VISVESVARAYA TECHNOLOGICAL UNIVERSITY

“Jnana Sangama”, Belagavi – 590018, Karnataka.

A Project Report

on

“Smart Assistive Stick”

Submitted in partial fulfillment for the award of degree of

BACHELOR OF ENGINEERING

in

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CERTIFICATE

Certified that the Project Report entitled "**Smart Assistive Stick**" carried out by **Mr. Ismail Zabiulla** (**4GM21IS019**), **Ms. Madiha Anjum** (**4GM21IS028**), **Ms. Shankramma M L** (**4GM21IS041**) **and Mr. Yerramsetty Nirmal Sai Teja** (**4GM21IS063**), bonafide students of VII Semester in partial fulfillment for the award of Bachelor of Engineering in Information Science And Engineering, GM Institute of Technology, Visvesvaraya Technological University, Belagavi for the academic year 2024-25. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the report. The project report has been approved as it satisfies the academic requirements in respect of project work prescribed for the said degree.

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ABSTRACT

This project presents the design and development of a Smart Assistive Stick integrated with ultrasonic sensors, a GSM module, a GPS module, an LCD display, a speaker, a servo motor, and a reliable power supply. The system is designed to enhance mobility and safety for visually impaired individuals. The ultrasonic sensors detect obstacles and measure depth, providing immediate feedback through a speaker to ensure safe navigation. The GPS module continuously tracks the user's location, transmitting it via the GSM module to caregivers or guardians for real-time monitoring and enhanced security. The SOS alert button enables the user to send emergency notifications promptly, while the LCD display provides essential information. A servo motor is utilized to extend the functionality of the stick, such as signaling or interacting with the environment. The device is lightweight, energy-efficient, and user-friendly, designed for extended use. By combining essential features, this smart stick empowers visually impaired individuals with greater independence and ensures their safety while maintaining connectivity with loved ones.

ACKNOWLEDGEMENT

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Ismail Zabiulla
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Yerramsetty Nirmal Sai Teja

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ACRONYMS

Sl.No	ACRONYMS	ABBREVATIONS
1	IOT	Internet of Things
2	GPS	Global Positioning System
3	SMS	Short Message Service
4	GSM	Global System For Mobile Communication

CHAPTER 1

INTRODUCTION

Blindness is a state of lack of visual perception due to physiological or neurological factors. Imagine that you are walking in an unfamiliar place. One has to ask for guidance to get to the destination. But what if the person is visually impaired. A person must completely depend on other people to get to the destination. In general, we note that the white cane is the best friend of visually impaired people. But oftentimes that stick isn't helpful. The Blind Stick is developed using many hardware and software applications. An individual with a disability is a member of society and has the same rights and responsibilities as people. But blind people face a large number of problems that are difficult to solve. Blind people are members of society, and their diversity in the world and social situations has been restricted. Blind people's disadvantages should not be seen as an excuse to shorten their lives; rather, they should be used as motivation to persevere. As a result, anyone with visual impairments requires assistance in the form of replacements for their eye function, specifically the visual function. In addition to the normal touch sticks, the blind often needs a switch for their sense of sight so that the ultrasonic and sound sensors can be used.

1.1 PROBLEM STATEMENT

Visually impaired individuals face numerous challenges in achieving safe and independent mobility. Conventional walking aids, such as traditional white canes, are limited in their ability to detect obstacles, measure changes in terrain, or provide environmental awareness. These limitations often lead to accidents, restricted mobility, and a dependency on others for navigation.

Existing mobility aids for the visually impaired are either cost-prohibitive or lack essential features such as real-time obstacle detection, height detection, and location tracking. The absence of an integrated, user-friendly interface further limits their effectiveness in addressing the needs of this community.

This project aims to bridge the gap by designing and developing a smart, affordable, and efficient blind stick. Equipped with advanced sensors, voice guidance, and GPS functionality, this solution enhances mobility, safety, and independence for visually impaired individuals in both indoor and outdoor environments.

"In the domain of assistive technology, visually impaired individuals often encounter difficulties in navigating their surroundings due to the limitations of traditional walking aids. Existing solutions lack affordability, real-time obstacle detection, terrain awareness, and user- friendly interfaces, hindering their ability to ensure safe and independent mobility. This creates a significant gap in providing an efficient, accessible, and technologically advanced mobility solution tailored to their needs."

