the project's effectiveness and reliability. Overall, the chapter established a theoretical foundation and a clear roadmap for the successful development and implementation of the Smart Blind Stick.

CHAPTER 3: ANALYSIS

3.1 Introduction

The analysis phase in the Smart Blind Stick project is the initial stage of the software development life cycle (SDLC) where the requirements and objectives of the project are identified and analyzed. During this phase, detailed information is collected and a thorough examination of the problem domain, user needs, and existingsystems is conducted. In this chapter, an overview is provided of the requirements collected for both the current assistive technologies and the proposed Smart Blind Stick system. The requirements are summarized in relation to various aspects such as user interactions, data flow diagrams, functional requirements, and non-functional requirements.

3.2 Problem Analysis

The current systems and technologies used by blind and visually impaired individuals for mobility and navigation are predominantly traditional canes and electronic canes. These devices offer basic assistance by providing tactile feedback when an obstacle is encountered. However, they lack advanced features such as real-time obstacle detection, emergency alerts, and location tracking, which are essential for ensuring the safety and independence of users. Existing solutions also do not provide seamless integration with mobile applications that can offer additional functionalities like voice commands and real-time monitoring.

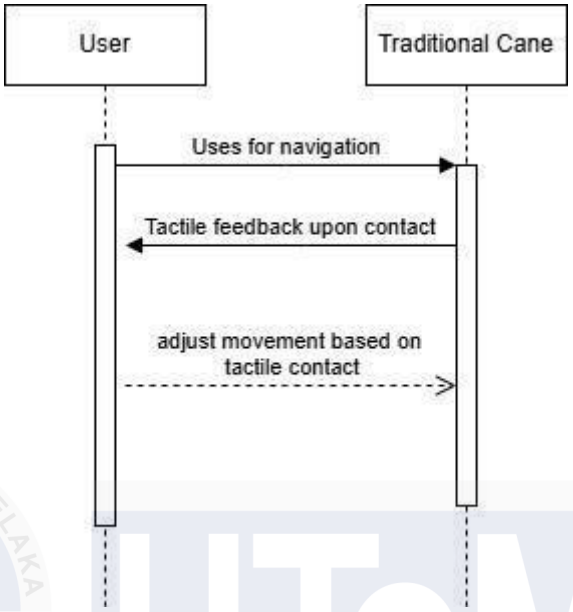

Figure 3.1: Sequence Diagram of the Current System

Traditional mobility aids, like white canes, provide only basic tactile feedback, detecting obstacles only upon direct contact. This limitation reduces the freedom of movement for blind and visually impaired individuals, as they cannot detect obstacles at a distance. Consequently, users often depend more on others for navigation, decreasing their independence and confidence.

Traditional aids fail to offer real-time feedback on unexpected obstacles which increases the risks of accidents and injuries. Visually impaired individuals may walk into objects or trip over surfaces that a white cane does not detect in time, increasing the chances of falls and collisions. This gap in real-time detection is a critical shortfall.

Existing mobility aids do not support real-time location tracking or data collection on user movements and emergencies, making it difficult for guardians to monitor the user. This lack of monitoring can lead to uncertainty and anxiety about the user's well-being, especially if an incident occurs and the user cannot communicate promptly. Improved monitoring solutions are essential to provide guardians with timely and accurate information.

3.3 Requirement Analysis

Requirement analysis is the process of understanding, documenting, and analyzing the needs, objectives, and constraints of a software project or system. It involves gathering, clarifying, and organizing the requirements from various stakeholders, including clients, users, and other relevant parties. The goal of requirement analysis is to identify and define the essential functionalities, features, and characteristics that the software or system should possess to meet the desired objectives. It helps in determining what the software or system needs to do, how it should behave, and what constraints and limitations should be considered during development.

This section reviews all the necessary requirements-related activities, such as creating a data dictionary, defining functional requirements, and specifying non-functional requirements. Additionally, it involves seeking clarificationfrom the client to gain a clear understanding of the relative importance of different requirements.

3.3.1 Data Requirements

The Smart Blind Stick system requires a comprehensive data management approach to ensure smooth functionality and reliable performance. This involves identifying the types of data the system needs to input, output, and store internally. The following outlines the data requirements for the system:

i. Data Input:
   - Obstacle Data: Information from the ultrasonic sensors about the presence of detection and distance of obstacles.
   - Location Data: GPS of latitude and longitude coordinates to track the real-time location of the smart blind stick.
   - Emergency Alert Data: Signals from the smart blind stick indicating that an emergency has occurred.
   - User Input Data: Data entered by the user or guardian via the mobile application, including login, registration credentials, profile

information, edit profile information, change password and forget password activities.

ii. Data Output:

- Obstacle Alerts: Real-time alerts to the user about detected obstacles, including audible alerts from the buzzer and voice commands from the mobile application.
- Emergency Alerts: Text message alerts are sent to guardians when the emergency protocol situation is triggered.
- Location Tracking Data: Real-time updates on the smart blind stick's location will be displayed on the mobile application for guardians.

iii. Internal Data Storage:

- User Profiles: Information about the users and their guardians including contact details, preferences, and login credentials.
- Emergency Alert History: Records of all emergency alerts triggered by the system including the date and time of the incident.
- Session Data: Temporary data to manage real-time operations and user sessions.

3.3.1.1 Data Dictionary

A data dictionary, also known as a metadata repository, is a central component of a database management system (DBMS). It serves as a comprehensive catalog or repository that provides detailed information about the data within a database. These are the data dictionary of the Smart Blind Stick.

- Table User Data

Table 3.1 shows the attributes that will be created in User table which are Email, Password, and User ID.

Table 3.1 User Data Dictionary

Field Name	Data Type	Size	Constraint
userId	varchar	30	Primary key
email	varchar	30	
password	varchar	30	

- Table User Profile

Table 3.2 shows the attributes that will be created in User Profile table which are UserID, Email, Phone Number, Identity No, Guardian Name and User Name.

Table 3.2 User Profile Data Dictionary

Field Name	Data Type	Size	Constraint
userId	varchar	30	Primary key
email	varchar	30	Foreign Key
phone_number	integer	12	
identity_no	integer	12	
guardian_name	varchar	100	
user_name	varchar	100	

- Table Sos Alert

Table 3.3 shows the attributes that will be created in Sos Alert table which are Sos ID, User ID, Message and Timestamp.

Table 3.3 Sos Alert Data Dictionary

Field Name	Data Type	Size	Constraint
sos_id	varchar	30	Primary key
userId	varchar	30	Foreign Key
message	varchar	45	
timestamp	date		

- Table Realtime Firebase

Table 3.4 shows the attributes that will be created in Realtime Firebase table which are User ID, Location, Ultrasonic 1, Ultrasonic 2 and Phone Number.

Table 3.4 Realtime Firebase Data Dictionary

Field Name	Data Type	Size	Constraint
userId	varchar	30	Primary key
location	string	45	
ultrasonic_1	varchar	30	
ultrasonic_2	varchar	30	
phone_number	integer	12	

3.3.2 Functional Requirements

- Obstacle Detection:
  - The system uses ultrasonic sensors to detect obstacles and measure the distance from the smart blind stick.
  - The data from the sensors is processed by the NodeMCU microcontroller to determine if an obstacle is within a critical range.

- Real-Time Alerts:
  - If an obstacle is detected within the critical range, the system triggers an audible alert using a buzzer.
  - Simultaneously, the system sends a signal to the mobile application, which provides a voice command alert to the user.

- Location Tracking:
  - The system uses GPS to determine the real-time location of the smart blind stick.
  - Location data is transmitted to the Firebase Realtime Database and displayed on the mobile application for guardians to monitor.

- Emergency Alert System:
  - The system monitors for emergency situations such as if the stick falls over.
  - When the emergency protocol is detected, the GSM module sends a text message alert to the guardian’s phone number.
  - The system also updates the emergency alert history in the Firestore Database and displays it in the application.

- User and Guardian Interaction:
  - Users and guardians interact with the system via a mobile application.
  - The application allows user login, registration, profile management, and viewing of real-time alerts and location data.
  - Guardians receive emergency notifications and can track the user's smart blind stick location through the application.

3.3.3 Non-Functional Requirements

The non-functional requirements for the Smart Blind Stick system focus on ensuring that the system performs its intended functions efficiently, reliably, and accurately. These requirements cover various aspects such as performance, quality, accuracy, and data storage capabilities.

i. Quality Requirements:
   - Reliability: The system must be highly reliable with minimal downtime to ensure continuous operation and safety for users.
   - Usability: The mobile application should have an intuitive user interface which eases the blind and visually impaired individuals and guardians to navigate and use.
   - Maintainability: The system should be easy to maintain and update that allow for quick fixes and upgrades without significant downtime.

ii. Performance Requirements:
   - Resource Utilization: The system should be optimized to use minimal computational resources. The NodeMCU microcontroller and mobile application should operate efficiently without excessive battery drain or processing lag.
   - Response Time: The system should detect obstacles and send alerts within 1.5 seconds of detection to ensure timely warnings. The GPS location updates should be transmitted in real time with minimal delay.
   - Data Processing: The Firebase Realtime Database should handle real-time data processing efficiently, ensuring that location data and emergency alerts are updated and accessible immediately.

iii. Accuracy Requirements:
   - Obstacle Detection: The ultrasonic sensors should accurately detect obstacles within a range of up to 35 centimeters, with a margin of error of no more than 5 cm.

- Location Tracking: The GPS module should provide location accuracy within 10 meters, ensuring precise tracking of the smart blind stick's location.
- Emergency Alerts: The system should accurately detect and differentiate between normal usage and emergency situations, minimizing false alerts.

iv. Data Storage Requirements:

- Data Integrity: The system must ensure the integrity and security of stored data, with proper encryption and access controls to prevent unauthorized access and data breach

3.3.4 Use Case Diagram

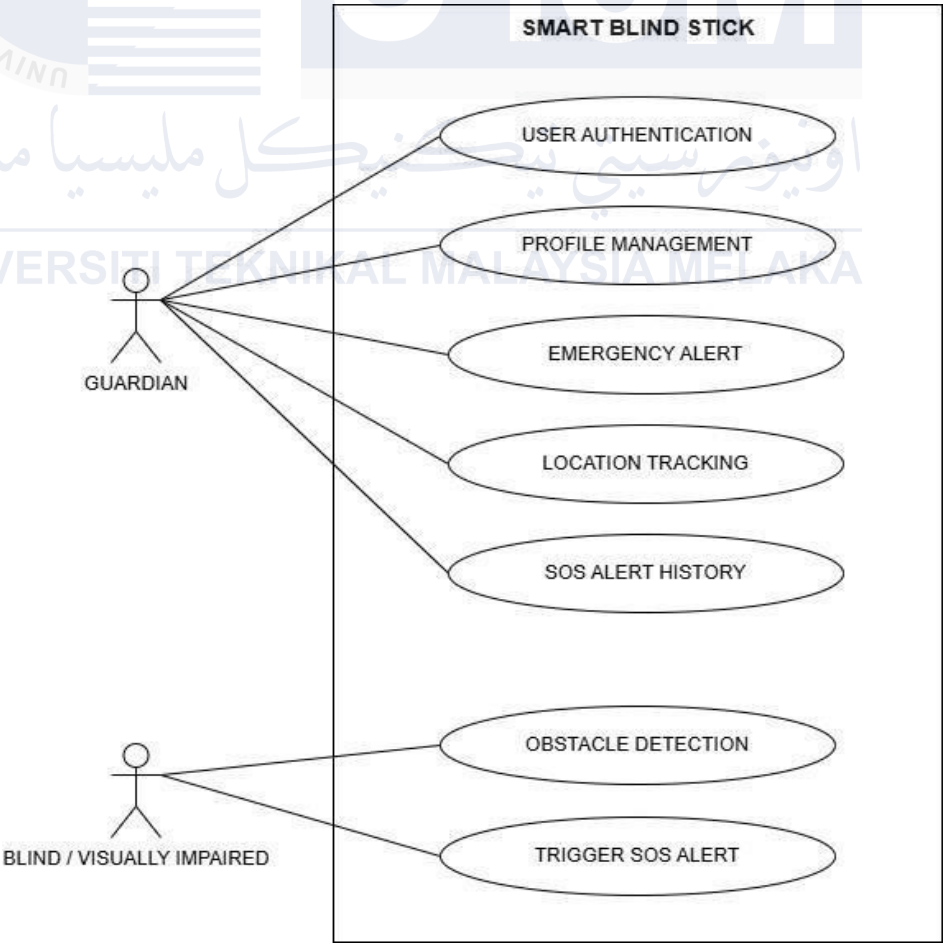

Figure 3.2: Use Case Diagram of Smart Blind Stick

Figure 3.2 shows the use case diagram of Smart Blind Stick that illustrates the interactions between two primary actors guardian, the blind and visually impaired individual and the system itself. The guardian can perform several actions including user authentication to access the system, managing profiles, receiving emergency alerts, tracking the real-time location of the user, and viewing the history of emergency alerts. On the other hand, the blind and visually impaired individual interacts with the system to detect obstacles using the smart blind stick and to trigger SOS alerts in emergencies. This diagram provides a clear overview of the system's functionalities and how the users interact with these features to enhance the safety and independence of visually impaired individuals.

3.4 Conclusion

In conclusion, the Smart Blind Stick project addresses significant limitations of traditional mobility aids by integrating advanced features such as real-time obstacle detection, emergency alerts, and location tracking. Through comprehensive requirement analysis, including functional and non-functional requirements, the project aims to enhance the safety and independence of visually impaired individuals. The proposed system leverages modern technology to provide a seamless and reliable solution for users and their guardians.

CHAPTER 4: DESIGN

4.1 Introduction

This chapter outlines the design process for the Smart Blind Stick project,detailing both the preliminary and detailed design stages. The goal is to translate the requirements identified during the analysis phase into a practical and functional system. This includes defining the system architecture, designinghardware and software components, and developing user interfaces. The design phase ensures that all components work cohesively to provide a reliable and user- friendly assistive device for blind and visually impaired individuals.

4.2 High Level Design

The high-level design of the Smart Blind Stick project provides an overarching view of the system's structure and how its components interact to deliver the intended functionalities. This design phase establishes the system architecture and highlights the primary modules and their interactions and integrated approach to developing the assistive device.

4.2.1 System Architecture

The system architecture of the Smart Blind Stick project integrates hardware components, software applications, and communication protocols to create a comprehensive assistive device for visually impaired individuals. The architecture is designed to ensure seamless data flow between the smart stick, cloud database, and mobile application, facilitating real-time monitoring and alerts.

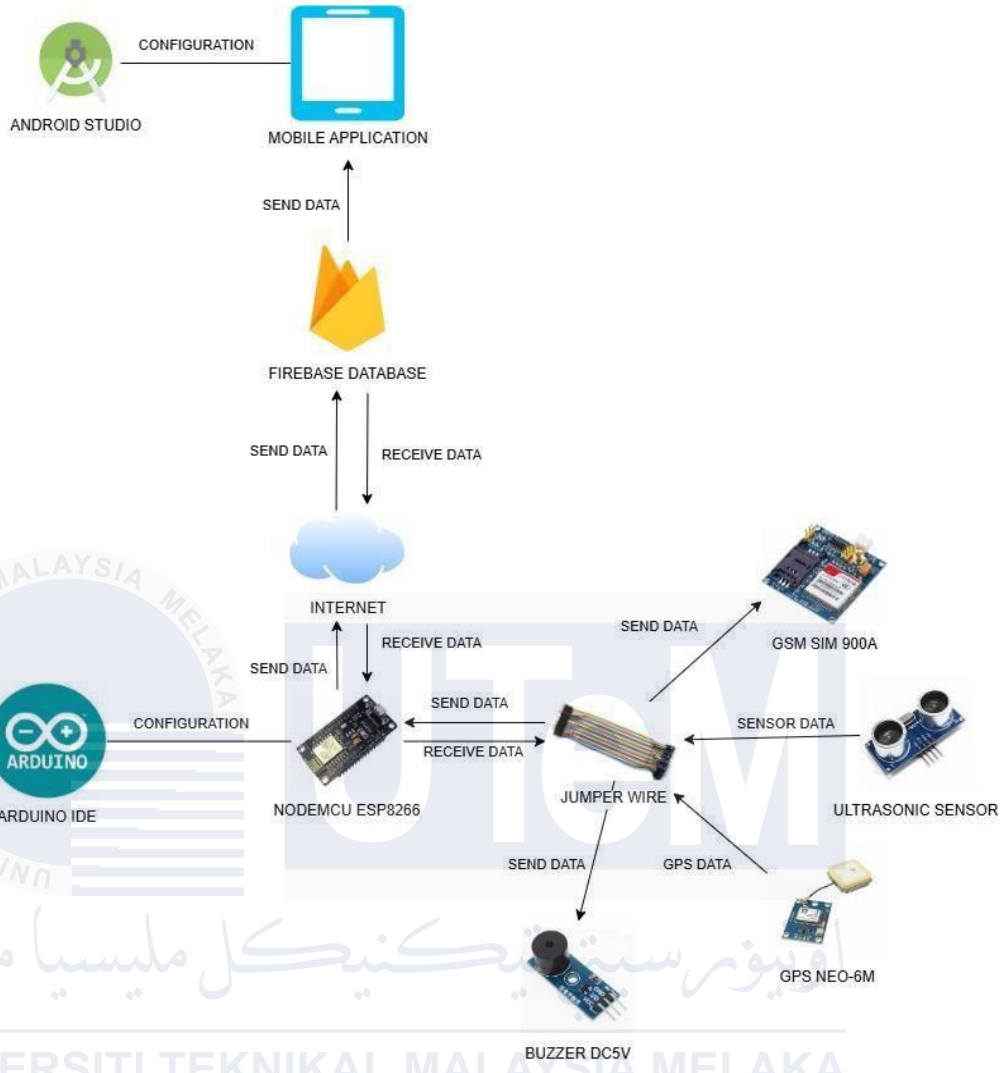

Figure 4.1 System Architecture of Smart Blind Stick

Figure 4.1 shows the interaction between various components of the system. The NodeMCU ESP8266 microcontroller, configured using the Arduino IDE, serves as the central processing unit. It receives sensor data from the ultrasonic sensor and GPS data from the GPS NEO-6M through jumper wires. This data is processed and transmitted via the internet to the Firebase Database, enabling real-time storage and retrieval. The mobile application, developed using Android Studio, interacts with the Firebase Database to receive data, such as obstacle detection, location updates, and SOS alerts. Additionally, the GSM SIM 900A module sends emergency alerts directly to the guardian's phone. This integrated approach ensures that visually impaired users receive timely alerts and guardians can monitor the user's location and safety effectively.

4.2.2 Hardware Design

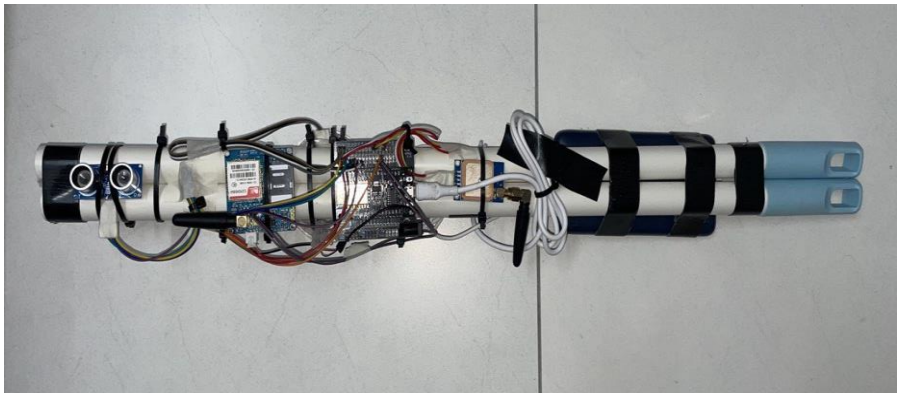

Figure 4.2: Smart Blind Stick

The hardware design of the Smart Blind Stick involves integrating several key components to create a functional and reliable assistive device for visually impaired individuals. The primary goal is to ensure that all components work seamlessly together to provide accurate obstacle detection, real-time location tracking, and emergency alert capabilities. This section outlines the major hardware components and their roles in the system.

i. NodeMCU Lua WiFi ESP8266 Module

Figure 4.3: The NodeMCU Lua WiFi ESP8266 Module

- The NodeMCU Lua WiFi ESP8266 Module is the central microcontroller for the Smart Blind Stick. It is responsible for processing data from the sensors and managing communication

with the mobile application and Firebase database. The ESP8266 is chosen for its low power consumption, built-in WiFi capabilities, compatibility with Firebase and Arduino IDE.

ii. Ultrasonic Sensors

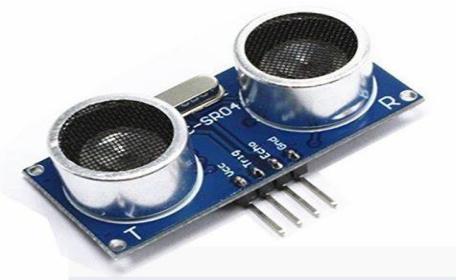

Figure 4.4: Ultrasonic Sensors

Two ultrasonic sensors are used in the system: one for obstacle detection and the other for emergency alert detection.