1.2 THE SOLUTION

Our solution addresses as

The proposed solution to address the challenges faced by visually impaired individuals is the development of a Smart Assistive Stick. This innovative device integrates multiple advanced technologies to enhance mobility, safety, and independence. By combining ultrasonic sensors, a GPS module, a GSM module, an LCD display, a speaker, a servo motor, and a reliable power supply, the smart stick offers a comprehensive and user-friendly solution tailored to the needs of visually impaired users.

The ultrasonic sensors enable real-time obstacle detection and depth measurement, allowing users to navigate their surroundings safely. Immediate feedback is provided through a speaker, ensuring timely alerts about potential hazards. The GPS module continuously tracks the user's location, transmitting it via the GSM module to caregivers or guardians, thus enabling real-time monitoring and enhanced security. This feature not only provides peace of mind to loved ones but also ensures prompt assistance in case of emergencies.

To further enhance safety, the device includes an SOS alert button that allows users to send emergency notifications quickly. The LCD display provides essential information, such as battery status and connectivity updates, in a simple and accessible format. Additionally, the integration of a servo motor extends the functionality of the stick, enabling features such as signaling or interacting with environmental elements. The stick is designed to be lightweight, energy-efficient, and durable, ensuring extended usability without compromising on comfort or reliability.

By incorporating these essential features, the Smart Assistive Stick bridges the gap left by traditional walking aids. It provides an affordable, technologically advanced, and easy-to-use solution that empowers visually impaired individuals to navigate both indoor and outdoor environments independently. This device not only enhances their safety and mobility but also fosters a sense of confidence and autonomy, significantly improving their quality of life.

1.3 OBJECTIVES OF PROJECT

- **Detect Obstacles in All Directions:** Enhance obstacle detection using ultrasonic sensors combined with servo motor movement for 360-degree scanning.
- **Provide Voice Alerts for Guidance:** Deliver real-time voice alerts to inform users about obstacles location and distance, ensuring safe navigation.
- **Send Location-Based SMS Alerts:** Use GPS and GSM modules to track user location and send automated emergency SMS alerts to guardians.
- **Improve Navigation Independence:** Empower visually impaired individuals to navigate independently with obstacle detection, voice guidance, and location-based support.
- **Integrate Assistive Technology:** Combine real-time safety and monitoring features, such as geofencing and hazard detection, into a single, user-friendly Smart Assistive Stick.

1.4 ADVANTAGES

- **Enhanced Mobility:** The integration of ultrasonic sensors allows for real-time detection of obstacles, enabling users to navigate their surroundings safely and with confidence.
- **Independence:** By providing audio feedback and navigation assistance, the device reduces reliance on caregivers, empowering visually impaired individuals to move independently.

- **Safety Features:** The GPS module ensures real-time location tracking, while SMS alerts to guardians provide added security in case of emergencies or unexpected situations.
- **Comprehensive Obstacle Detection:** The inclusion of a servo motor with ultrasonic sensors enables 360-degree scanning for obstacles, ensuring comprehensive hazard detection.
- **User-Friendly Design:** Audio-based guidance and a lightweight design make the stick easy to use and carry, ensuring comfort for extended periods.
- **Emergency Assistance:** The device incorporates SOS features that allow users to alert their guardians or caregivers instantly in case of emergencies, improving response times.

1.5 LITERATURE REVIEW

- **BlinDar: An Invisible Eye for the Blind People Using Internet of Things (IoT)**

  Authors: Zeeshan Saquib, Vishakha Murari, Suhas N Bhargav

  Year: 2017

  This research introduces BlinDar, an Electronic Traveling Aid (ETA) designed to assist visually impaired individuals using the Internet of Things (IoT). The device enhances mobility and independence by offering real-time assistance in both indoor and outdoor environments. It utilizes ultrasonic sensors to detect obstacles and potholes within a 2- meter range, ensuring user safety. Additionally, a GPS and ESP8266 Wi-Fi module allow location sharing with the cloud, while an MQ2 gas sensor detects fire hazards. The inclusion of an RF Tx/Rx module aids in locating the stick when misplaced. The system's ESP32 Mega2560 microcontroller simplifies the integration of various components, making BlinDar an efficient, lightweight, and cost-effective solution for the blind.

- **Navigational Aiding System for Visually Impaired**

  Authors: M. Micheal Priyanka, M. Michael Dharsana

  Year: 2017

  This paper presents an innovative electronic aid designed to replicate visual guidance for visually impaired individuals. The system integrates sensors with high accuracy and employs intelligent algorithms to enhance usability. Built into a walking stick, this device offers a user-friendly solution for navigation, allowing individuals to travel independently to their destinations. Its design ensures seamless integration of essential features, providing reliable assistance in diverse environments.

- **Electronic Travel Aid System for Visually Impaired People**

  Authors: P. S. Ranaweera, S. H. R. Madhuranga, H. F. A. S. Fonseka, D. M. L. D. Karunathilaka

  Year: 2017

  This study focuses on Electronic Travel Aids (ETAs) that improve mobility for visually impaired individuals in unfamiliar public locations. The proposed system leverages sensor technology, including IR sensors for obstacle detection and image processing for enhanced navigation. The device aims to overcome the limitations of traditional walking sticks by identifying obstacles beyond ground-level reach. It incorporates a web-based navigation system and emergency alerting features, enabling users to navigate independently in both indoor and outdoor environments.

- **HOT GLASS: Human Face, Object, and Textual Recognition for Visually Challenged**

  Authors: Diwakar Srinath A, Praveen Ram A.R, Siva R, Kalaiselvi V.K.G, Ajitha

  Year: 2017

  HOT GLASS is an innovative assistive technology designed to aid visually challenged individuals by providing audio descriptions of their surroundings. The system integrates features such as human face, object, and textual recognition, enabling users to interact with their environment effectively. Using a smart kit comprising an eyeglass-mounted camera, earphones, and a microphone, the system captures images, processes them, and generates corresponding audio outputs. A dynamic database allows for the addition of new entries, ensuring the system remains adaptable to diverse scenarios.

- **An Electronic Walking Stick for Blinds**

  Authors: Shashank Chaurasia, K. V. N. Kavitha

  Year: 2014

This research highlights the evolution of walking aids for the visually impaired, transitioning from traditional white canes to electronic solutions. The proposed electronic walking stick incorporates remote sensors to detect obstacles, providing enhanced navigation capabilities. The device aims to address the challenges of navigating streets and stairs, leveraging the sharp haptic sensitivity of blind users. By offering a more convenient means of mobility, the stick contributes to the independence and safety of visually impaired individuals.

1.6 ORGANIZATION OF REPORT

Chapter 1 Preamble:

The preamble in a chapter provides a concise introduction, outlining the chapter's main themes and objectives. It may include background information and context to help readers understand the subject matter. Additionally, the preamble serves as a roadmap, guiding readers through the upcoming content.

This section includes:

1. Problem statement
2. The solution
3. Objectives of the project
4. Advantages of the project

Chapter 2 Software Requirement specification:

A Software Requirements Specification (SRS) is a concise document.
It outlines the functional and non-functional requirements of a software system, providing a blueprint for development and ensuring alignment on project goals and constraints.

This section includes:

1. Functional overview
2. User characteristics
3. Input Requirements
4. Output requirements

5. Functional requirements
6. Software Requirements
7. Hardware requirements
8. Project cycle

Chapter 3 System design:

System design involves the process of creating a detailed blueprint for a software system, including its architecture, components, interfaces, and interactions. It encompasses defining system requirements, designing data structures, algorithms, and interfaces, and making decisions about technologies, platforms, and frameworks to be used.

This section includes:

1. Project Architecture
2. Database design
3. Sequence diagram
4. Dataflow diaram
5. Database table structure
6. Flow chart
7. Utilities

Chapter 4 Implementation:

Implementation refers to the process of translating a design or plan into a working software system. It involves writing code, integrating components, and testing the system to ensure that it functions according to the specified requirements.

Implementation typically follows the system design phase and involves programming, debugging, and optimizing the software to meet performance, reliability, and usability goals. Successful implementation results in a fully functional software product ready for deployment and use by end-users.