- Obstacle Detection Sensor: This sensor emits ultrasonic waves and measures the time taken for the waves to bounce back from an obstacle. The distance to the obstacle is calculated based on this time, allowing the system to detect obstacles in the user's path. This sensor is strategically placed on the stick to provide a wide detection range, ensuring the user can navigate safely.

- Emergency Alert Detection Sensor: This sensor is used to detect if the stick has fallen. If the stick falls, the sensor will detect the ground as an obstacle for a continuous period of 20 seconds. If this condition is met, it will trigger an emergency alert as it notifies the guardian that the user may be in distress.

iii. Module NEO-6M

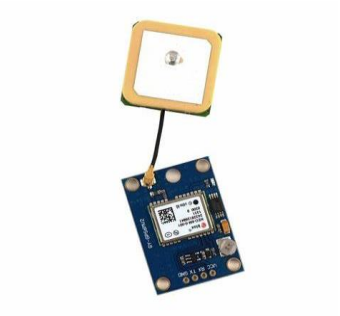

Figure 4.5: Module NEO-6M

- The NEO-6M GPS module provides real-time location tracking for the Smart Blind Stick. It continuously receives signals from GPS satellites and calculates the stick's precise location. This data is sent to the NodeMCU and then transmitted to the real-time firebase, allowing guardians to monitor the user's location via the mobile application.

iv. GSM Module SIM 900A

Figure 4.6: GSM Module SIM 900A

- The GSM Module SIM 900A is used for sending emergency alerts. In case of an emergency, such as the stick falling over, the NodeMCU triggers the GSM module to send a text message to the guardian's phone number. This ensures that guardians are immediately notified of any potential issues.

v. Buzzer DC5V

Figure 4.7: Buzzer DC5V

- A DC5V buzzer is included to provide audible alerts to the user. When an obstacle is detected within a critical range, the buzzer emits a sound to warn the user. This immediate auditory feedback helps the user avoid obstacles in real-time.

vi. Power Supply

Figure 4.8: Powerbank

- A reliable power supply is essential for the continuous operation of the Smart Blind Stick. The system uses a 10000 mAh power bank to power the NodeMCU, sensors, GPS module, and GSM module.

vii. Jumper Wires

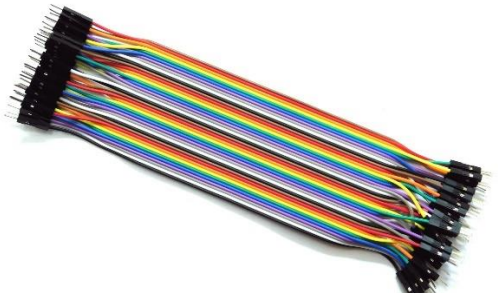

Figure 4.9: Jumper Wires

- Jumper wires are used to connect the various components of the Smart Blind Stick. These wires facilitate the electrical connections needed between the sensors, microcontroller, GPS module, and GSM module.

viii. Stick Construction

- The physical construction of the stick is designed to be lightweight and durable. The components are securely mounted on the plastic broom stick with duck tape used for the placement of sensors and ease of use for the visually impaired user.

4.2.3 User Interface Design

This section details the design of the mobile application's user interface, focusing on creating an intuitive and accessible experience for visually impaired users and their guardians. It includes layout structures, navigation flows, and accessibility features. The screenshots of the user interface design of Smart Blind Stick willbe explained in this section.

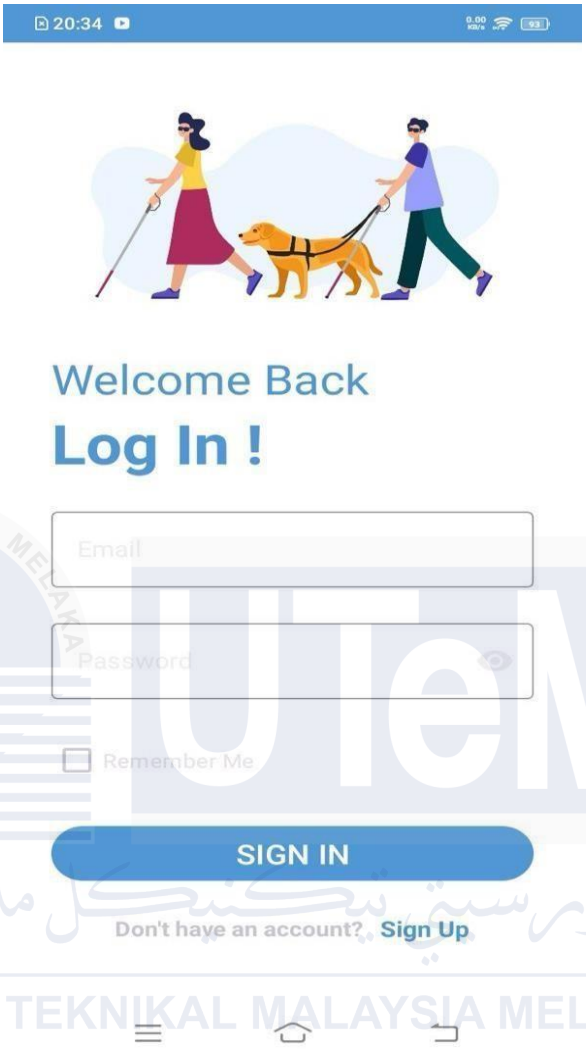

Figure 4.10 Login Page

Figure 4.10 shows the Login Page. On this page, users need to enter a username and password to log into the application which includes text input for validation rules. The email field validates for proper email format and the password field includes criteria for complexity. The "Remember Me" checkbox provides an additional option for user convenience. An eye toggle is placed at the password textbox for users to see their password once they inputit as it will be hidden due to security protocol.

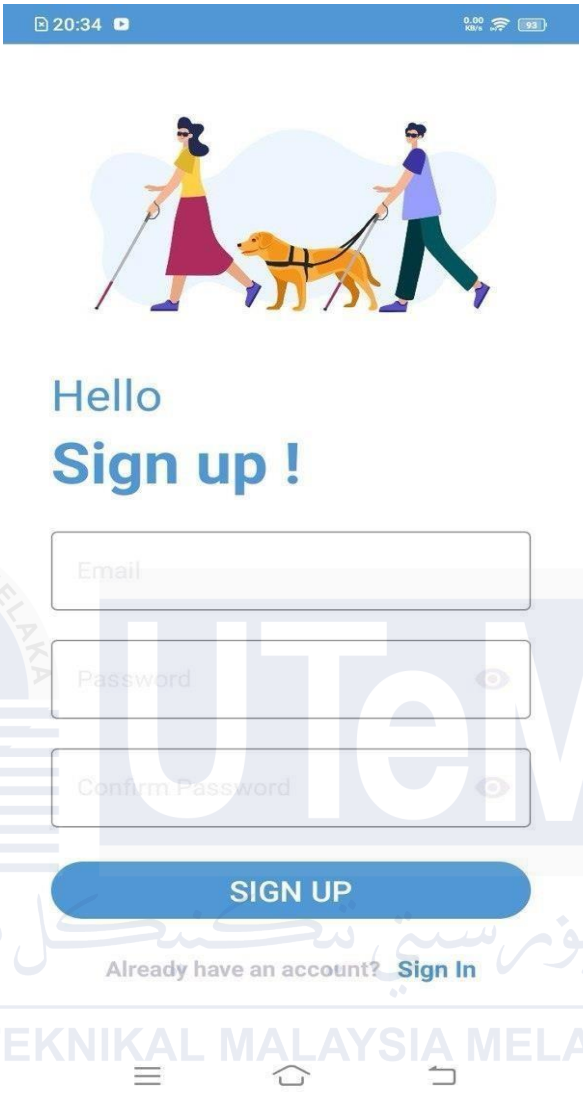

Figure 4.11 Sign Up Page

Figure 4.11 shows the Sign Up Page. Users need to register an accountbefore logging into the system by entering email, password and confirm password which include text input for validation rules. The email field validates for proper email format, while the password field includes criteria for complexity, and the confirm password must match the password. The “eye toggle” is placed on both the password and confirm password textbox for users to see their input for the passwords as it is in hidden format to enhance security.

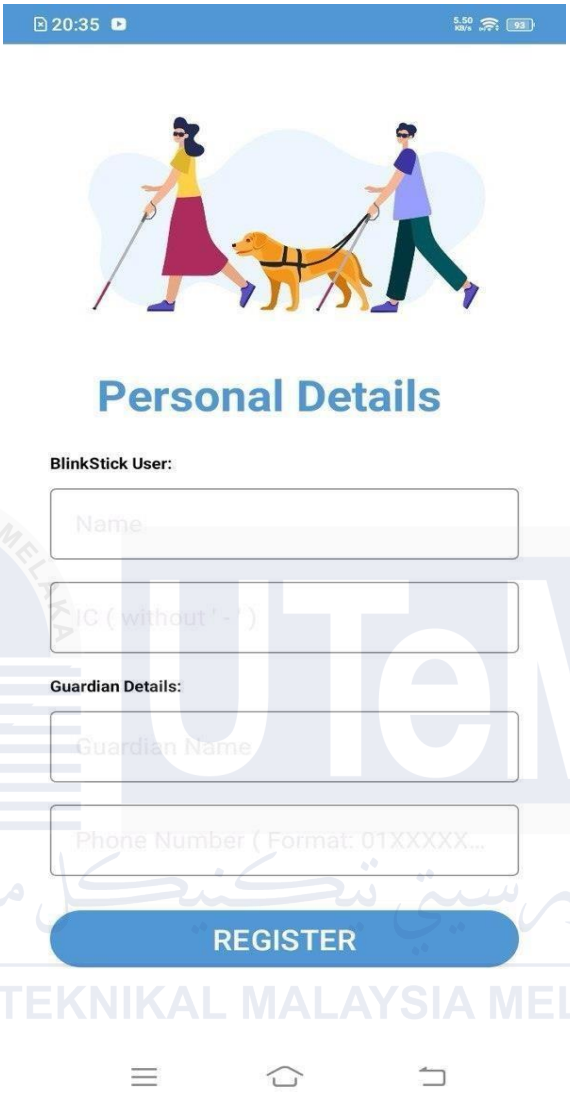

Figure 4.12 Personal Details Page

Figure 4.12 shows the Personal Details Page of the application. In thispage, after user input the email and password for account creation, personal details must be filled in that consists of blind stick user name, identity number of the blind or impaired user, name and phone number of the guardian whichincludes text input for validation rules. The identity number field validates for proper identity number format, while the phone number field for proper phone number format.

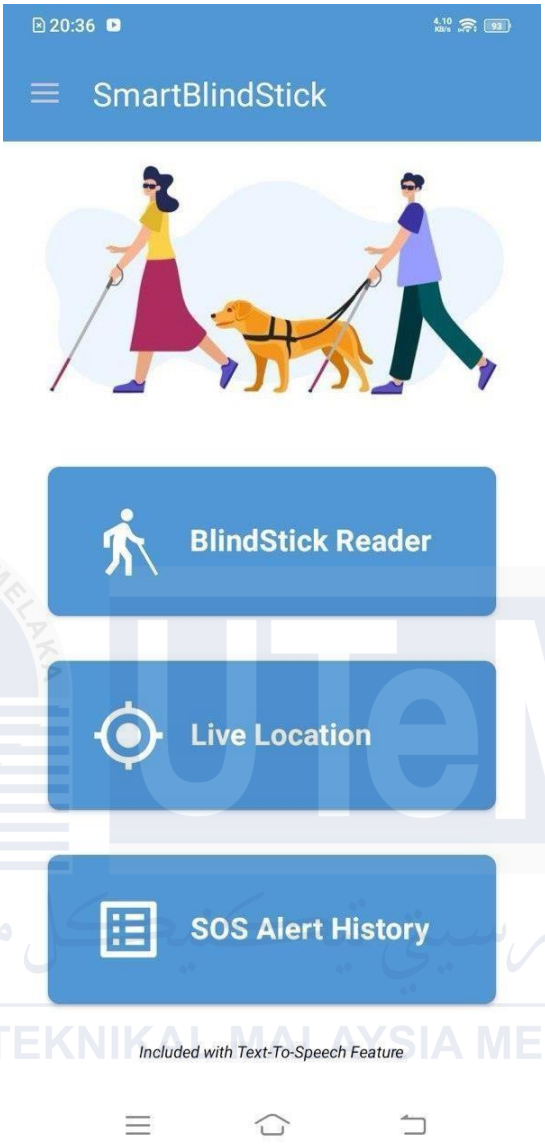

Figure 4.13 Home Page

Figure 4.13 shows the Home Page of the application. This page appears after the successful login by user and consists of 3 option menu buttons which are BlindStick Reader, Live Location and Sos Alert History. There is a side navigation menu placed on the top left of the application bar. In addition, this page is included with a Text-To-Speech feature that generates a voice command if the buttons are pressed.

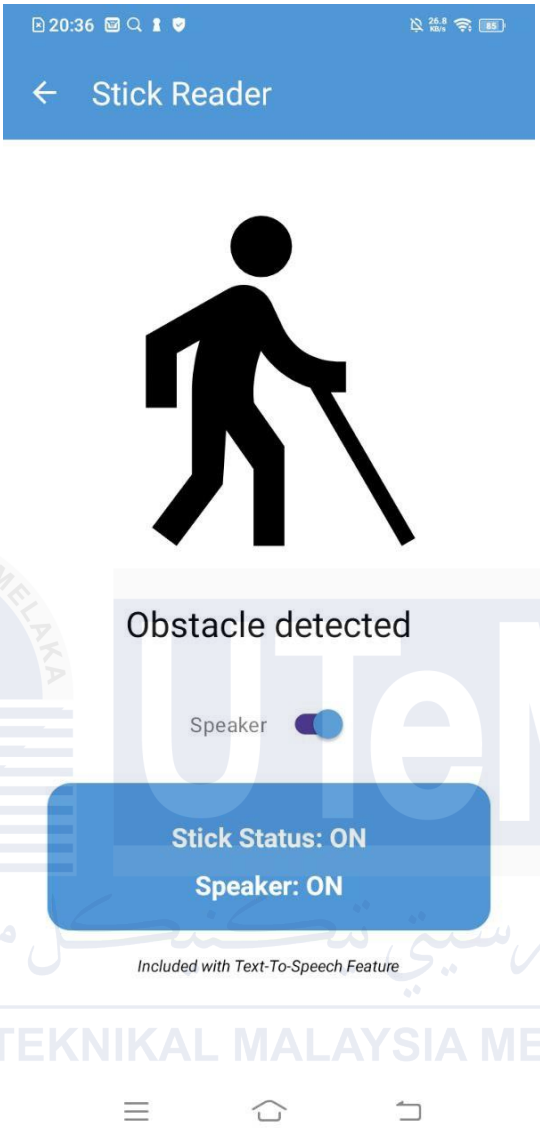

Figure 4.14 Blindstick Reader Page

Figure 4.14 shows the Blindstick Reader Page that shows if the obstacle is detected and creates a voice command for the user. There is a switch to turn on and off the speaker depending on the user's preferences.

Figure 4.15 Location Page

Figure 4.15 shows the location page that uses the Google Map API. This page is designed for the guardians to view the location of the blind stick in case of any emergency alert being triggered or monitor the blind stick user.

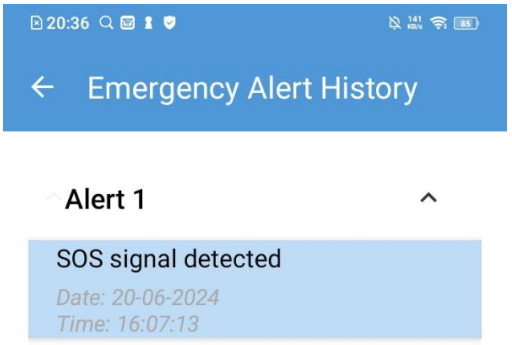

Figure 4.16 Emergency Alert History Page

Figure 4.16 shows the Emergency Alert History page for guardians to monitor the log history of emergency alerts that have been triggered. The history consists of the date and time of the emergency alerts.

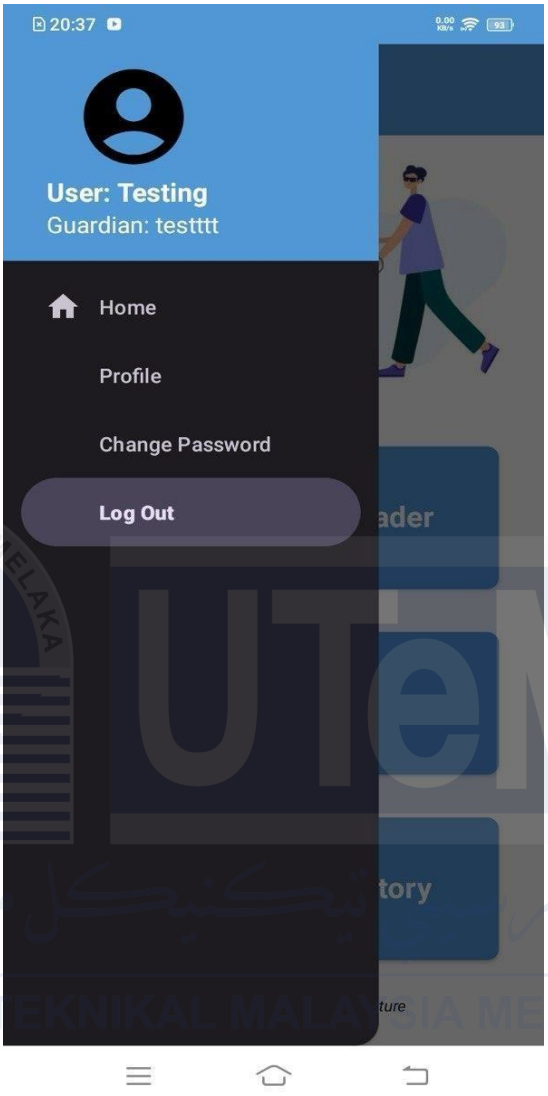

Figure 4.17 Navigation Drawer Page

Figure 4.17 shows the Navigation Drawer page that will appear if the button is pressed on the Home page. This page consists of buttons that direct to the Home page, Profile page, Change password page and Log out.