This section includes:

1. Software Tools used
2. Implementation details

3. Front end forms deign

Chapter 5 Testing:

Testing is the process of evaluating a software system to identify defects, errors, or discrepancies between expected and actual outcomes. It involves executing test cases, scripts, or scenarios to verify that the software functions correctly and meets specified requirements. Testing encompasses various techniques such as unit testing, integration testing, system testing, and acceptance testing, aiming to ensure the quality, reliability, and robustness of the software.

This section includes:

1. Scope
2. Unit Testing
3. Integration Testing
4. Functional testing
5. System Testing

Chapter 6 Results:

The results section summarizes and presents the findings of the study.

This section includes:

1. Snap shot of projects

Chapter 7 Conclusion:

The conclusion section summarizes the main findings and outcomes of the project, offering insights into its achievements, challenges, and potential future directions. It provides closure to the report and highlights the project's contributions to the field of software development.

This section includes:

1. Conclusion
2. Future Scope

Appendix:

The appendix section of a document typically contains supplementary materials that support or enhance the main content. These materials may include additional data, charts, graphs, tables, code samples, or other relevant information that provides further context or detail. The appendix serves as a reference for readers who may want to delve deeper into specific aspects of the document or need additional information to better understand the content.

References:

The references section of a document lists all the sources cited or consulted during the research or writing process. It provides readers with the necessary information to locate and verify the credibility of the sources used in the document. References are typically listed alphabetically by the author's last name or by the title of the source if no author is available. Each reference includes essential details such as the author's name, publication year, title of the work, publisher, and relevant page numbers or URLs.

CHAPTER 2

SOFTWARE REQUIREMENT SPECIFICATION

A Software Requirements Specification (SRS) is a comprehensive document detailing the functional and non-functional requirements of a software system, serving as a blueprint for development.

2.1 FUNCTIONAL OVERVIEW

The Smart Assistive Stick is an advanced, multi-functional assistive device designed to improve the mobility, independence, and safety of visually impaired individuals. By integrating various cutting-edge technologies, it provides a seamless navigation experience, real-time location tracking, environmental awareness, and emergency communication.

- **Obstacle Detection and Avoidance:** The stick uses ultrasonic sensors to detect obstacles in the user's immediate environment. By emitting ultrasonic waves and calculating the time taken for the sound to reflect back, the system determines the distance between the stick and any obstacles. Based on this data, the system provides timely feedback to the user through vibrations or audio cues. The ultrasonic sensors have a range from 20 cm to 350 cm, ensuring that obstacles at various heights (ground level to head level) are detected.
- **Real-Time Location Tracking (GPS):** The GPS module is integrated into the stick, enabling continuous tracking of the user's location. The GPS coordinates are transmitted to the guardian's mobile application, which provides real-time location data on an interactive map.
- In addition to regular tracking, the system can send the exact location to a caregiver or family member in case of emergencies. This feature is invaluable for situations where the user may be lost, disoriented, or require urgent assistance.
- **User Feedback and Interaction:** To ensure the system is intuitive and easy to use, the stick provides accessible feedback in the form of vibrations and audio signals. The intensity of vibrations and the volume of audio alerts can be adjusted according to the user's preferences, making the system highly adaptable.The stick features a simple keypad with tactile buttons that the user can easily press to send emergency messages (SOS). Each button is pre-programmed with specific messages (e.g., "I

am lost," "I need help," etc.) and automatically sends an SMS or notification to a designated caregiver or family member.

- **Emergency Communication System (GSM Module):** The system includes a GSM modem, which enables the user to send emergency text messages (SMS) to pre-registered family members or caregivers.In critical situations, the user can press a button to send an alert message with the current GPS coordinates, making it easy for responders to locate the user.

- **Power Efficiency and Battery Life:** The system is designed with energy efficiency in mind, ensuring the stick remains operational for extended periods, even with constant GPS tracking and sensor activity.The rechargeable battery is optimized for longevity and can last for several days with regular use.The system is built with energy-efficient components to minimize power consumption, extending the battery life without sacrificing performance.

2.2 INPUT REQUIREMENTS

The Smart Assistive Stick incorporates various input mechanisms to ensure its functionality and responsiveness to user needs.

- **Ultrasonic Sensor Inputs:**

  Detects obstacles in the path of the user by measuring the distance between the stick and nearby objects.Provides accurate real-time data for obstacle avoidance and navigation.

- **GPS Module Input:**

  Captures the precise geographical location of the user.Assists in navigation and enables emergency alerts to include location details.

- **GSM Module Input:**

  Receives input signals for transmitting SMS notifications.Facilitates communication with guardians or emergency services during critical situations.

- **SOS Alert Button:**

  Serves as a manual input for users to trigger an emergency alert.Sends predefined messages to pre-configured contacts when activated.

- **User Commands:**

Receives voice commands or manual inputs for specific actions.Enhances interactivity and user control over the device.

- **Environmental Feedback:**

  Collects data on environmental conditions like proximity to hazards.Enables dynamic responses to ensure user safety.

2.3 OUTPUT REQUIREMENTS

The Smart Assistive Stick is designed to deliver precise and reliable outputs that enhance the user's mobility and safety:

- **Voice Alerts:**

  The stick provides real-time voice guidance to alert users about obstacles and assist with navigation, ensuring that users are always aware of their immediate surroundings.

- **SMS Alerts:**

  In emergency situations, the stick sends SMS alerts containing the user's location to pre-configured guardians. This feature guarantees quick assistance by sharing vital information promptly.

- **LCD Display Information:**

  A 16x2 LCD screen is integrated into the stick to display system status, alerts, and relevant information. This ensures users can quickly reference any updates or notifications.

- **Obstacle Detection Alerts:**

  Equipped with ultrasonic sensors, the stick detects nearby obstacles and provides immediate alerts. This allows visually impaired users to navigate safely and avoid potential hazards.

2.4 FUNCTIONAL REQUIREMENTS

Functional requirements outline the specific functionalities or features that a software system must possess to fulfill its intended purpose and meet the needs of its users. These requirements describe what the system should do, including its capabilities, behaviours, and interactions with users and other system components.

- **Obstacle Detection and Feedback**
    - **Ultrasonic Sensors**: The stick should include ultrasonic sensors to detect obstacles in the user's path within a specified range (e.g., 20-350 cm). The system will provide immediate feedback (via vibration or audio signals) when obstacles are detected.
- **GPS Location Tracking**
    - **Emergency Alerts**: The GPS feature will enable automatic sending of location-based SOS messages to caregivers in emergency situations.
- **Communication with Guardian**
    - **SOS Functionality**: The user should be able to send SOS messages with their current location through the mobile app or by using a designated button on the stick.
- **User Feedback Mechanism**
    - **Vibration and Audio Alerts**: The system should offer vibration or audio feedback to alert the user to detected obstacles. The user should be able to adjust the intensity of these signals based on preference.
- **Power Management**
    - **Rechargeable Battery**: The device should operate on a rechargeable battery that supports long-lasting usage. It should also include a battery level indicator for the user to know when a recharge is needed.
- **Control Unit and Integration**
    - **Microcontroller**: The central processing unit will be an ESP32 microcontroller that integrates all system components (sensors, GPS, communication unit) and ensures seamless operation.
    - **Data Processing**: The microcontroller will handle real-time data processing, sending alerts, and managing communication between the device and the mobile app. users have access to accurate and up-to-date pricing information.

2.5 SOFTWARE REQUIREMENTS

The below Table 2.1 shows the Software requirements which includes Microcontroller Firmware and Programming Language

Table 2.1 Software requirements

Software	Requirement
Microcontroller Firmware	Arduino IDE
Programming Language	Embedded C

2.6 HARDWARE REQUIREMENTS

The below Table 2.2 shows all the Hardware requirements which includes GPS Module,GSM Module,Ultrasonic Sensors,Power Supply,LCD Display,SOS Alert Button,Speaker.

Table 2.2 Hardware requirements

Hardware	Requirement
GPS Module	Tracks the user's location for navigation and emergency alerts.
GSM Module	Enables SMS alerts for emergency and tracking.
Ultrasonic Sensors	Detects obstacles and measures depth for safe navigation.
Power Supply	Provides reliable and consistent energy.
LCD Display	16x2 Character LCD for displaying essential information.
SOS Alert Button	Allows quick emergency notifications.
Speaker	Provides real-time voice alerts and guidance.