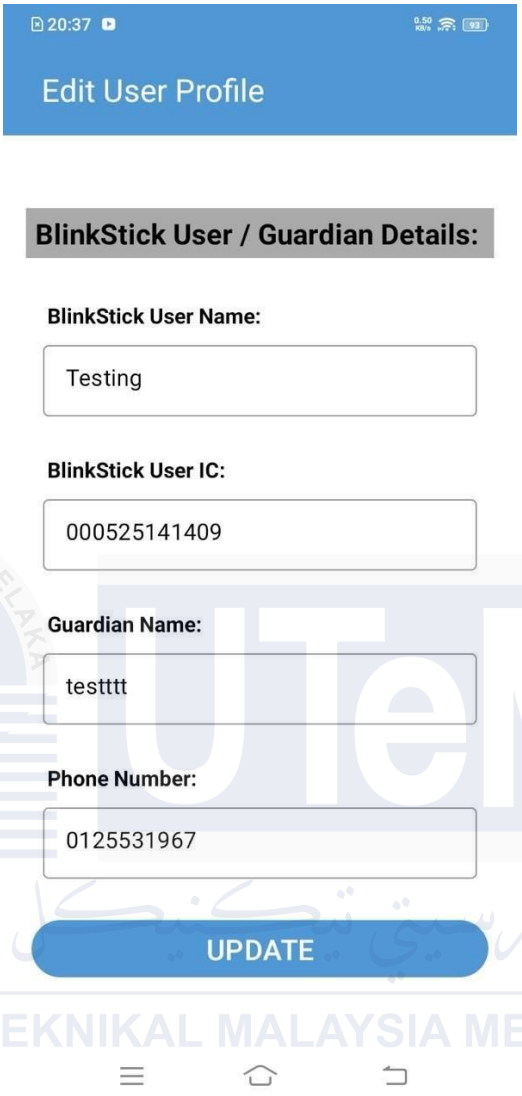

Figure 4.18 Profile Page

Figure 4.18 shows the Profile page that has the personal details that user can view, edit and update. It also consists of text validation for the identity number and phone number that need to be filled in and followed as per the format.

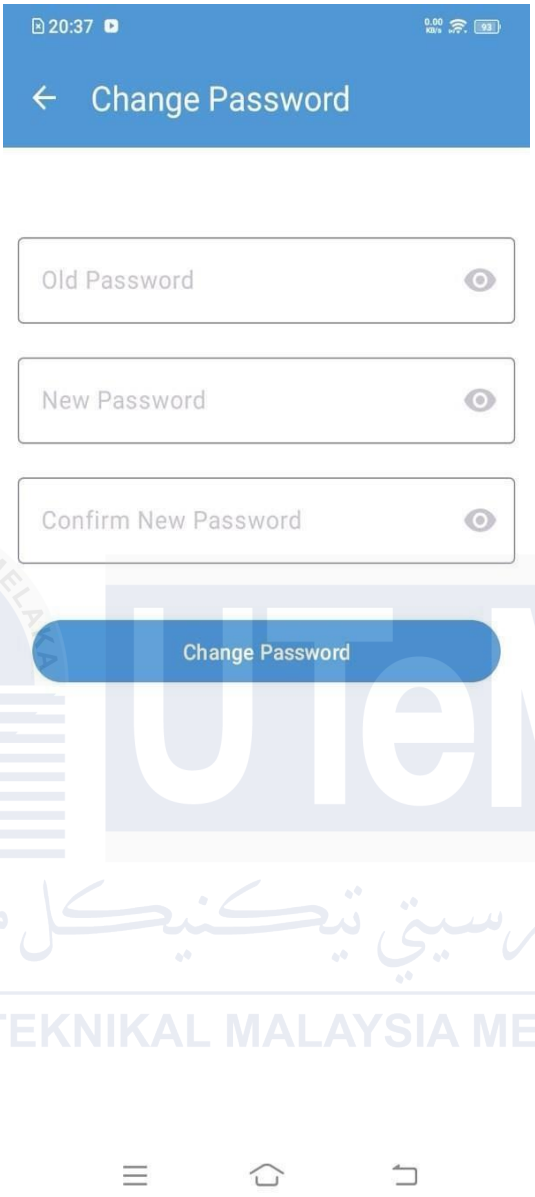

Figure 4.19 Change Password Page

Figure 4.19 shows the Change Password page where user will input their old password, new password and confirmation password. It consists of the text validation for the format of the password, matching old password and the input password for the new password and confirmation password must be the same.

4.2.4 Conceptual and Logical Database Design

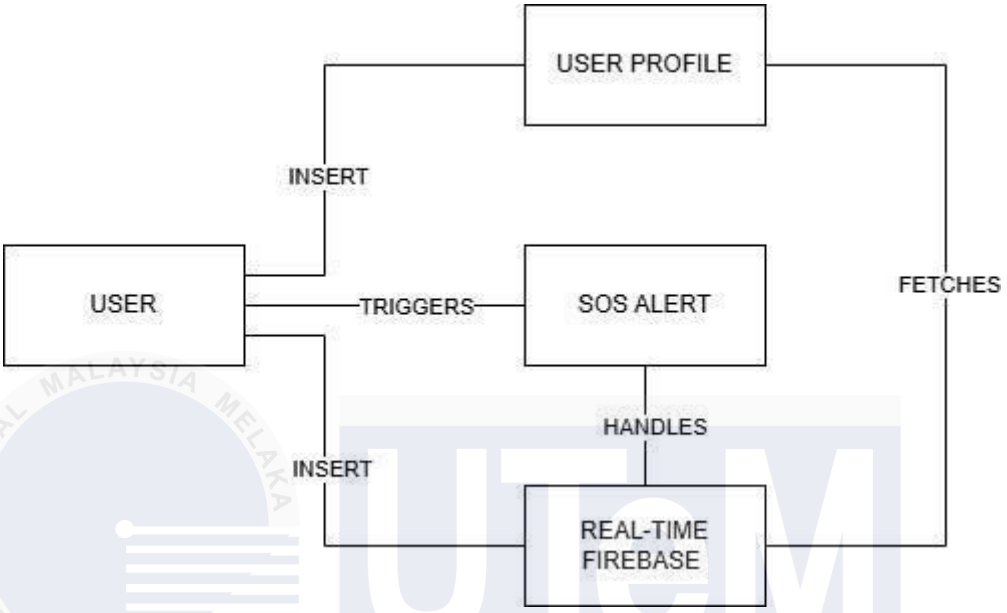

Figure 4.20 Conceptual Database Design

Figure 4.20 shows the conceptual database design for Smart Blind Stick. This design consists of four entities which are User entity, User Profile entity, Sos Alert entity and Realtime Database entity. Each user can only have one data of user profile and real-time database. However, they can update their data from time to time. Each user can have one or more SOS alert data. Each real-time database handles one or more SOS alerts and fetches one or more user profiles.

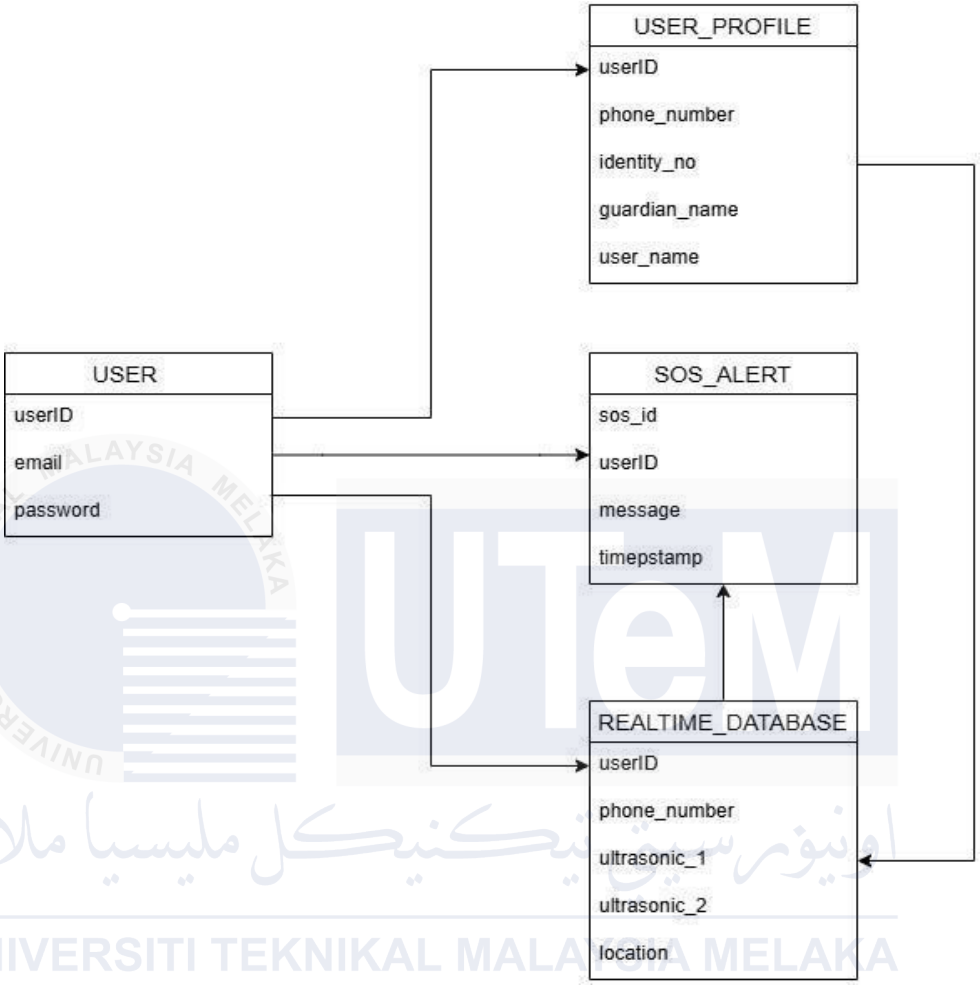

Figure 4.21 Logical Database Design

Figure 4.21 shows the logical data model of the system. This logical data model displays all the attributes used in all of the tables. Some of the attributes cannot be null because some data will only be recorded into the system after the bidding process is ended. All IDs in all tables will be unique and cannot be null.

4.3 Detailed Design

Detailed design refers to the phase where the high-level architecture and requirements of a software system are translated into a more detailed and specific design. It involves creating the technical blueprint or plan for implementing the software solution. The detailed design of the Smart Blind Stick will be explained in this section.

4.3.1 Software Design

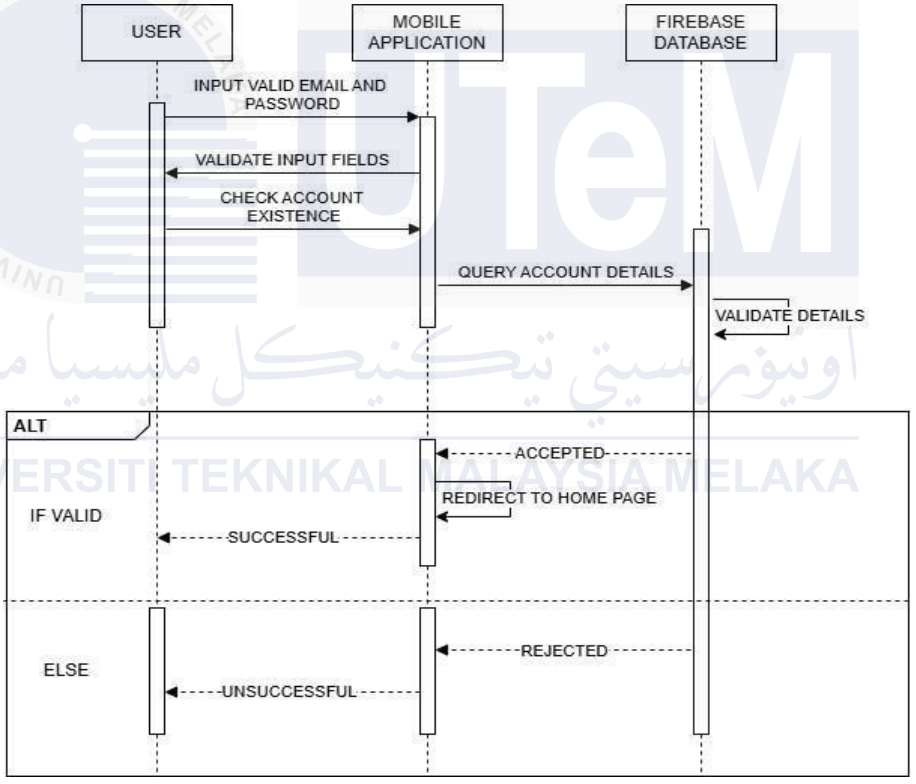

Figure 4.22 Sequence Diagram of Login Process

a) Login

- Process name: Login
- Objective: To provide a standard gateway for the user to enter the system and verify the username, password, and account status before accessing the system.
- Input: email and password

- Output: User home page
- Buttons: Login, Register
- Messages: Error messages for invalid inputs and log in successful

Description:

1) User inputs their email and password in the respective fields.
2) The system validates the input fields to check for valid entries. If valid, the system proceeds to check the existence of the account in the database.
3) If the account exists and the password is correct, it will be directed to the home page.

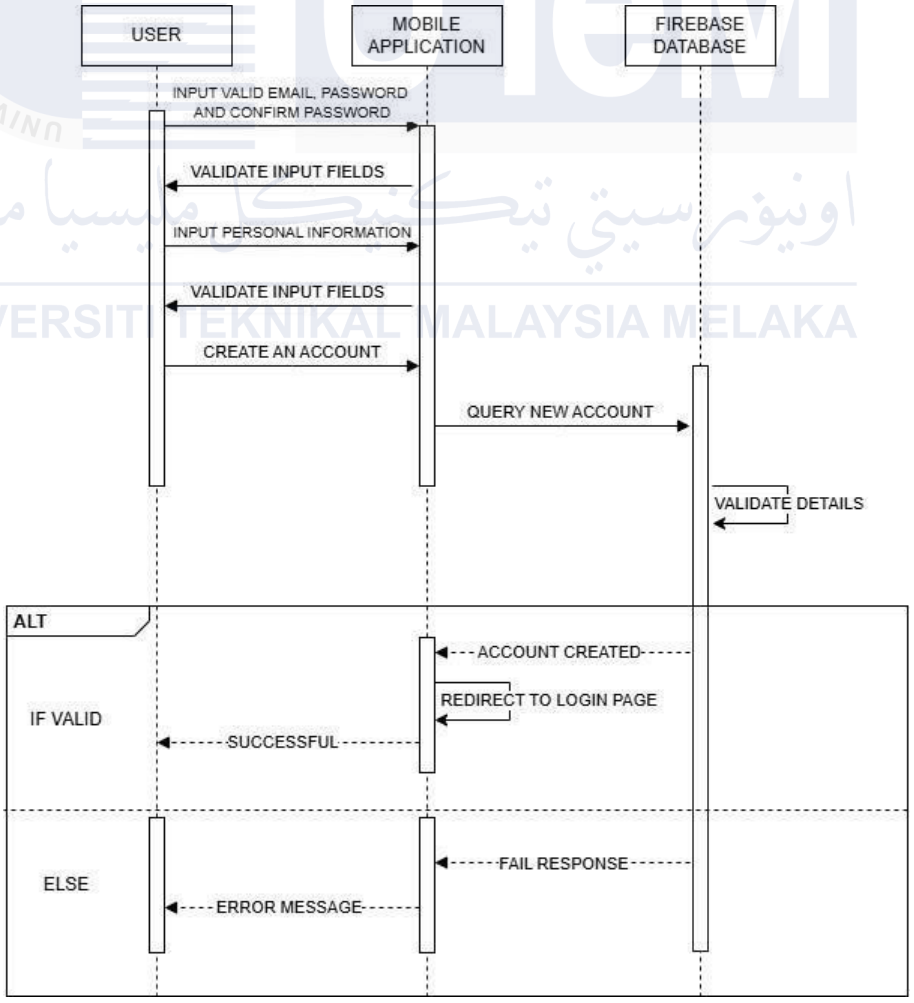

Figure 4.23 Sequence Diagram of Registration Process

b) Registration

- Process name: Registration
- Objective: To allow new users to create an account by providing necessary personal and guardian information.
- Input: email, password, confirm password, user name, identity number, guardian name, guardian phone number.
- Output: New user account in the database and directs to login page.
- Buttons: Register, Login
- Messages: Error messages for invalid inputs and successful registration.

Description:

1) User inputs their email, password and confirmation password in the respective fields.
2) The system validates the input fields to check for valid entries. If valid, it will direct to the personal details page.
3) User inputs the personal information fields.
4) The system validates the input fields to check for valid entries. If valid, the system proceeds to the login page.

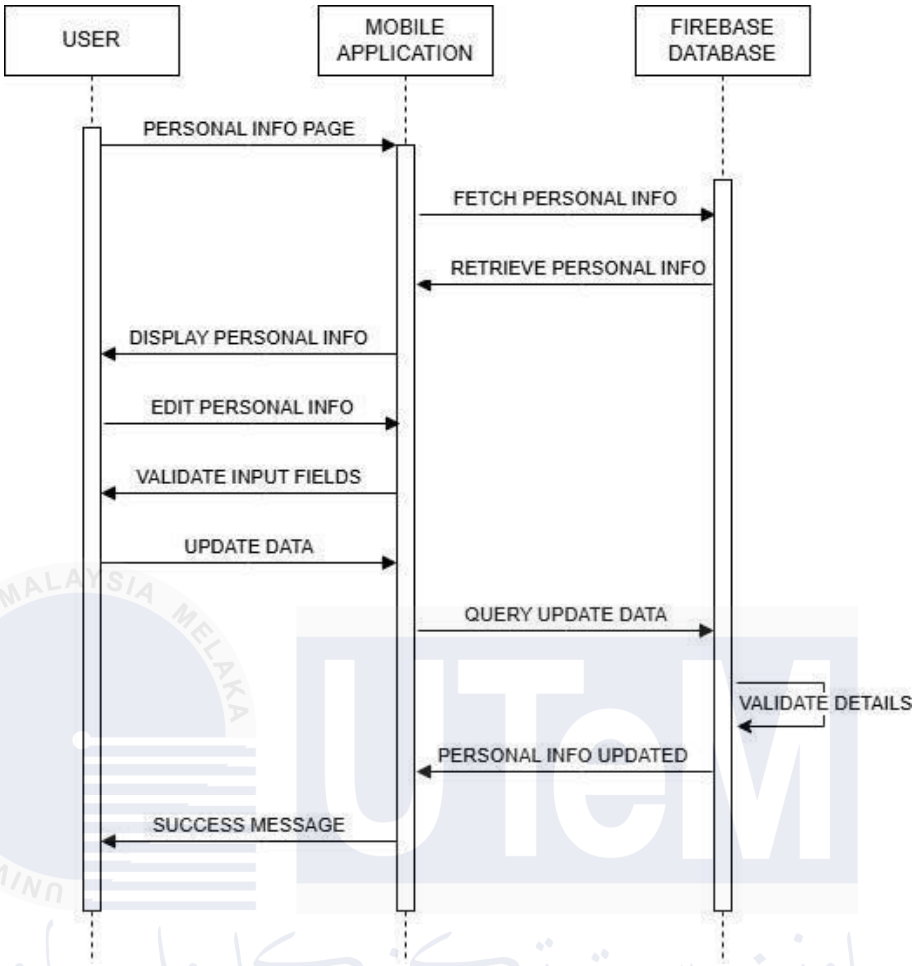

Figure 4.24 Sequence Diagram of View and Update Personal Information Process

c) Personal Information

- Process name: Personal Information
- Objective: To allow users to view and edit their personal and guardian information.
- Input: user name, identity number, guardian name, guardian phone number.
- Output: Profile information
- Buttons: Edit, Update and Back
- Messages: Error messages for invalid inputs and successful updates.

Description:

1) User accesses the personal information section.
2) The system retrieves and displays the current profile information.
3) User edits the personal information fields.
4) The system validates the input fields to check for valid entries. If valid, the system proceeds to update the data and show the changed personal information section.