2.7 PROJECT CYCLE

The project cycle, also known as the software development life cycle (SDLC), refers to the stages involved in the development of a software project from initiation to completion.

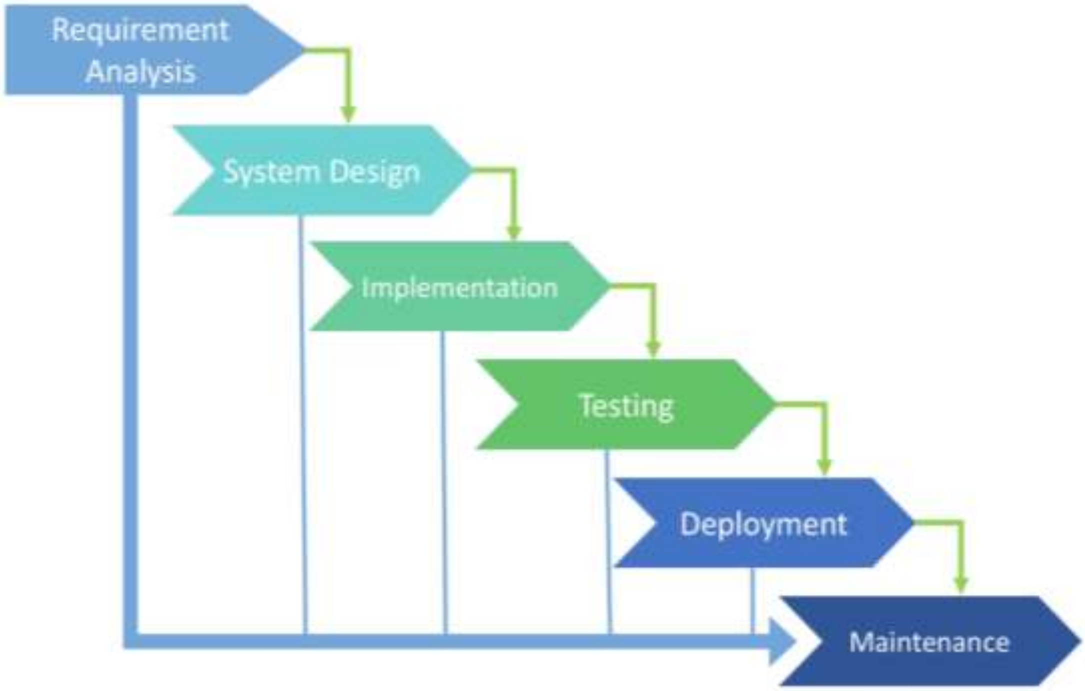

Figure 2.3 Project Cycle

Figure 2.2 represents project cycle which comprises of the following

- **Requirements Analysis:**
  The Smart Assistive Stick is designed to assist visually impaired individuals by offering features like obstacle detection, GPS navigation, and emergency alerts via GSM. The hardware includes an Arduino microcontroller, ultrasonic sensors, GPS, GSM modules, and a rechargeable battery.

- **System Design**:
  This phase focuses on creating detailed plans for hardware and software integration. Circuit diagrams connect the ultrasonic sensors, GPS, GSM, and Arduino, while a compact and ergonomic stick design houses the components. Software algorithms ensure efficient sensor data processing, real-time feedback, and emergency alerts.

- **Implementation**

  In this phase, hardware components are assembled, and the software is developed to create a functional system. The Arduino is programmed to process sensor data, provide alerts, and integrate GPS and GSM functionality. A durable, ergonomic stick is built to house the system securely. User manuals and training materials are prepared to ensure ease of operation.

- **Testing**

  Testing ensures the system's reliability through unit, integration, and field testing. Each component, such as the ultrasonic sensors, GPS, and GSM module, is tested individually for accuracy. Integration testing ensures seamless operation between hardware and software. Real-world testing provides insights into the device's performance and areas for improvement.

- **Deployment**

  The device is introduced to users through training sessions and detailed user manuals. The stick is deployed for real-world use, and its performance is monitored closely. Feedback from users is collected to enhance the device's features and usability. This phase ensures the Smart Assistive Stick meets the needs of its target audience effectively.