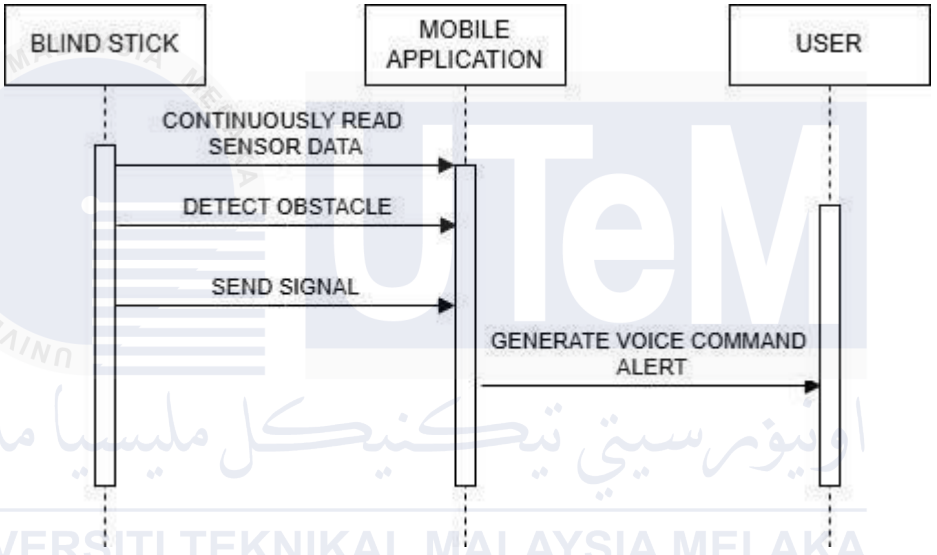

Figure 4.25 Sequence Diagram of Blind Stick Reader Process

d) Blindstick Reader

- Process name: Blindstick Reader
- Objective: To notify the user of detected obstacles via voice commands.
- Input: Data from ultrasonic sensors
- Output: Voice command alert
- Button: Speaker on/off
- Messages: Voice command alerts

Description:

1) The system continuously reads data from the ultrasonic sensors.

2) If an obstacle is detected within a critical range, the system sends a signal to the mobile application.
3) The mobile application generates a voice command alert for the user.

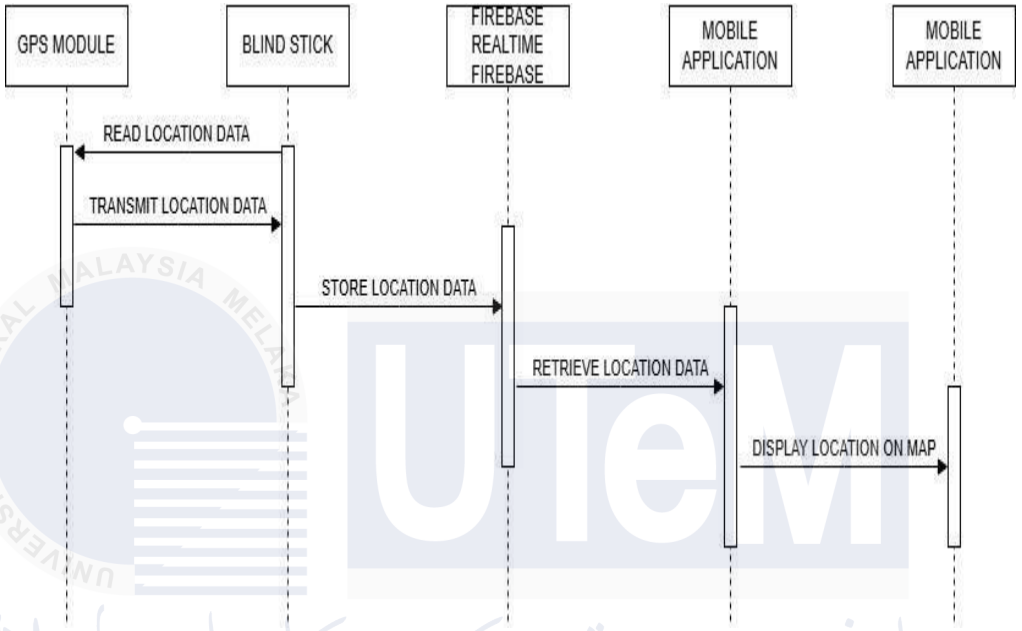

Figure 4.26 Sequence Diagram of GPS Location Process

e) GPS Location

- Process name: GPS Location
- Objective: To provide real-time location tracking of the smart blind stick.
- Input: Location data from the GPS module
- Output: Real-time location displayed on the application
- Buttons: Refresh and Back
- Messages: Real-time map with current location and error message of fetching location

Description:

1) The system continuously reads location data from the GPS module.
2) The location data is transmitted to the Firebase Realtime Database.

3) The mobile application retrieves and displays the current location on a map.

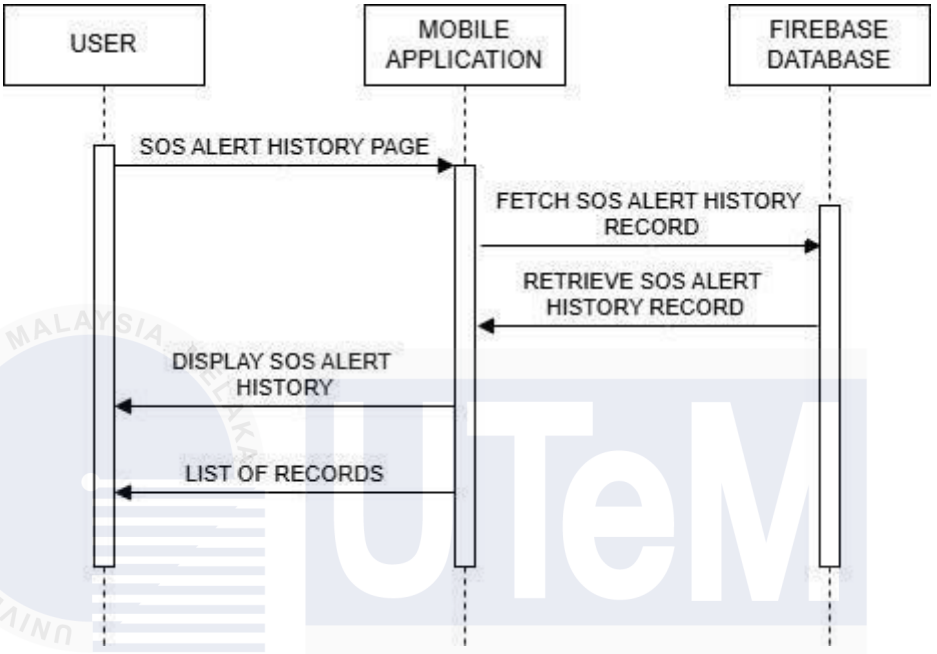

Figure 4.27 Sequence Diagram of SOS Alert History Process

f) SOS Alert History

- Process name: SOS Alert History
- Objective: To display the history of emergency alerts triggered by the user.
- Input: -
- Output: List of past emergency alerts
- Button: Back
- Messages: List of past alerts

Description:

1) The user accesses the SOS Alert History section.
2) The system retrieves the list of past emergency alerts from the database.
3) The alerts are displayed with details such as date, time, and message.

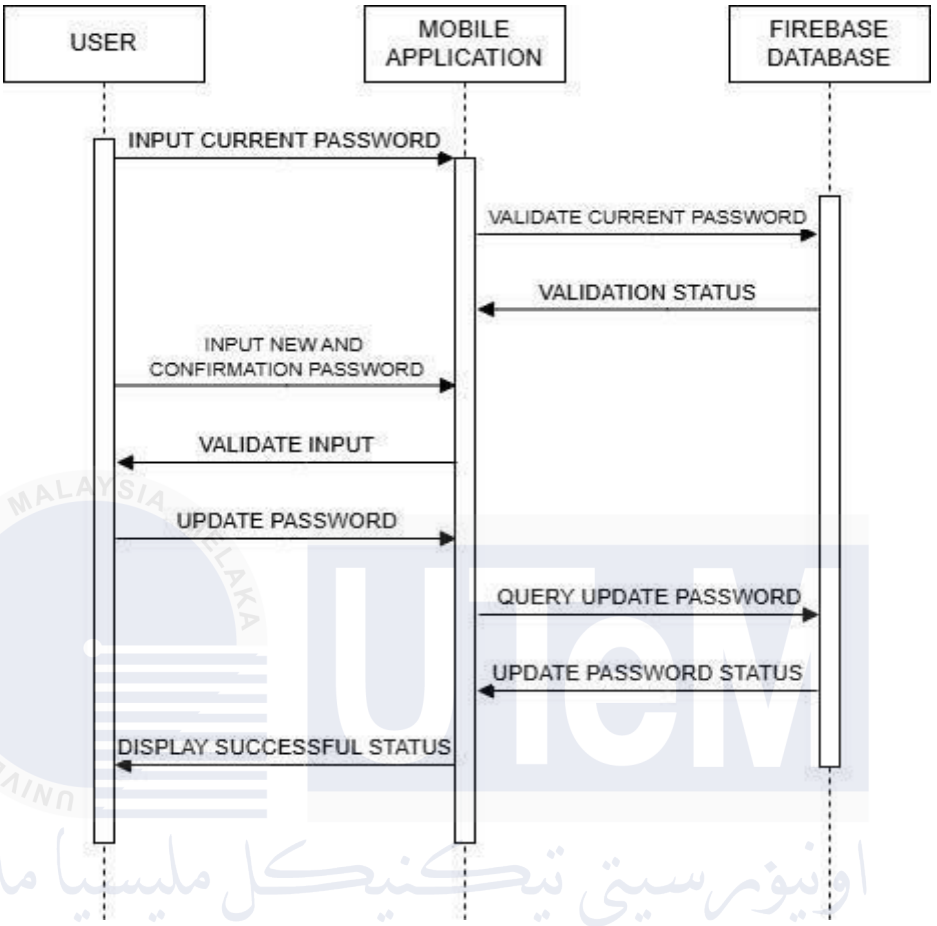

Figure 4.28: Sequence Diagram of Change Password Process

g) Change Password

- Process name: Change Password
- Objective: To allow users to change their account password.
- Input: Current password, new password, confirm new password.
- Output: Password update confirmation.
- Button: Back and Save.
- Messages: Confirmation of successful update, error messages for invalid inputs.

Description:

1) User inputs their current password, new password, and confirmation new password.

2) The system validates the current password.
3) The system validates the new password and confirmation password. The validation consists of password format and matching password input.

4.3.2 Physical Design

i. Class Diagram

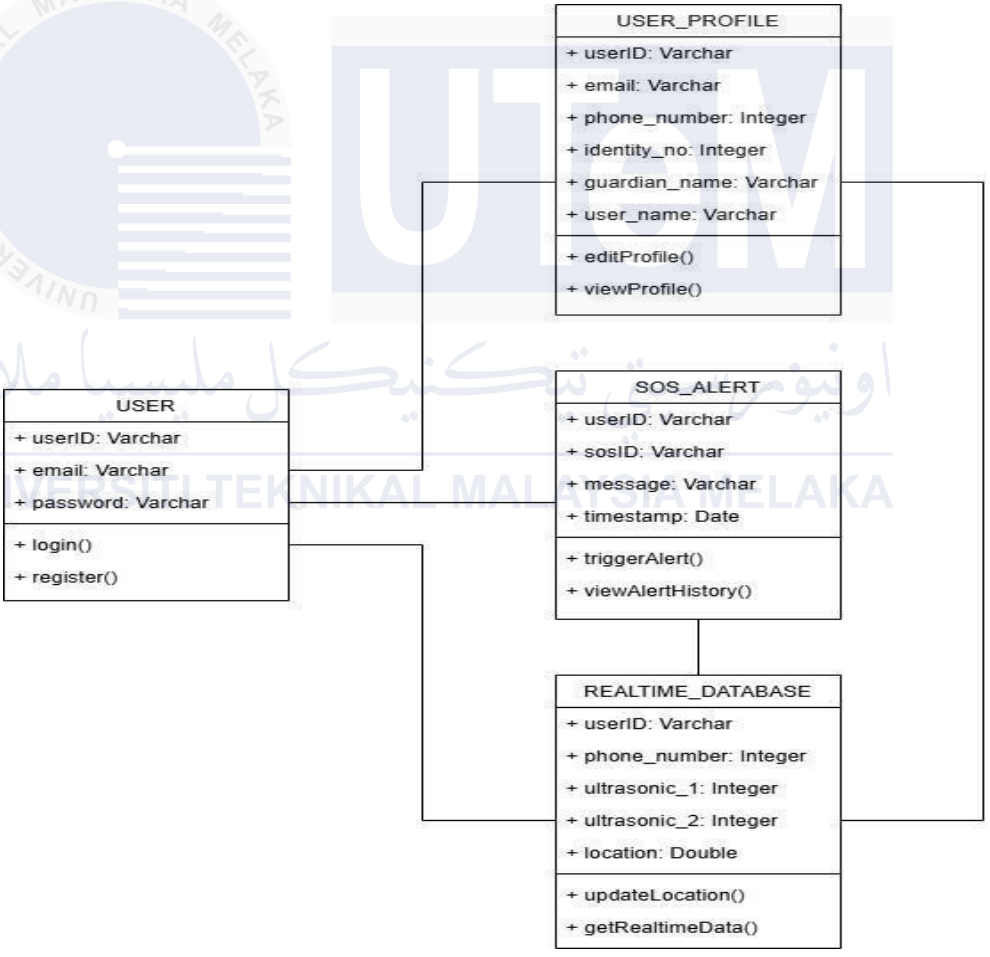

Figure 4.29 Class Diagram

Figure 4.29 shows the class diagram for Smart Blind Stick which displays four tables showing all the attributes contained for each table.

ii. Entity Relationship Diagram

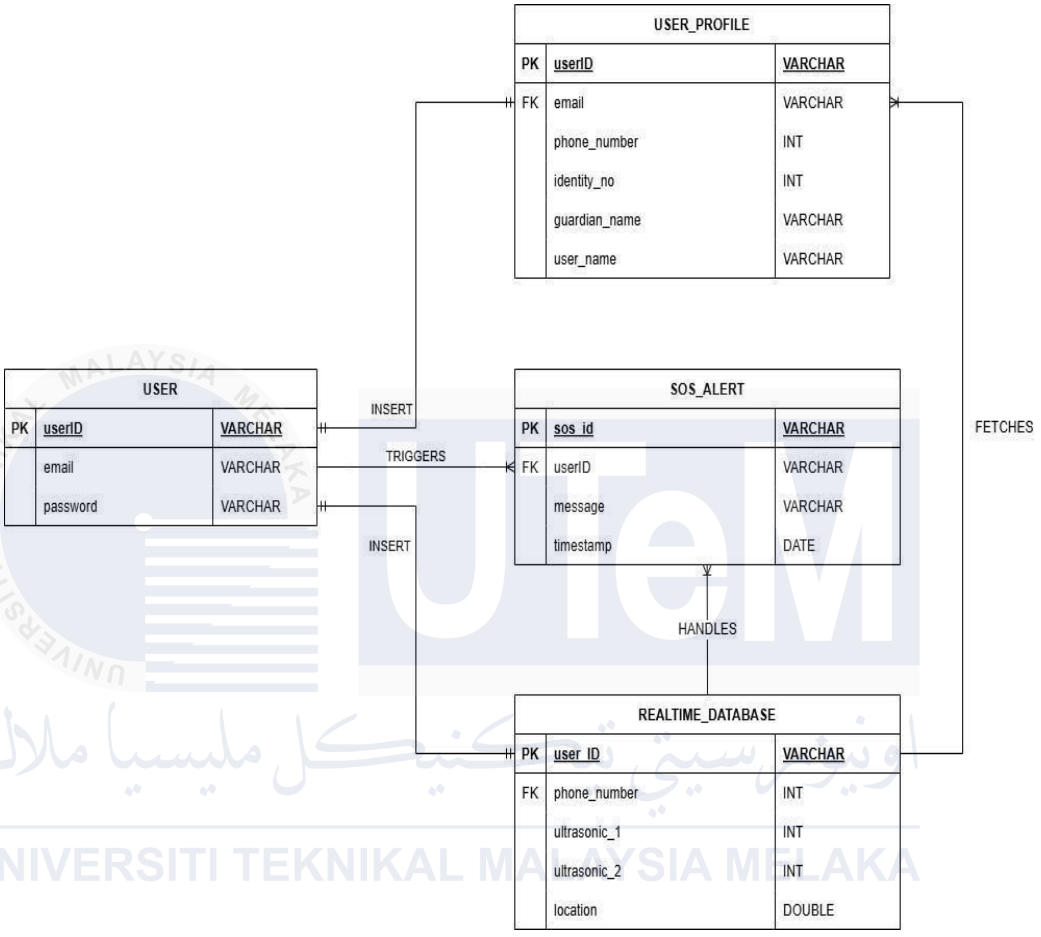

Figure 4.30 Entity Relationship Diagram

Figure 4.30 shows the Entity Relationship Diagram (ERD) for Smart Blind Stick. This ERD displays the details of the relationship between each table and the details of the attributes of the tables.

4.4 Conclusion

In conclusion, this chapter explains all the high-level design containing the system architecture, user interface design, and the database design which consists of conceptual and logical database design. This chapter also explains the detailed design of the system such as the software design of the system and the physical database design. The next chapter is going to talk about the implementation phase.

CHAPTER 5: IMPLEMENTATION

5.1 Introduction

The implementation phase transforms the planning and design into a functional Smart Blind Stick. This includes installing software tools, developing hardware and software components, and conducting thorough testing and debugging. The goal is to ensure the final product operates smoothly and meets the design specifications. This phase is crucial for delivering a reliable, efficient, and user-friendly assistive device.

5.2 Hardware and Software Development Environment Setup

The development environment setup of the Smart Blind Stick and control system involves hardware and software requirements. All of the setups are stated step by step and clearly shown. The hardware and software requirements are already stated in Chapter 4 and explained further for the connection in the section below.

5.2.1 Software Development Environment Setup

i. Android Studio

Figure 5.1: Android Studio

Figure 5.1 shows the main software development environment setup used to develop the Smart Blind Stick application, which is Android Studio. Android Studio is an integrated development environment (IDE) specifically designed for Android app development. It is the official development platform for building Android applications and is widely used by developers to create, test, and debug Android apps. Android Studio provides a comprehensive set of tools and features to streamline the development process and make it easier for developers to create high-quality Android applications. It includes a code editor, a visual layout editor, and debugging tools, among other resources. Regular updates and enhancements make Android Studio an invaluable tool for Android app developers, simplifying the app development process and providing extensive resources and documentation to assist developers at all levels of expertise.

ii. Firebase Database

Figure 5.2: Firebase Database

Figure 5.2 shows the Firebase Database setup used in the development of the Smart Blind Stick. Firebase is a comprehensive platform provided by Google for building mobile and web applications. It offers real-time database services that are crucial for the synchronization of data between the Smart Blind Stick and the mobile application. Firebase Database provides robust features of Firestore Database, Realtime Database, and Authentication which are essential for ensuring that user data is securely managed and easily accessible. The integration with Firebase allows seamless communication between the hardware components and the Android application, facilitating real-time location tracking and emergency alerts. Firebase continues to receive updates and enhancements, making it a valuable tool for developers looking to create responsive and scalable applications.

iii. Arduino IDE

Figure 5.3: Arduino IDE

Figure 5.3 shows the Arduino IDE setup used in the development of the Smart Blind Stick. Arduino IDE is an open-source software that makes it easy to write code and upload it to Arduino-compatible boards. It supports the integration of various libraries and modules needed for the project such as ESP8266WiFi, FirebaseESP8266, and GSM. The Arduino IDE provides a simple and clear interface for coding, which is crucial for programming the NodeMCU ESP8266 microcontroller. It allows developers to write, compile, and upload code efficiently. The Arduino IDE is a versatile tool that supports various hardware

components, enabling the seamless integration of sensors, GPS modules, and GSM communication in the Smart Blind Stick project.

5.2.2 Hardware Development Environment Setup

In this project, the hardware used is already stated in Chapter 4. The following hardware is combined to perform as a complete mushroom system. Figure 5.4 below shows the details of how all components are connected and interact with each other. The components are represented by symbols. Lines and wires on the schematic diagram indicate the electrical connection between components. Figure 5.5 below shows the hardware installation.

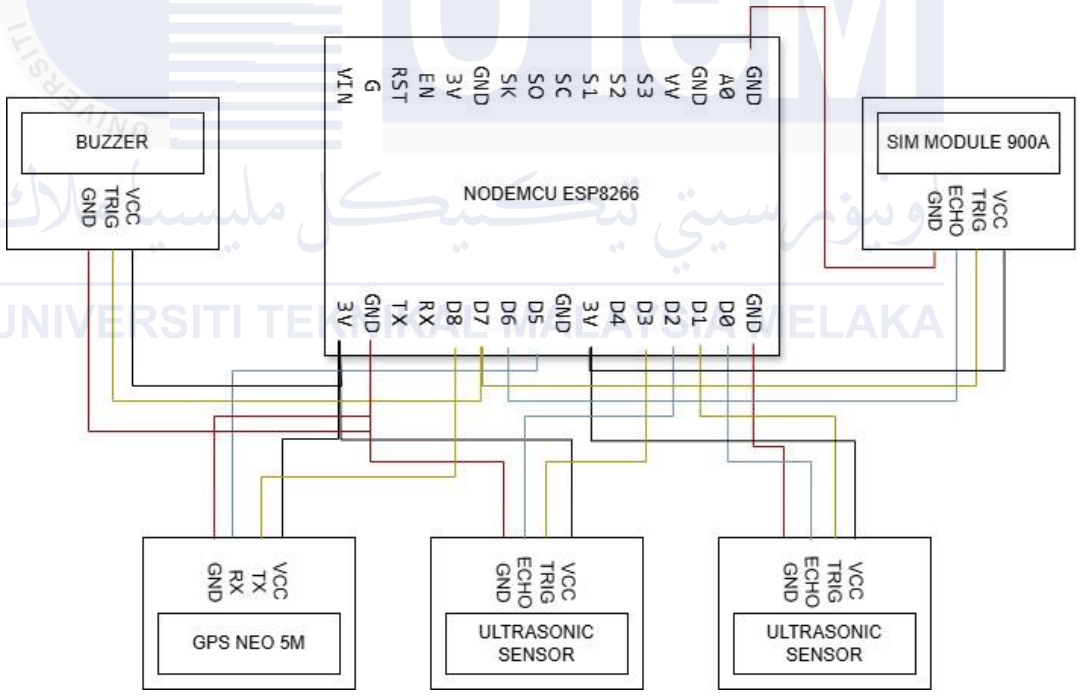

Figure 5.4: Schematic Design

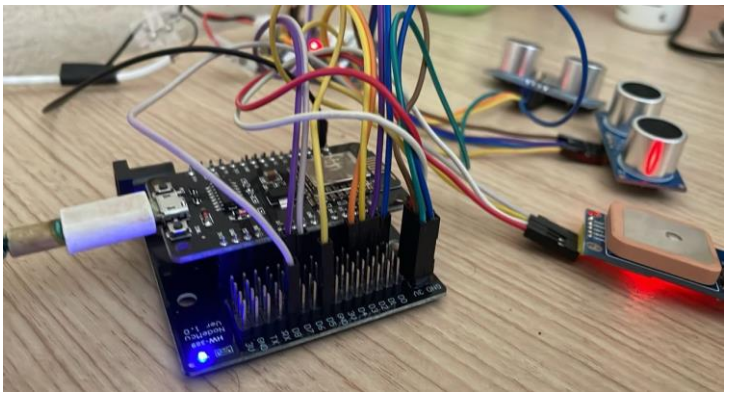

Figure 5.5: Hardware Installation

5.2.3 Environment Architecture

The environment architecture of the Smart Blind Stick system is designed to integrate various software and hardware components, ensuring seamless communication and functionality. This section presents the deployment diagram that illustrates the setup of the client software, server software, hardware, and network configurations.

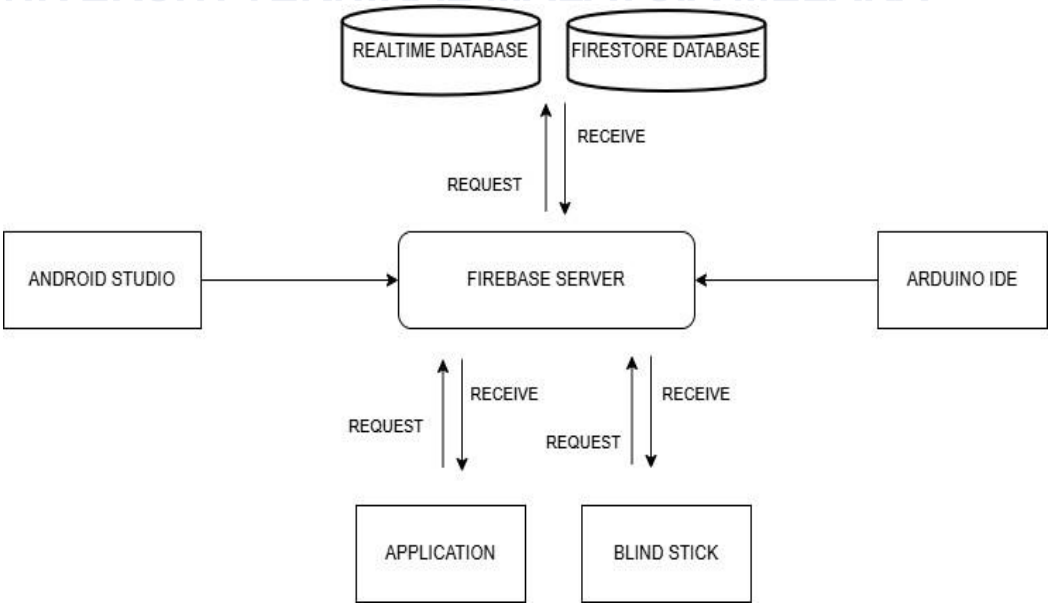

Figure 5.6: Environment Architecture of the System

Figure 5.4 shows the environment architecture of the Smart Blind Stick system illustrating the interaction between different components. Android Studio serves as the primary IDE for developing the mobile application, which communicates with the Firebase server to request data and updates, ensuring real-time synchronization. The Arduino IDE is used to program the NodeMCU ESP8266 microcontroller, which handles sensor data and communicates with the Firebase server. The Firebase server, as the central component, processes requests, and data from both the mobile application and the blind stick, interacting with the Realtime Database and Firestore Database. The Realtime Database stores real-time sensor data and location updates, while the Firestore Database manages user authentication and historical data logging. The mobile application interfaces with the Firebase server for real-time updates, voice alerts, and location tracking, while the blind stick detects obstacles and sends data to the server. This integrated architecture ensures a reliable and scalable solution for enhancing mobility and safety for visually impaired users.

5.3 Software Configuration Management

5.3.1 Configuration environment setup

To ensure consistent and controlled development, configuration management is essential. This section details the setup of the configuration environment for Firebase, Android Studio, and Arduino IDE used in the Smart Blind Stick project.

i. **Firebase Database Setup**

- Create a Firebase project, and go to the Firebase console. Add a new project and follow the steps to create a new Firebase project. Complete the setup to create the project, as illustrated in Figure 5.7.

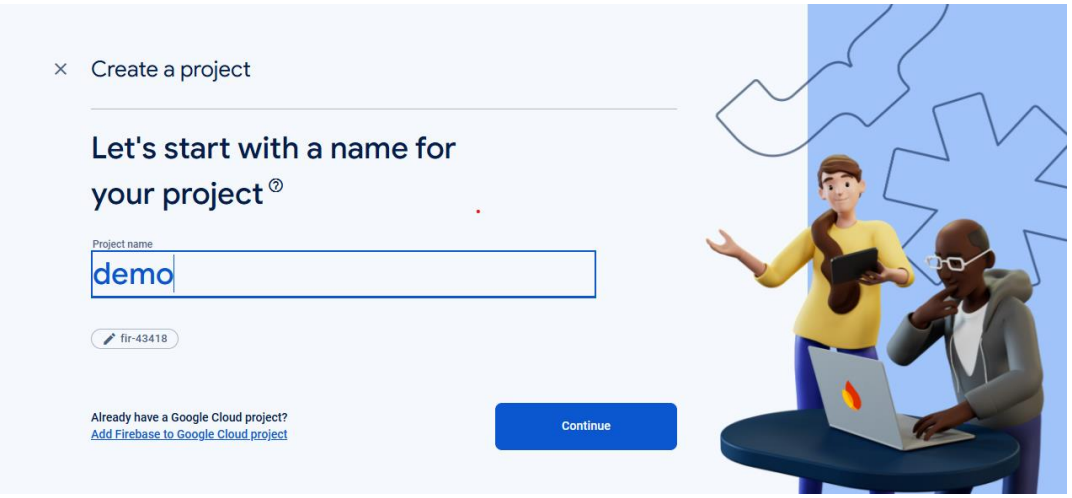

Figure 5.7: Create Firebase Project

- Within the Firebase project, link the Android Application by following the specific instructions for each platform, as illustrated in Figure 5.8.

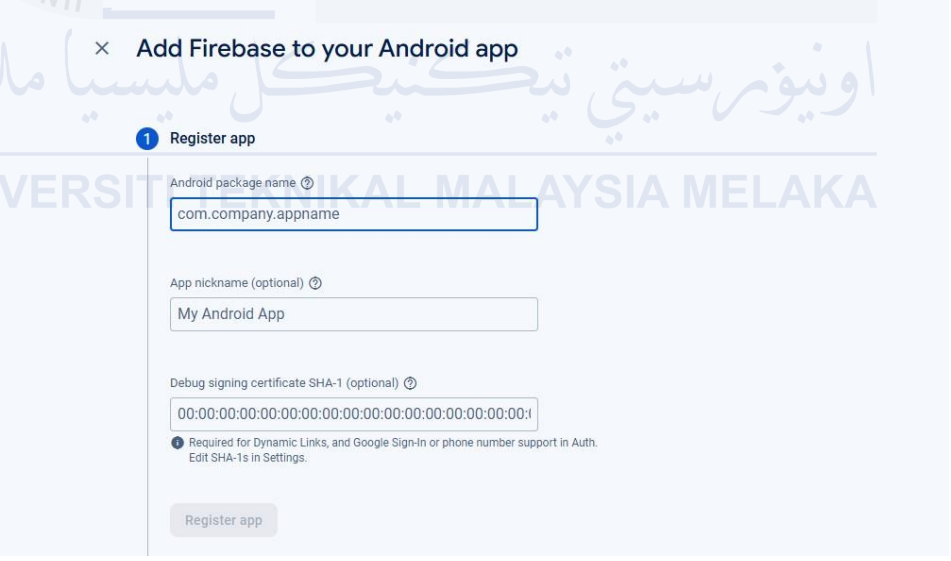

Figure 5.8: Add Firebase to Android Application

- Enable and set up desired Firebase services, such as Authentication for user sign-ins, Real-time Firebase for real-time data management, and Firestore Database for database management. Figure 5.9 shows the implementation of the Cloud Firestore setup.

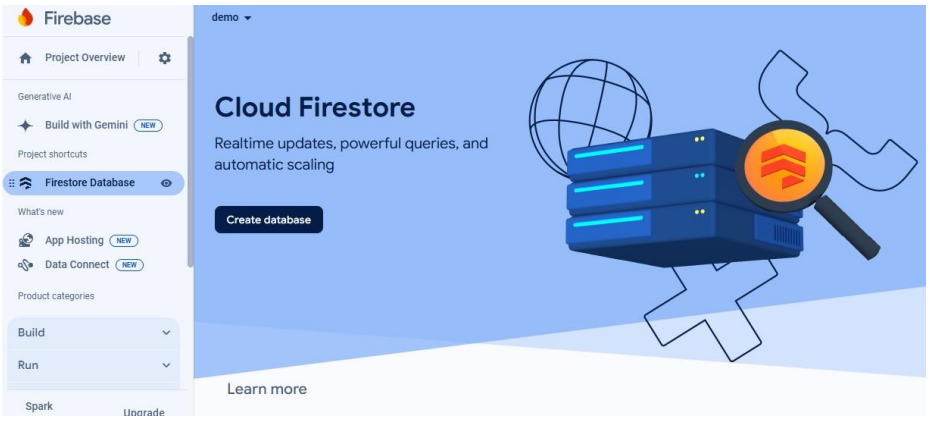

Figure 5.9: Setup Firebase Services

- Figure 5.10 shows the preview of Firestore Database.

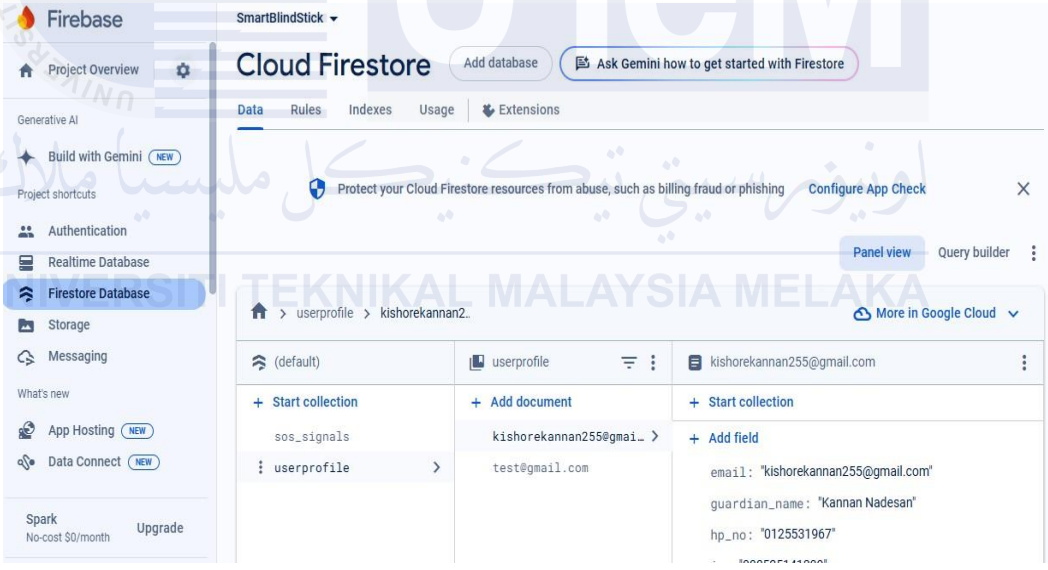

Figure 5.10: Preview of Firestore Database

- Figure 5.11 below shows the preview of Realtime Database.

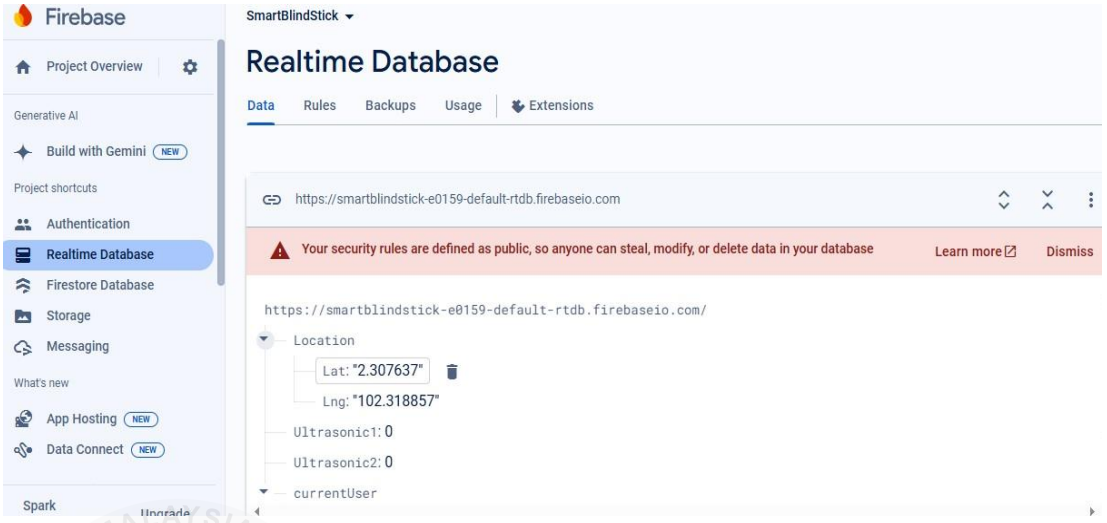

Figure 5.11: Preview of Realtime Database

- Figure 5.12 shows the collection for authentication of users.

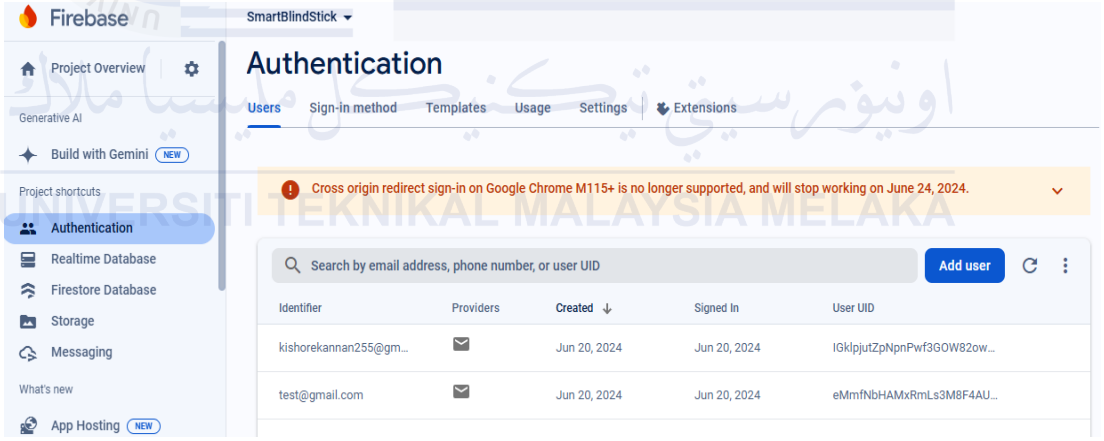

Figure 5.12: Preview of Authentication

ii. Android Studio Setup

- Create a Java project and select the minimum SDK requirement for the device used to run the application, as illustrated in Figure 5.13.

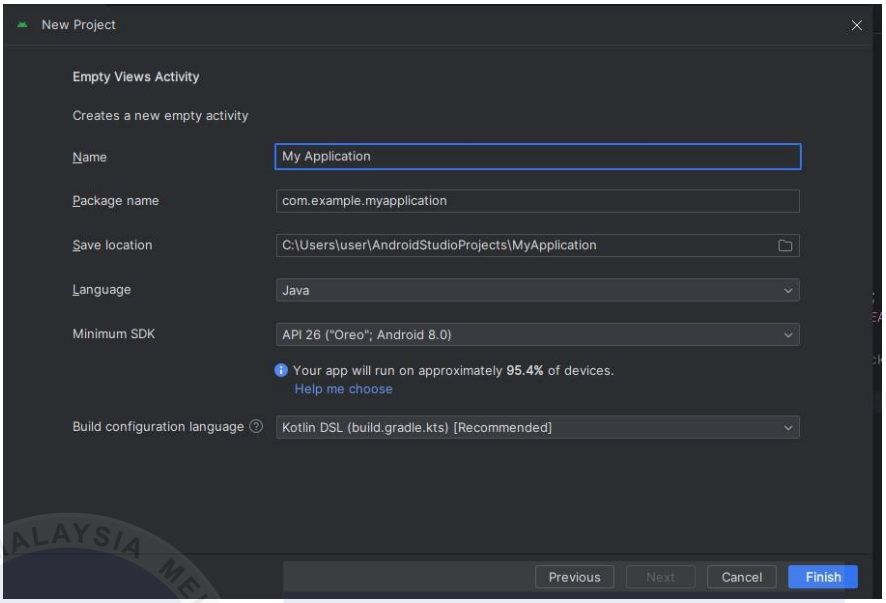

Figure 5.13: Create a New Java Project

- After creating, link the project with Firebase services in the Android Studio such as Realtime Database, Cloud Firestore, and Authentication, as illustrated in Figure 5.14.

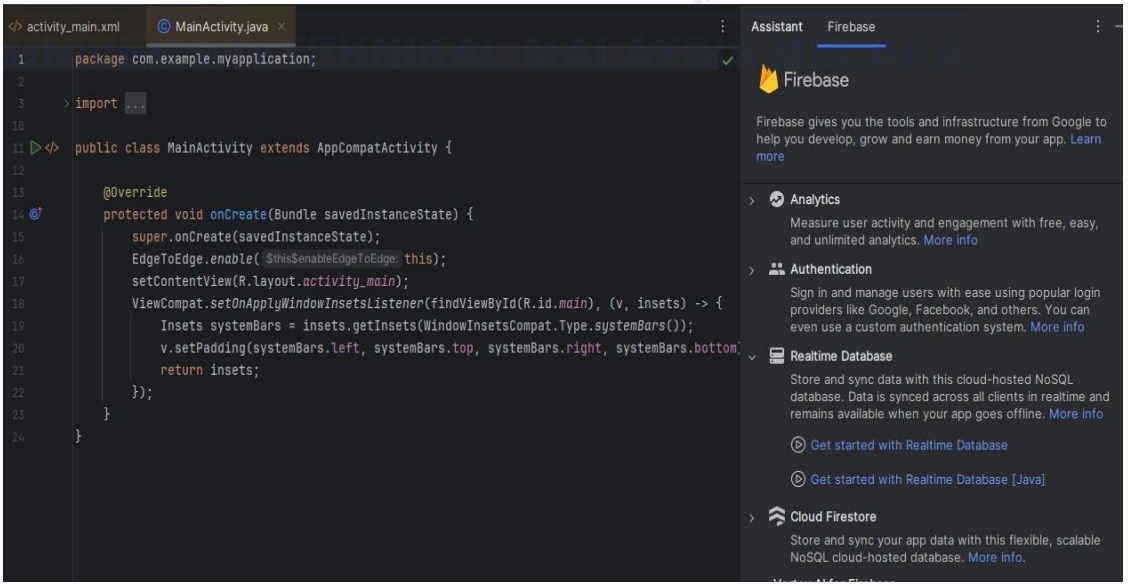

Figure 5.14: Link Firebase with Android Studio Project

- Add the Realtime Database SDK into build.gradle in the application and project level, as illustrated in Figure 5.15.

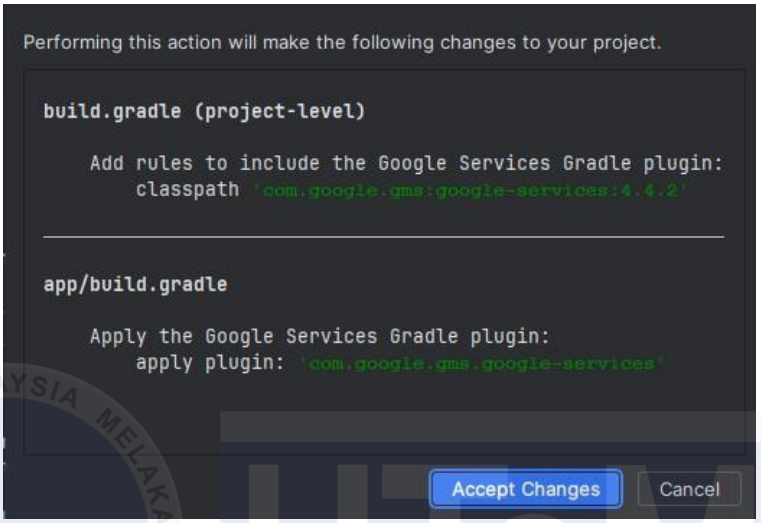

Figure 5.15: Adding SDK into the build.gradle file

- After adding SDK, the Firebase will be connected to the Android Studio Project, as illustrated in Figure 5.16.

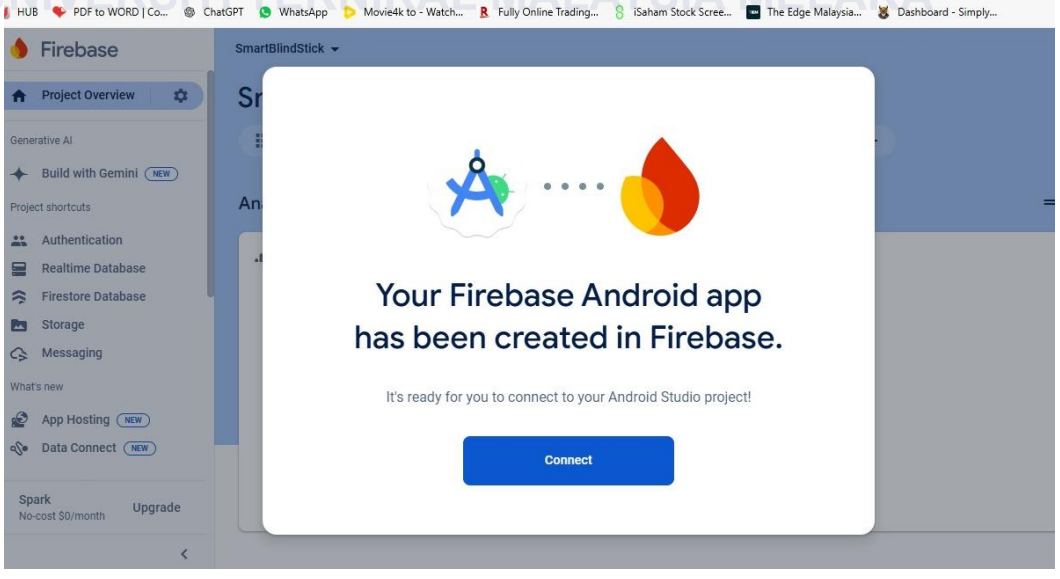

Figure 5.16: Android Studio Connected to Firebase

iii. **Arduino IDE Setup**

- The source code for the NodeMCU ESP8266 microcontroller is maintained in a Git repository, tracking changes, and maintaining versions.
- Figure 5.17 shows the configuration management involves managing the source code and libraries used in the project after the installation of Arduino IDE.

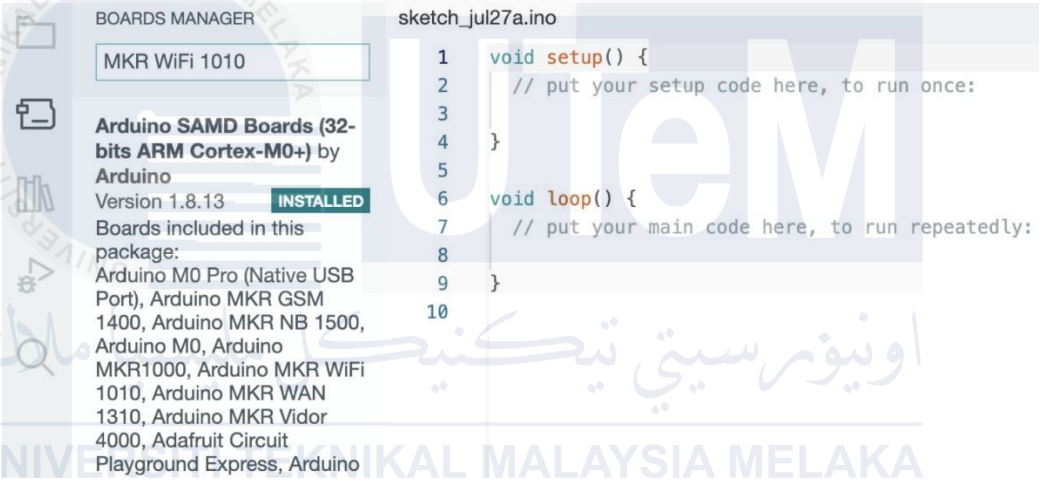

Figure 5.17: Configuration Management in Arduino IDE

5.3.2 Version Control Procedure

The project is backed up and saved to an external hard disk to manage the source code version once a week. Every week after the backup, the version number increases by 1 for example, 1.0 becomes 2.0. This is to prevent any incident that could cause the folder or the project to go missing or become corrupted. Weekly backup is the solution to prevent these problems.

5.4 Implementation Status

Table 5.1: Progress of the development status

No.	Module Name	Description	Duration to Complete
1.	Hardware Integration	• Assemble hardware components (NodeMCU, sensors, GPS, GSM, buzzer). • Ensure secure and functional connections. • Initial testing of hardware components.	7 days
2.	Obstacle Detection	• Develop ultrasonic sensor integration for obstacle detection. • Provide real-time alerts via buzzer. • Adjust sensor sensitivity and range.	6 days
3.	Authentication	• Implement login, logout, and registration and forgot password features. • Ensure correct and incorrect credential validation.	5 days
4.	Profile Management	• Allow users to view and update personal details. • Include fields for user and guardian information. • Ensure data validation.	4 days
5.	Location Tracking	• Integrate GPS for real-time tracking. • Display location on the mobile app using Google Maps API. • Ensure accurate location updates.	5 days
6.	Emergency Alert	• Implement a GSM module for SMS alerts. • Log emergency events in Firebase. • Test alert functionality.	5 days
7.	Mobile UI/UX	• Design and develop the mobile app interface. • Include accessibility features (voice commands, navigation). • Conduct usability testing.	9 days

8.	Data Synchronization	• Set up Firebase for real-time data sync. • Ensure reliable data handling. • Test data flow between hardware and application.	6 days
9.	Testing and Debugging	• Conduct comprehensive testing of system components. • Perform integration testing. • User acceptance testing and feedback collection.	6 days

5.5 Conclusion

In conclusion, this chapter presents the software development environment setup and the software configuration management which consists of configuration environment setup, version control procedure and the implementation status. The next phase is the testing phase.

CHAPTER 6: TESTING

6.1 Introduction

In this chapter, software testing is conducted for the Smart Blind Stick application. This chapter is the stage where the software product or system undergoes thorough testing to identify and fix any defects, errors, or issues before it is released to users or clients. This phase ensures that the software meets the specified requirements, functions as intended, and provides a reliable and satisfactory user experience. The main objective of this testing phase is to ensure the application system functions appropriately without any errors and problems occurring.

6.2 Test Plan

6.2.1 Test Organization

Two testers are involved in the testing of the system, and more than 30 participants are involved in an online questionnaire survey to assess user satisfaction with the system. Testers are blind and visually impaired individuals along with their guardians. The survey respondents are random people of various ages and genders.

6.2.2 Test Environment

The testing was conducted at the Disabled People's Center located in the Klang Valley, in collaboration with the center's residents, who are the primary users of the Smart Blind Stick. The hardware used included the Smart Blind Stick prototype and a smartphone with the mobile application installed. System

configuration details can be referred to in Chapter 5.3. Before the testing, training was provided to ensure the testers understood their tasks and how to evaluate the system's functionality. The training involved demonstrations of the Smart Blind Stick's features, including obstacle detection and emergency alerts, as well as instructions on how to conduct the testing process. This preparation ensured a structured and meaningful evaluation of the system. Additionally, a questionnaire survey was distributed to both the residents and the staff at the center to gather feedback on the system's usability. Participants were given a link to access the system demonstration and the questionnaire, allowing them to use the system and provide feedback based on their experience. The data collected from this process offered valuable insights into the Smart Blind Stick's performance in real-world conditions, highlighting areas for further improvement.

6.2.3 Test Schedule

In the testing phase of a software development project, a test schedule is a comprehensive plan that specifies the timing and order of testing tasks to be carried out. The test schedule is an important part of the overall project schedule since it ensures that testing activities are planned, carried out effectively and finished in the allocated amount of time. Table 6.1 shows the test schedule for the Smart Blind Stick.

Table 6.1: Test Schedule

Testing Module	Start Date	End Date	Duration
User Authentication	1/8/2024	2/8/2024	1 day
User Profile	3/8/2024	4/8/2024	1 day
Blind Stick Reader	5/8/2024	6/8/2024	1 day
Blind Stick Location	7/8/2024	8/8/2024	1 day
SOS Alert History	9/8/2024	10/8/2024	1 day
Change Password	11/8/2024	12/8/2024	1 day

6.3 Test Strategy

Test Strategy is a comprehensive record in software testing that precisely outlines the specific approach and testing goals for a software application. This test strategy addresses various inquiries, including the intended accomplishments and the methods to achieve them. In this phase, two types of testing are conducted which are dynamic testing and user acceptance testing that will be conducted through questionnaires to the end users.

6.3.1 Dynamic Testing

Dynamic testing is a method of software testing that assesses the behavior of an application during its execution. Static testing reviews the code and documentation without running the program, while dynamic testing concentrates on evaluating the software's functionality, performance, and other characteristics in an operational setting. For the Smart Blind Stick, two forms of dynamic testing will be performed: Black Box Testing and White Box Testing.

Black box testing is a software testing technique that does not require knowledge of the internal structure or implementation details of the system being tested. The tester provides input to the system and observes the output. This allows the tester to identify how the system responds to expected and unexpected user actions, its response time, usability issues, and reliability issues. Meanwhile, white box testing is a software testing technique that requires knowledge of the internal structure of the system being tested. The tester uses this knowledge to design test cases that target specific areas of the code, such as the control flow, data flow, and decision points. This type of testing can help to identify defects that are caused by the internal workings of the system, such as logic errors, boundary conditions and performance bottlenecks.

6.3.2 User Acceptance Testing

User Acceptance Testing also known as application testing or end-user testing, represents a critical stage in the software development process. During this phase, the software undergoes testing by its intended users in a real-world context. It typically serves as the final checkpoint in the software testing journey and occurs prior to the official release of the software to its target audience. The primary objective is to verify that the software performs real-world tasks in accordance with the specified development criteria. In the test, users are given opportunity to engage with the software before its formal release, aiming to identify any overlooked features or potential defects. It can be executed internally with volunteers, involve paid testers using the software and offer the test version for download as a free trial. Feedback from these initial testers is then communicated to the development team which makes any necessary final adjustments before the software's commercial launch.

6.4 Test Design

6.4.1 Test Description

The test description section is used to verify that the system function produces the desired result. Each test description includes a unique identifier, a description and the expected outcome of the system. The following table lists the test cases for each module. For Smart Blind Stick, the test is conducted by the end user. This test is run in a testing environment where the tester given time to test the data according to the test schedule.

Table 6.2 shows the test case which consists of the module, test case ID, test case and expected result for User Authentication.

Table 6.2: Test Case for User Authentication

Module	Test Case ID	Description	Expected Result
Login	UA1_01	To check the login functionality using the correct username or password	The "Logging In" loading bar and "Login Successful" messages will be displayed and directed to the home page
	UA1_02	To check the login functionality using the incorrect username or password	The "Login Failed. Do check your credentials " message will be displayed and the text input will turn red
	UA1_03	To check the login functionality using the empty username or password	The "Enter email" or "Enter password" message will be displayed and the text input will turn red
	UA1_04	To check the visibility of password functionality	The password will be displayed if the eye toggle is enabled
Register	UA2_01	To check the signup functionality using the correct username password, confirmation password and user details.	The "Signing Up" loading bar and "Sign Up Successful" messages will be displayed and redirected to the login page
	UA2_02	To check the signup functionality using	The "Email should consist of "@","." and

		an invalid format of username details	“com”” message will be displayed and the text input will turn red
	UA2_03	To check the signup functionality using an invalid format and length of password	The “Password must be at least 8 characters long and contain at least one capital letter, one symbol and one number” and the text input will turn red
	UA2_04	To check the signup functionality using the empty username, password and confirmation password	The “All fills must be filled” message will be displayed and the text input will turn red
	UA2_05	To check the signup functionality using an invalid match of password and confirmation password	The “Password and confirm password do not match” message will be displayed and the text input will turn red
	UA2_06	To check the signup functionality if the username entered is available	The “Username exist” error message will be displayed
	UA2_07	To check the visibility of password and confirm password functionality	The password and confirm password will be displayed if the eye toggle is enabled
	UA2_08	To check the signup functionality using an invalid format of	The “Phone number should consist of 10-11 digits

		phone number	(Format:01X-XXXXXXX)" error message will be displayed and the text input will turn red
	UA2_09	To check the signup functionality using an invalid format of identity number	The "Identity number should consist of 12 digits (without "-")" error message will be displayed and the text input will turn red
Forget Password	UA3_01	To check the forget password functionality using the correct email	The "An email has been sent to change password" message will be displayed
	UA3_02	To check the forget password functionality using the incorrect email	The "Incorrect email" error message will be displayed

Table 6.3 shows the test case which consists of the module, test case ID, test case and expected result for the User Profile.

Table 6.3: Test Case for User Profile

Module	Test Case ID	Description	Expected Result
View User Profile	UP1_01	To check the functionality if the system will display the correct user profile information	The correct user profile details will be displayed
	UP1_02	To check the functionality of the edit button	The edit button should redirect to the Edit User Profile page and display the "Edit User Profile" message
Edit User Profile	UP2_01	To check the edit user profile functionality using the correct format of username, identity number, guardian name and phone number.	The "Updated Successfully" message will be displayed and redirect to the User Profile page
	UP2_02	To check the edit user profile functionality using an empty username, identity number, guardian name and phone number.	The "All fills must be filled" message will be displayed and the text input will turn red
	UP2_03	To check the edit user profile functionality using	The "Invalid IC Number" message will be displayed and

		an invalid format of identity number	the text input will turn red
	UP2_04	To check the edit user profile functionality using an invalid format of phone number	The "Invalid Phone Number" message will be displayed and the text input will turn red

Table 6.4 shows the test case which consists of the module, test case ID, test case and expected result for the Blind Stick Reader.

Table 6.4: Test Case for Blind Stick Reader

Module	**Test Case ID**	**Description**	**Expected Result**
Blind Stick Reader	BR1_01	To check the functionality if the system will display the correct blind stick reading	The correct blind stick reading will be displayed
	BR1_02	To check the functionality of the speaker toggle	The text-to-speech feature will enabled if the toggle is turned on
	BR1_03	To check the functionality of the back button	The back button should redirected to the home page

Table 6.5 shows the test case which consists of the module, test case ID, test case and expected result for the Blind Stick Location.

Table 6.5: Test Case for Blind Stick Location

Module	Test Case ID	Description	Expected Result
Blind Stick Location	BL1_01	To check the functionality if the system will display the correct blind stick location	The correct blind stick location will be displayed
	BL1_02	To check the functionality of the location if an error is detected	The "Error, please try again later" error message will be displayed
	BL1_03	To check the functionality of the refresh map button	The location data will load and display the refreshed current location
	BL1_04	To check the functionality of the back button	The back button should redirected to the home page

Table 6.6 shows the test case which consists of the module, test case ID, test case and expected result for the Emergency Alert History.

Table 6.6: Test Case for Emergency Alert History

Module	Test Case ID	Description	Expected Result
Emergency Alert History	EH1_01	To check the functionality if the system will display the correct	The correct emergency alert history will be displayed

		emergency alert history	
	EH1_02	To check the functionality of the emergency alert history if no alert has been triggered	The "No alert has been triggered" message will be displayed
	EH1_03	To check the functionality of the drop-down button on the alerts	Information about the alert will be displayed
	EH1_04	To check the functionality of the back button	The back button should redirected to the home page

Table 6.7 shows the test case which consists of the module, test case ID, test case and expected result for the Change Password.

Table 6.7: Test Case for Change Password

Module	**Test Case ID**	**Description**	**Expected Result**
Change Password	CP1_01	To check the change password functionality using the correct old password, new password and confirm new password.	The "Successfully changed password" messages will be displayed and redirected to the main page
	CP1_02	To check the change password functionality using the incorrect old	The "Incorrect old password" message will be displayed

		password	
	CP1_03	To check the change password functionality using the incorrect format of new password	The "Invalid new password. Password must be 8 characters long, consists of a capital letter, number and symbol" error message will be displayed
	CP1_04	To check the change password functionality using the incorrect match of new password and confirmation password	The "New password and confirmation password do not match" error message will be displayed

6.4.2 Test Data for Dynamic Testing

Test data is the input supplied to a software program during testing. This input includes data that either affects the software's behavior or is affected by it throughout the testing process. Test data fulfills two main roles: first, in positive testing situations, it verifies that the functions produce expected results when given certain inputs; second, in negative testing scenarios, it evaluates the software's ability to handle rare, exceptional and unexpected inputs.

6.4.2.1 Test Data for User Authentication

System: Smart Blind Stick
Version: v1
Module: User Authentication
Revision: -
Processed by: Kishore
Date: 1/8/2024

Test Case ID	Test Scenario	Test Steps	Test Data	Expected Results
UA1_01	Log into the system using a valid username and password	1. Enter a valid username and password 2. Click the login button	Username: kishorekannan255@gmail.com Password: Test.123	The “Logging In” loading bar and “Login Successful” message will be displayed and redirected to the Home page
UA1_02	Log into the system using wrong username or password	1. Enter wrong username or password 2. Click the login button	Username: kishorekannan@gmail.com Password: Test.111	“Login failed. Do check your credentials” error message will be displayed and text input will turn red
UA1_03	Log into the system using an empty username or password field	1. Enter empty username or password	Username: or Password:	“Enter email” or “Enter password” error message will be displayed and text input will turn red
UA1_04	The eye toggle enables password visibility	1. Enter password 2. Enable the eye toggle button	Password: Test.123 Eye toggle: Enabled	“Test.123” password will be displayed
UA2_01	Register into the system using a valid username,	1. Enter a valid username, password, confirmation	Username: kishorekannan255@gmail.com	The “Signing Up” loading bar and “Sign Up Successful” message will be

	password, confirmation password, blind stick username, identity number, guardian name and phone number	password, blind stick user name, identity number, guardian name and phone number	Password: Test.123 Confirm Password: Test.123 Blind Stick User Name: Kishore Identity No: 000525141309 Guardian Name: Kannan Phone Number:0125531967	displayed and redirected to the Login page
UA2_02	Register into the system using the wrong format of username	1. Enter the wrong format of username	Username: kishorekannan	“Email should consist of ”@”,”.” and “com”” error message will be displayed and text input will turn red
UA2_03	Register into the system using the wrong format and length of password	1. Enter the wrong format and length of password	Password: kishore	“Password must be at least 8 characters long, contain at least one capital letter and one symbol” error message will be displayed and text input will turn red
UA2_04	Register into the system using an empty username or password or confirmation password	1. Enter empty username or password or confirmation password	Username: or Password: or Confirm Password:	“Enter email” or “Enter password” or “Enter confirmation password” error message will be displayed and text input will turn red
UA2_05	Register into the system using an invalid match of	1. Enter invalid match of password and confirmation	Password: Test.1234 Confirm password: Test.1111	“Password and confirm password do not match” error message will be displayed

	password and confirm password	password		and text input will turn red
UA2_06	Register into the system using a username that is already taken	1. Enter unavailable username, password and confirmation password 2. Click the next button	Username: test@gmail.com Password: Test.123 Confirm password: Test.123	"Username exist" error message will be displayed and the text input will turn red
UA2_07	The eye toggle enables password and confirmation password visibility	1. Enter password and confirmation password 2. Enable the eye toggle button	Password: Test.123 Confirm Password: Test.123 Eye toggle: Enabled	"Test.123" password and confirmation password will be displayed
UA2_08	Register into the system using the wrong format of phone number	1. Enter the wrong format of phone number	Phone number: 01255319	"Phone number should consist of 10-11 digits (Format:01X-XXXXXXX)" error message will be displayed and text input will turn red
UA2_09	Register into the system using the wrong format of identity number	1. Enter the wrong format of identity number	Identity Number: 0005251413	"Identity number should consist of 12 digits (without "-") " error message will be displayed and text input will turn red
UA3_01	Forget password using the correct email address	1. Enter the correct email address	Email: kishorekannan255@gmail.com	"An email has been sent to change password" message will be displayed
UA3_02	Forget password using the incorrect email address	1. Enter the incorrect email address	Email: kishorekannan@gmail.com	"Incorrect email" message will be displayed

6.4.2.2 Test Data for User Profile

System: Smart Blind Stick
Version: v1
Module: User Profile
Revision: -
Processed by: Kishore
Date: 3/8/2024

Test Case ID	Test Scenario	Test Steps	Test Data	Expected Results
UP1_01	Display correct user profile information	1. Click the user profile page button	-	The correct user profile information will be displayed
UP1_02	Edit button redirects to Edit User Profile page	1. Click the edit button	-	Edit button will redirect to the Edit User Profile page and display the "Edit User Profile" message
UP2_01	Edit User Profile information using the correct format of username, identity number, guardian name and phone number	1. Edit the fields of username, identity number, guardian name and phone number 2. Click the update button	Blind Stick User Name: Kishore IdentityNumber: 000525141309 Guardian Name: Kannan Phone Number: 012-5531967	"Updated Successfully" message will be displayed and redirect to the User Profile Page
UP2_02	Edit User Profile information using the empty username, identity	1. Empty the username, identity number, guardian name and phone number	Blind Stick User Name: Identity Number: Guardian Name:	"All fills must be field" error message will be displayed and the text input will turn red

	number, guardian name and phone number	fields 2. Click the update button	Phone Number:	
UP2_03	Edit User Profile information using the invalid format of identity number	1. Edit the fields of identity number using invalid format 2. Click the update button	Identity Number: 0005251413	"Invalid Identity Number" error message will be displayed and the text input will turn red
UP2_04	Edit User Profile information using the invalid format of phone number	1. Edit the fields of phone number using invalid format 2. Click the update button	Phone Number: 12553196	"Invalid Phone Number" error message will be displayed and the text input will turn red

6.4.2.3 Test Data for Blind Stick Reader

System: Smart Blind Stick
Version: v1
Module: Blind Stick Reader
Revision: -
Processed by: Kishore
Date: 5/8/2024

Test Case ID	Test Scenario	Test Steps	Test Data	Expected Results
BR1_01	Display correct blind stick reading	1. Click the Blind Stick Reader page button	-	The correct blind stick reading will be displayed
BR1_02	Text-to-speech feature of the blind stick reading	1. Turn on the speaker toggle	-	Vocal output of blind stick reading
BR1_03	Back button redirects to the Home page	1. Click the back button	-	"Home Page" message will be displayed and redirect to the Home page

6.4.2.4 Test Data for Blind Stick Location

System: Smart Blind Stick
Version: v1
Module: Blind Stick Location
Revision: -
Processed by: Kishore
Date: 7/8/2024

Test Case ID	Test Scenario	Test Steps	Test Data	Expected Results
BL1_01	Display the correct blind stick location	1. Click the Blind Stick Location page button	-	The correct blind stick location will be displayed
BL1_02	Error handling if an error is detected in fetching location data	1. Click the Blind Stick Location page button	-	"Error, please try again later" error message will be displayed
BL1_03	Refresh button loads the current location data	1. Click the refresh button	-	The location data will load and display the refreshed current location
BL1_04	Back button redirects to the Home page	1. Click the back button	-	"Home Page" message will be displayed and redirect to the Home page

6.4.2.5 Test Data for Emergency Alert History

System: Smart Blind Stick
Version: v1
Module: Emergency Alert History
Revision: -
Processed by: Kishore
Date: 9/8/2024

Test Case ID	Test Scenario	Test Steps	Test Data	Expected Results
EH1_01	Display the correct emergency alert history	1. Click the Emergency Alert History page button	-	The correct emergency alert history will be displayed
EH1_02	Display empty record of emergency alert history	1. Click the Emergency Alert History page button	-	"No alert has been triggered" message will be displayed
EH1_03	View detailed information of the alert	1. Click the drop-down button on alert	-	Information about the alert will be displayed
EH1_04	Back button redirects to the Home page	1. Click the back button	-	"Home Page" message will be displayed and redirect to the Home page

6.4.2.6 Test Data for Change Password

System: Smart Blind Stick
Version: v1
Module: Change Password
Revision: -
Processed by: Kishore
Date: 11/8/2024

Test Case ID	Test Scenario	Test Steps	Test Data	Expected Results
CP1_01	Change password using correct old password, new password and confirmation new password	1. Enter the correct old password, new password and confirmation new password	Old password: Test.123 New password: Test.888 Confirmation new password: Test.888	"Successfully changed password" message will be displayed
CP1_02	Change password using incorrect old password	1. Enter the incorrect old password	Old password: Test.122	"Incorrect old password" error message will be displayed
CP1_03	Change password using incorrect format of new password	1. Enter the incorrect format of new password	New password: Test3	"Invalid new password. Password must be 8 characters long, consists of a capital letter, number and symbol" error message will be displayed
CP1_04	Change password using incorrect match of new password and confirmation new password	1. Enter the incorrect match of new password and confirmation new password	New password: Test.888 Confirmation New Password: Test.880	"New password and confirmation new password do not match" error message will be displayed

6.5 User Acceptance Testing

User Acceptance Testing, commonly known as "acceptance testing," represents a crucial stage in software development. It is the last testing phase before a software product or system is launched to end-users or clients. The main objective of User Acceptance Testing is to confirm that the software is prepared for deployment and will function effectively and efficiently in a real-world setting. This test was carried out with 30 participants using questionnaires distributed via Google Forms.

6.5.1 Questionnaires for User Acceptance Testing

Table 6.8 shows the questionnaires given to the end users

Table 6.8: User Acceptance Questionnaires

Number	Questions	Section
1	Age	Respondent Information
2	Gender	Respondent Information
3	Have you heard about Smart Blind Stick or any other electronic aid blind stick?	Respondent Information
4	The Smart Blind Stick and its mobile application are flexible to interact with.	Perceived Ease of Use
5	I find it easy to get the Smart Blind Stick and its mobile application to do what I want to do.	Perceived Ease of Use
6	I find the Smart Blind Stick and its mobile application easy to use.	Perceived Ease of Use
7	Interaction with the Smart Blind Stick and its mobile application is clear and understandable	Perceived Ease of Use
8	Using the Smart Blind Stick enables me to navigate more safely.	Perceived Usefulness
9	I find the Smart Blind Stick useful in my daily life.	Perceived Usefulness
10	Using the Smart Blind Stick enhances my effectiveness in moving around independently.	Perceived Usefulness

11	Using the Smart Blind Stick makes it easier to avoid obstacles.	Perceived Usefulness
12	Using the Smart Blind Stick makes it easier to keep my guardians informed of my location.	Perceived Usefulness
13	The Smart Blind Stick provides clear instructions for use.	Capability
14	Alerts and notifications can be easily received on the Smart Blind Stick's mobile application.	Capability
15	The applications and capabilities of the Smart Blind Stick meet my mobility and safety needs	Capability
16	I trust the Smart Blind Stick for the information on my profile.	Trustworthiness
17	The Smart Blind Stick provides security for my personal data.	Trustworthiness
18	The Smart Blind Stick provides security for my location data.	Trustworthiness
19	I feel safe using the Smart Blind Stick.	Trustworthiness
20	I like to use the Smart Blind Stick.	Attitude
21	It is a pleasure for me to use the Smart Blind Stick.	Attitude
22	It is desirable for me to learn how to use the Smart Blind Stick.	Attitude
23	I intend to use the Smart Blind Stick for daily navigation.	Intention to Use
24	I intend to use the Smart Blind Stick to improve my independence.	Intention to Use
25	I will continue to use the Smart Blind Stick for my mobility needs.	Intention to Use

6.6 Test Result and Analysis

The software testing process should encompass both the evaluation of test outcomes and a thorough analysis of the data collected. This involves examining the test results and interpreting the information to gain insights into the functionality and quality of the software being tested. Ultimately, the analysis of test results plays a crucial role in the software development lifecycle, as it provides valuable information about the software's performance, reliability, and adherence to specifications. These activities contribute to delivering a more dependable product to end users and continuously improving software quality over time.

6.6.1 Test Result for Dynamic Testing

Table 6.9 shows the test result and analysis for User Authentication.

Table 6.9: Test Result and Analysis for User Authentication

Test Case ID	Actual Result	Status
UA1_01	A message of “Login Successful” is displayed and redirects to the home page	Pass
UA1_02	An error message of “Login Failed. Do check your credentials” is displayed and the text input will turn red	Pass
UA1_03	An error message of “Enter email” or “Enter password” is displayed and the text input will turn red	Pass
UA1_04	The password is displayed as the eye toggle is enabled	Pass
UA2_01	A message of “Sign Up Successful” is displayed and redirects to the login page	Pass
UA2_02	An error message of “Email should consist of “@”,”.” and “com”” is displayed and the text input will turn red	Pass
UA2_03	An error message of “Password must be	Pass

	at least 8 characters long and contain at least one capital letter, one symbol and one number" is displayed and the text input will turn red	
UA2_04	An error message of "All fills must be filled" is displayed and the text input will turn red	Pass
UA2_05	An error message of "Password and confirm password do not match" is displayed and the text input will turn red	Pass
UA2_06	An error message of "Username exist" is displayed	Pass
UA2_07	The password and confirm password are displayed if the eye toggle is enabled	Pass
UA2_08	An error message of "Phone number should consist of 10-11 digits (Format:01X-XXXXXXX)" is displayed and the text input will turn red	Pass
UA2_09	An error message of "Identity number should consist of 12 digits (without "-")" is displayed and the text input will turn red	Pass
UA3_01	A message "An email has been sent to change password" displayed	Pass
UA3_02	An error message of "Incorrect email" displayed	Pass

Table 6.10 shows the test result and analysis for User Profile.

Table 6.10: Test Result and Analysis for User Profile

Test Case ID	Actual Result	Status
UP1_01	The correct user profile details displayed	Pass
UP1_02	The edit button redirects to the Edit User Profile page and displays the "Edit User Profile" message	Pass
UP2_01	A message of "Updated Successfully" is displayed and redirects to the User Profile page	Pass
UP2_02	An error message of "All fills must be filled" is displayed and the text input will turn red	Pass
UP2_03	An error message of "Invalid IC Number" is displayed and the text input will turn red	Pass
UP2_04	An error message of "Invalid Phone Number" is displayed and the text input will turn red	Pass

Table 6.11 shows the test result and analysis for Blind Stick Reader.

Table 6.11: Test Result and Analysis for Blind Stick Reader

Test Case ID	Actual Result	Status
BR1_01	The correct blind stick reading is displayed	Pass
BR1_02	The text-to-speech feature is enabled as the speaker toggle is turned on	Pass
BR1_03	The back button redirects to the home page	Pass

Table 6.12 shows the test result and analysis for Blind Stick Location.

Table 6.12: Test Result and Analysis for Blind Stick Location

Test Case ID	Actual Result	Status
BL1_01	The correct blind stick location is displayed	Pass
BL1_02	An error message “Error, please try again later” is displayed	Pass
BL1_03	The location data loads and displays the refreshed current location	Pass
BL1_04	The back button is redirected to the home page	Pass

Table 6.13 shows the test result and analysis for Emergency Alert History.

Table 6.13: Test Result and Analysis for Emergency Alert History

Test Case ID	Actual Result	Status
EH1_01	The correct emergency alert history is displayed	Pass
EH1_02	A message “No alert has been triggered” is displayed	Pass
EH1_03	Information about the alert is displayed	Pass
EH1_04	The back button redirects to the home page	Pass

Table 6.14 shows the test result and analysis for Change Password.

Table 6.14: Test Result and Analysis for Change Password

Test Case ID	Actual Result	Status
CP1_01	A message of "Successfully changed password" is displayed and redirected to the main page	Pass
CP1_02	A message of "Incorrect old password" is displayed	Pass
CP1_03	An error message "Invalid new password. Password must be 8 characters long, consists of a capital letter, number and symbol" is displayed	Pass
CP1_04	An error message of "New password and confirmation password do not match" is displayed	Pass

6.6.2 User Acceptance Testing Analysis and Results

Table 6.15: Questionnaire Result - respondent

Title	Option	Total (person)	Total (%)
Age	0-18	0	0
	19-25	0	0
	26-40	12	60.0
	40 and above	18	40.0
Gender	Male	16	53.3
	Female	14	46.7
	Prefer not to say	0	0

Have you heard about Smart Blind Stick or any other electronic aid blind stick?	Yes	16	53.3
	No	14	46.7

Based on Table 6.15, there is a total of 12 respondents aged between 26-40 years old and 18 respondents aged between 40 and above. There are 16 male and 14 female respondents which concludes to 30 respondents who willingly help conduct this User Acceptance Test. From Table 6.15, we also can see that 53.3% which is 16 respondents had heard about Smart Blind Stick or any other electronic aid blind stick while there are only 46.7% which is 14 respondents had not heard about Smart Blind Stick or any other electronic aid blind stick before.

Table 6.16: Questionnaire Result - responses

Question	**Frequency**					**Satisfaction (Average)**
	1	**2**	**3**	**4**	**5**	
The Smart Blind Stick and its mobile application are flexible to interact with.	0	0	7	14	9	4.07
I find it easy to get the Smart Blind Stick and its mobile application to do what I want to do.	0	0	7	15	8	4.03
I find the Smart Blind Stick and its mobile application easy to use.	0	0	4	14	12	4.27
Interaction with the Smart Blind Stick and its mobile application is clear and understandable	0	0	9	10	11	4.07
Using the Smart Blind Stick enables me to	0	0	4	14	12	4.27

navigate more safely.						
I find the Smart Blind Stick useful in my daily life.	0	0	2	14	14	4.40
Using the Smart Blind Stick enhances my effectiveness in moving around independently.	0	0	3	11	16	4.43
Using the Smart Blind Stick makes it easier to avoid obstacles.	0	0	2	10	18	4.53
Using the Smart Blind Stick makes it easier to keep my guardians informed of my location.	0	0	5	12	13	4.27
The Smart Blind Stick provides clear instructions for use.	0	1	8	14	7	3.90
Alerts and notifications can be easily received on the Smart Blind Stick's mobile application.	0	0	5	14	11	4.20
The applications and capabilities of the Smart Blind Stick meet my mobility and safety needs	0	0	3	15	12	4.5
I trust the Smart Blind Stick for the information on my profile.	0	2	9	12	7	3.80
The Smart Blind Stick provides security for my personal data.	0	3	8	12	7	3.77
The Smart Blind Stick provides security for my	0	4	8	11	7	3.70

location data.						
I feel safe using the Smart Blind Stick.	0	2	7	14	7	3.87
I like to use the Smart Blind Stick.	0	0	3	14	13	4.33
It is a pleasure for me to use the Smart Blind Stick.	0	0	3	13	14	4.37
It is desirable for me to learn how to use the Smart Blind Stick.	0	0	3	9	18	4.50
I intend to use the Smart Blind Stick for daily navigation.	0	0	4	13	13	4.30
I intend to use the Smart Blind Stick to improve my independence.	0	0	4	14	12	4.27
I will continue to use the Smart Blind Stick for my mobility needs.	0	0	4	14	12	4.27

Based on Table 6.16, a frequency of 1 indicates that the respondent disagrees with the statement, while a frequency of 5 indicates total agreement. The overall average for all respondents is 4.19, which falls into the 'agree' category. This result suggests that users are generally satisfied with the system.

Table 6.17: End User Average Satisfaction

Section	Average
Perceived ease of use	4.11
Perceived usefulness	4.38
Capability	4.20
Attitude	4.40
Trustworthiness	3.79
Intention of use	4.28

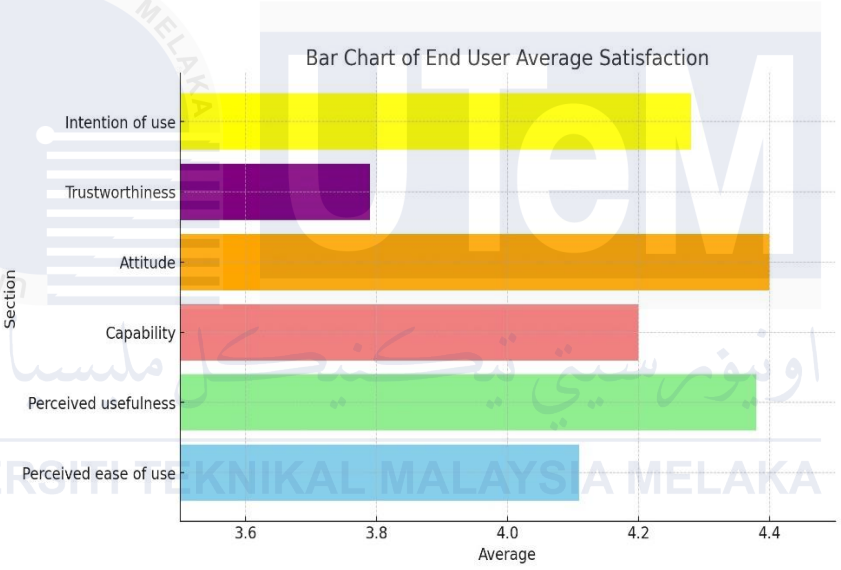

Figure 6.1 End User Average Satisfaction

Based on Figure 6.1, the attitude section received the highest satisfactionamong the others category at 4.40 average. While trustworthiness has the lowest satisfaction among others at 3.79 average. However, the trustworthiness average of satisfaction still can be considered as high average as 3.79 is more than half. To conclude, the end user is satisfied with the system.

6.7 Conclusion

In conclusion, this testing phase plays a crucial role in confirming that the software adheres to quality standards and delivers a dependable user experience.

This phase is conducted after the software code has been developed and before it is released to users. The main objective of this testing stage is to identify and resolve any issues or discrepancies within the software, thereby improving its overall quality and reliability.

CHAPTER 7: CONCLUSION

7.1 Observation on Weakness and Strength

Observing the strengths and weaknesses of this Smart Blind Stick project is essential to understanding its impact and future potential. The strengths of thisproject include its ability to enhance the mobility and safety of blind and visually impaired individuals by providing real-time obstacle detection and alert features. It also helps to improve the independence and confidence of users. However, theproject also consists of weaknesses that need to be addressed for further improvement. Identifying these areas for enhancement will ensure the continued relevance and effectiveness of the Smart Blind Stick in assisting visually impaired individuals.

7.1.1 Strength of the Smart Blind Stick

The Smart Blind Stick offers advantages to blind and visually impaired users. The integration of ultrasonic sensors for obstacle detection ensures that users receive real-time alerts when obstacles are within a critical range, hence improving their ability to navigate independently. The use of GPS for real-time location tracking and GSM modules for emergency alerts further enhances the safety features, providing guardians with the ability to monitor and respond to emergencies. The inclusion of a mobile application with user-friendly interfacesand voice command capabilities ensures that the system is accessible and easy to use for blind and visually impaired individuals.

7.1.2 Weaknesses of the Smart Blind Stick

While the Smart Blind Stick has several strengths, it also has weaknesses. One of the main issues is its reliance on continuous internet connectivity for real-time data synchronization which may limit its effectiveness in areas with poor network coverage. Additionally, the complexity of setting up and maintaining the hardware components may cause difficulties for non-technical users. Another identified weakness is the lack of advanced customization options for the alerts such as choosing alert types and the frequency of notifications which could develop a flexible alert system based on user preferences.

7.2 Proposition for Improvement

Based on the weaknesses stated, several proposals can be made for its improvement. Firstly, enhancing the system's offline capabilities would make it more reliable in areas with limited internet access. Additionally, creating a straightforward setup process and providing comprehensive user guides would make the device more easily understandable for the users. Moreover, offering customization options in the mobile application could allow users to change the alerts and notifications based on their needs to improve the overall user experience. Lastly, integrating more advanced features like AI-based obstacle recognition enable more precise detection of objects, allowing users to navigate complex environments with greater safety and confidence.

7.3 Project Contribution

The Smart Blind Stick project makes significant contributions to the field of assistive technology. It provides a comprehensive solution that enhances the safety and mobility of blind and visually impaired individuals by enabling them to navigate their environment with greater confidence and independence. The integration of real-time obstacle detection, location tracking, and emergency alert systems represents a substantial advancement over traditional mobility aids. The

project also sets a foundation for future research and development in assistive technology, encouraging the exploration of more sophisticated and intelligent systems to support blind and visually impaired individuals.

7.4 Conclusion

In conclusion, the Smart Blind Stick project addresses critical challengesfaced by blind and visually impaired individuals by providing a technologically advanced solution that enhances their mobility and safety. While there are areasfor improvement such as enhancing offline capabilities and offering more customization options, the project has already demonstrated its potential to positively impact the lives of these individuals. Continued development and refinement of the Smart Blind Stick will ensure that it remains a valuable tool in the assistive technology landscape, contributing to greater independence and quality of life for its users.

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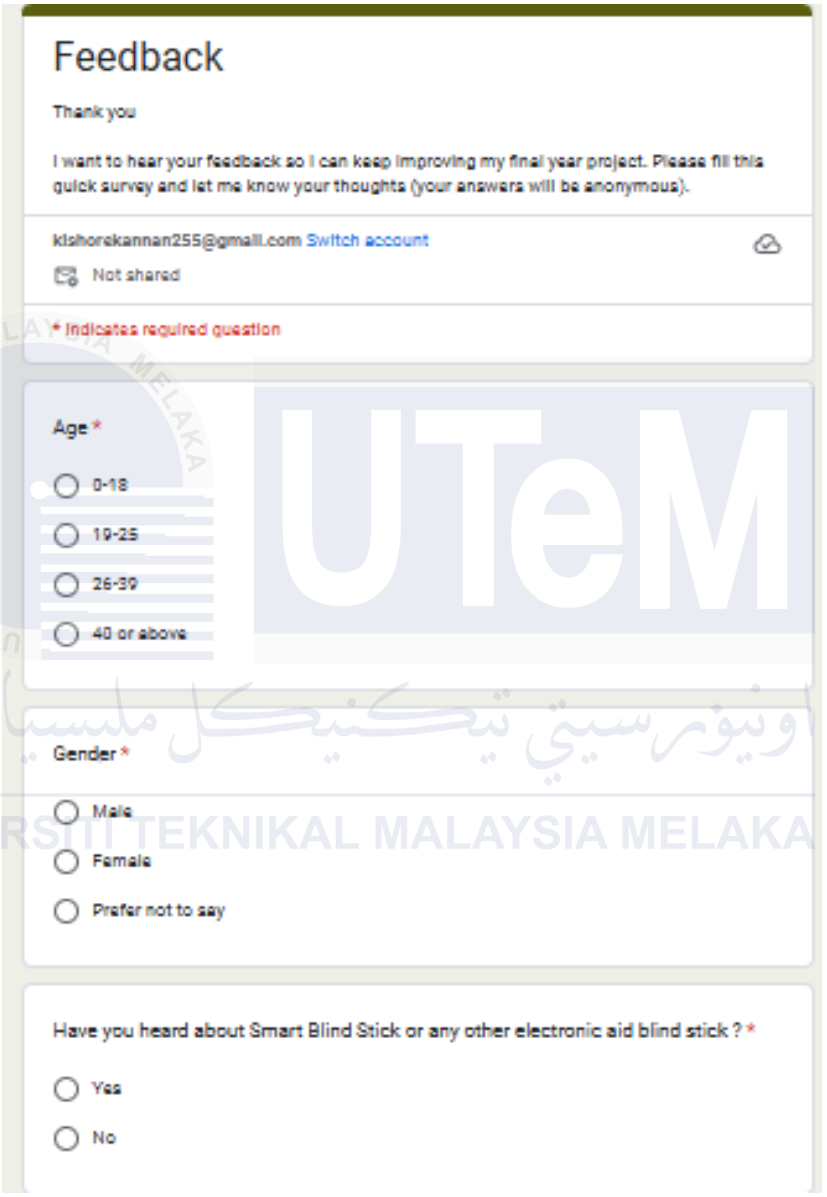
Third Eye for The Blind Person https://www.hackster.io/embeddedlab786/third-eye-for-the-blind-person-a5a449

APPENDIX

Appendix A



Feedback

Thank you

I want to hear your feedback so I can keep improving my final year project. Please fill this quick survey and let me know your thoughts (your answers will be anonymous).

kishorekannan255@gmail.com Switch account

Not shared

* Indicates required question

Age *

- 0-18
- 19-25
- 26-39
- 40 or above

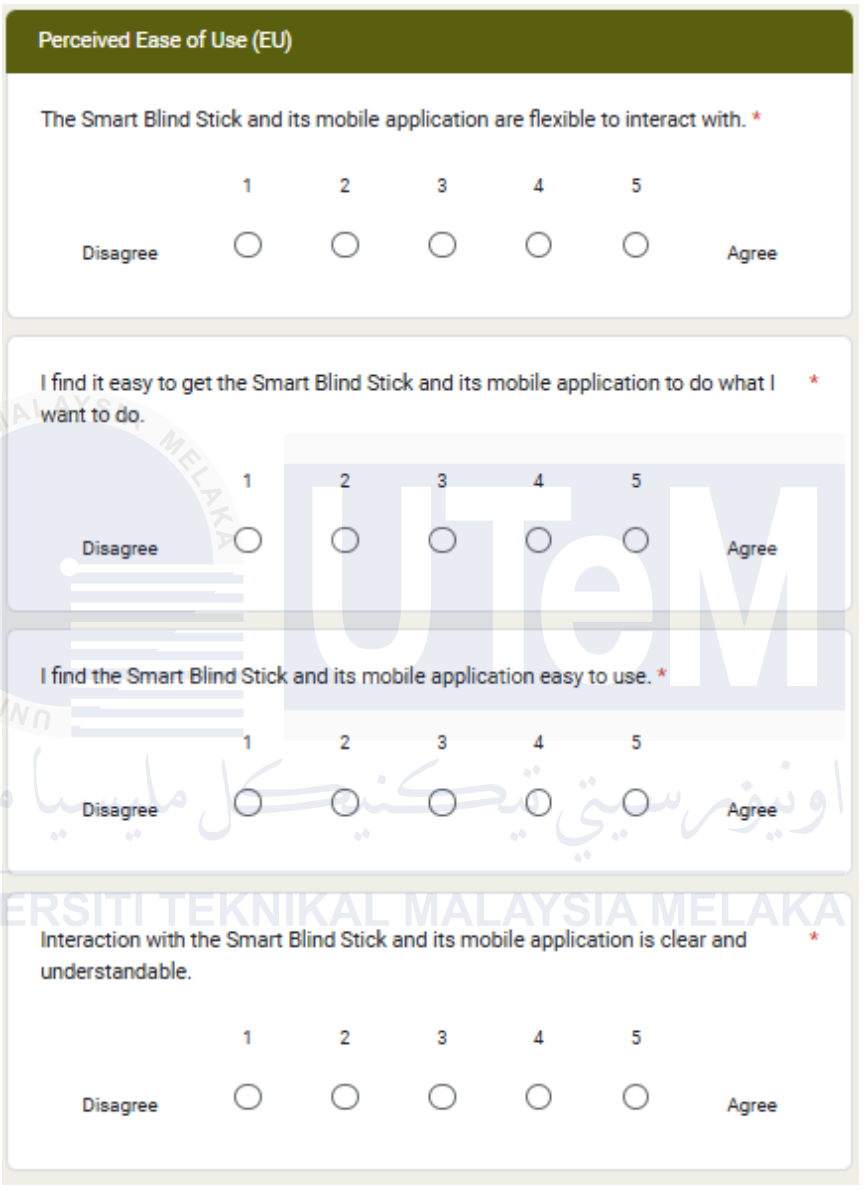
Gender *

- Male
- Female
- Prefer not to say

Have you heard about Smart Blind Stick or any other electronic aid blind stick ? *

- Yes
- No

Appendix B



Perceived Ease of Use (EU)

The Smart Blind Stick and its mobile application are flexible to interact with. *

	1	2	3	4	5	
Disagree	○	○	○	○	○	Agree

I find it easy to get the Smart Blind Stick and its mobile application to do what I want to do. *

	1	2	3	4	5	
Disagree	○	○	○	○	○	Agree

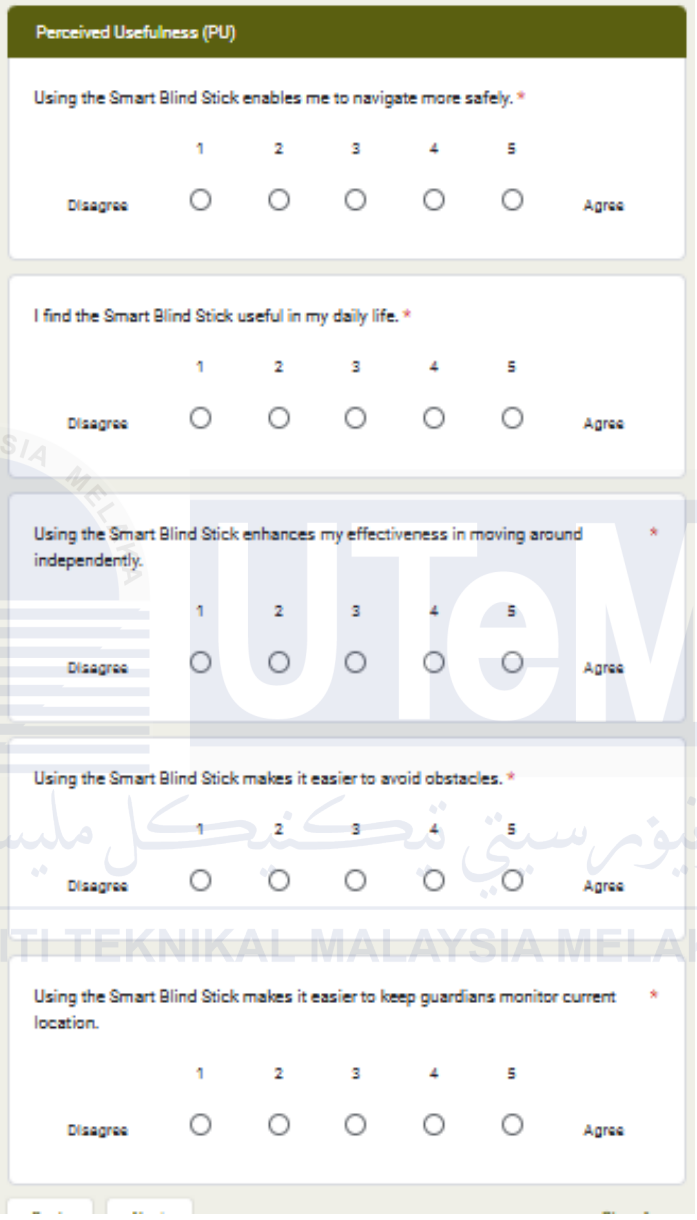
I find the Smart Blind Stick and its mobile application easy to use. *

	1	2	3	4	5	
Disagree	○	○	○	○	○	Agree

Interaction with the Smart Blind Stick and its mobile application is clear and understandable. *

	1	2	3	4	5	
Disagree	○	○	○	○	○	Agree

Appendix C



Perceived Usefulness (PU)

Using the Smart Blind Stick enables me to navigate more safely. *

	1	2	3	4	5	
Disagree	○	○	○	○	○	Agree

I find the Smart Blind Stick useful in my daily life. *

	1	2	3	4	5	
Disagree	○	○	○	○	○	Agree

Using the Smart Blind Stick enhances my effectiveness in moving around independently. *

	1	2	3	4	5	
Disagree	○	○	○	○	○	Agree

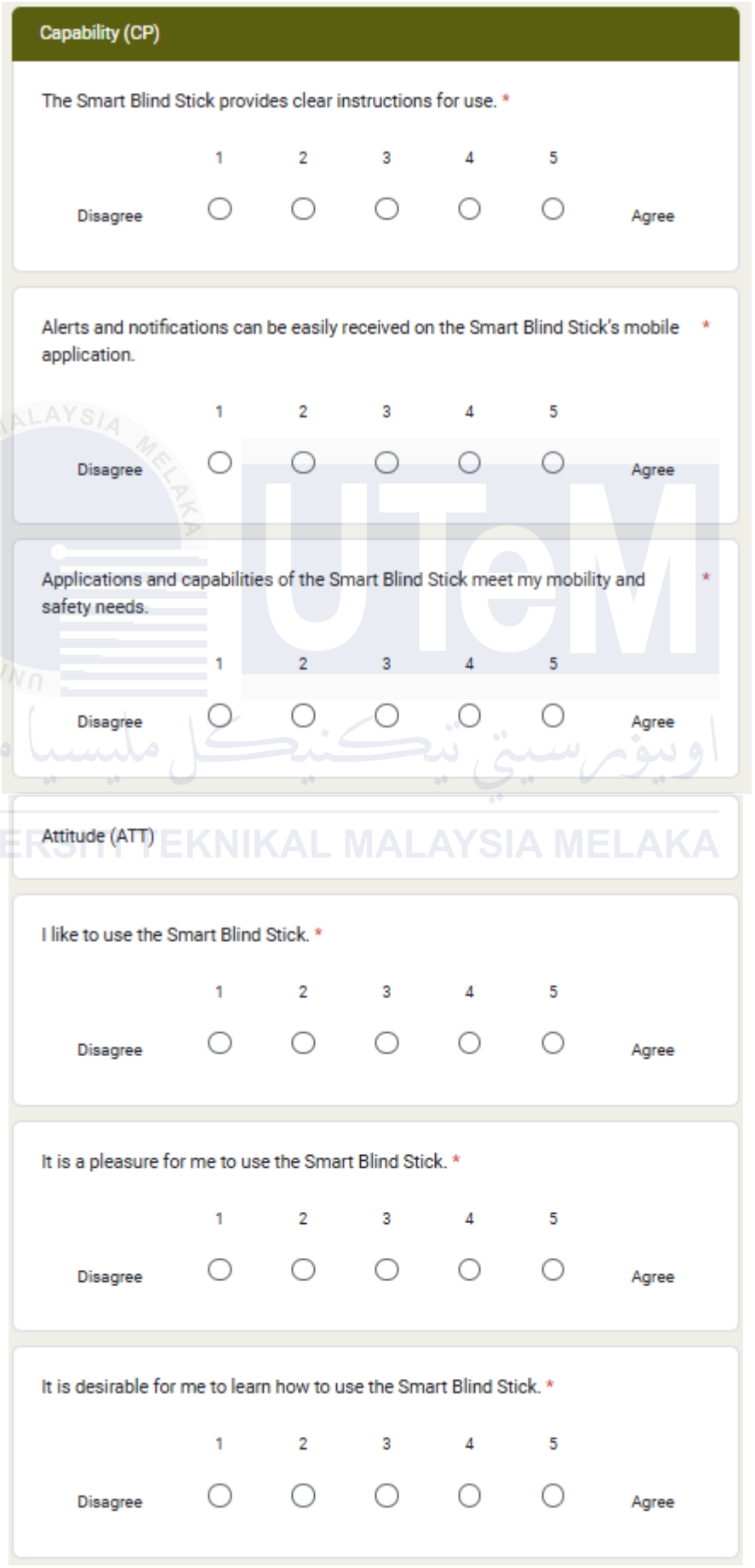
Using the Smart Blind Stick makes it easier to avoid obstacles. *

	1	2	3	4	5	
Disagree	○	○	○	○	○	Agree

Using the Smart Blind Stick makes it easier to keep guardians monitor current location. *

	1	2	3	4	5	
Disagree	○	○	○	○	○	Agree

Appendix D



Capability (CP)

The Smart Blind Stick provides clear instructions for use. *

	1	2	3	4	5	
Disagree	○	○	○	○	○	Agree

Alerts and notifications can be easily received on the Smart Blind Stick's mobile application. *

	1	2	3	4	5	
Disagree	○	○	○	○	○	Agree

Applications and capabilities of the Smart Blind Stick meet my mobility and safety needs. *

	1	2	3	4	5	
Disagree	○	○	○	○	○	Agree

Attitude (ATT)

I like to use the Smart Blind Stick. *

	1	2	3	4	5	
Disagree	○	○	○	○	○	Agree

It is a pleasure for me to use the Smart Blind Stick. *

	1	2	3	4	5	
Disagree	○	○	○	○	○	Agree

It is desirable for me to learn how to use the Smart Blind Stick. *

	1	2	3	4	5	
Disagree	○	○	○	○	○	Agree

Appendix E

Trustworthiness (TW)

I trust the Smart Blind Stick for the information on my profile. *

	1	2	3	4	5	
Disagree	○	○	○	○	○	Agree

The Smart Blind Stick provides security for my personal data. *

	1	2	3	4	5	
Disagree	○	○	○	○	○	Agree

The Smart Blind Stick provides security for my location data. *

	1	2	3	4	5	
Disagree	○	○	○	○	○	Agree

I feel safe using the Smart Blind Stick. *

	1	2	3	4	5	
Disagree	○	○	○	○	○	Agree

Intention to Use (IU)

I intend to use the Smart Blind Stick for daily navigation. *

	1	2	3	4	5	
Disagree	○	○	○	○	○	Agree

I intend to use the Smart Blind Stick to improve my independence. *

	1	2	3	4	5	
Disagree	○	○	○	○	○	Agree

I will continue to use the Smart Blind Stick for my mobility needs. *

	1	2	3	4	5	
Disagree	○	○	○	○	○	Agree