- **Maintenance**

  Regular updates and support ensure the stick's long-term functionality and reliability. Hardware components are replaced as needed, and software improvements are made based on user feedback. New features, like AI-based detection, can be added over time. Troubleshooting assistance is provided to resolve any technical issues users may face.

CHAPTER 3

SYSTEM DESIGN

This chapter includes project architecture and description, Sequence Diagram, Circuit diagram and flow chart.

3.1 PROJECT ARCHITECTURE

The project architecture section typically provides an overview of an ultrasonic sensor, which is used to measure the distance between the sensor and nearby objects by emitting ultrasonic waves and calculating the time for the echo to return. This is ideal for obstacle detection or proximity sensing. GPS modem continuously sends data string to the Microcontroller. This data contains various type of information. It includes Longitude Latitude of the place where project is currently situated. Thus Microcontroller gets co-ordinates of the place. Then it sends SMS after periodic interval of time, for example after every 1 minute.

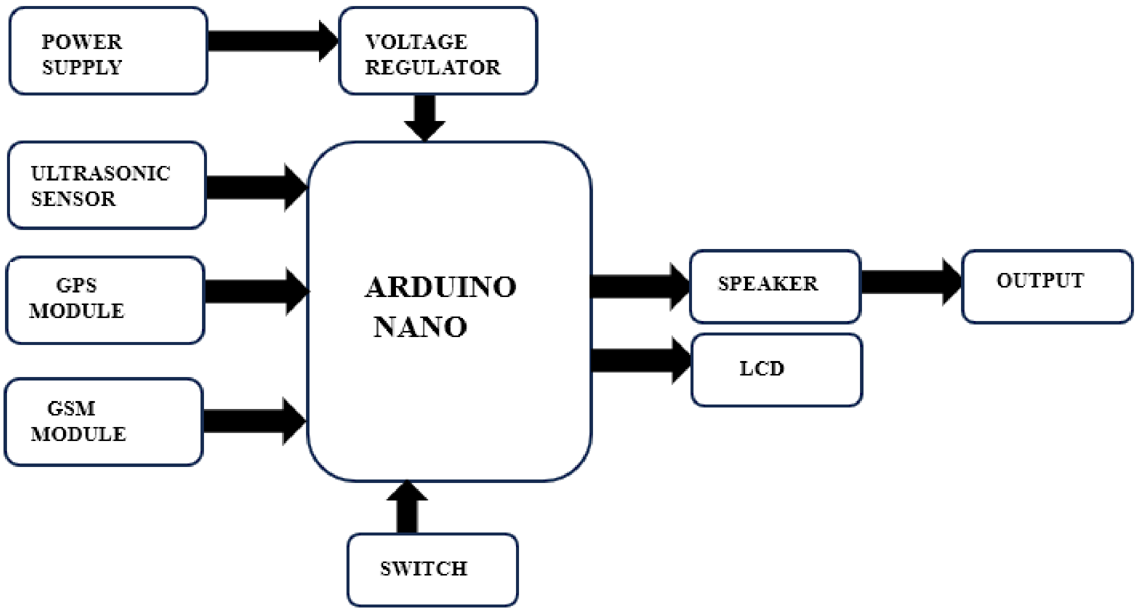

Figure 3.1 Project Architecture

The Figure 3.1 illustrates the hardware architecture of a smart Assistive stick system, highlighting the interconnection between various hardware components. At the core of the system is the Arduino Nano microcontroller, which serves as the primary control unit to process data and manage the operations of other components. An ultrasonic sensor is connected to the Arduino for detecting obstacles in the path of the user, enabling safe navigation by measuring the distance to objects. The GSM module is integrated for communication purposes, such as sending alerts or emergency messages to caregivers or family members. A GPS module provides real-time location tracking, ensuring that the user's position can be determined in emergencies. The system is powered by a battery, supplying the necessary voltage to all components. A speaker is included to provide auditory feedback, relaying critical information such as detected obstacles or alerts to the user. Together, these components create a cohesive and functional system aimed at enhancing mobility and safety for visually impaired individuals.

3.2 SEQUENCE DIAGRAM

A sequence diagram illustrates how objects interact in a particular scenario of a system. It shows the sequence of messages exchanged between objects over time, depicting the flow of control and collaboration among various components.

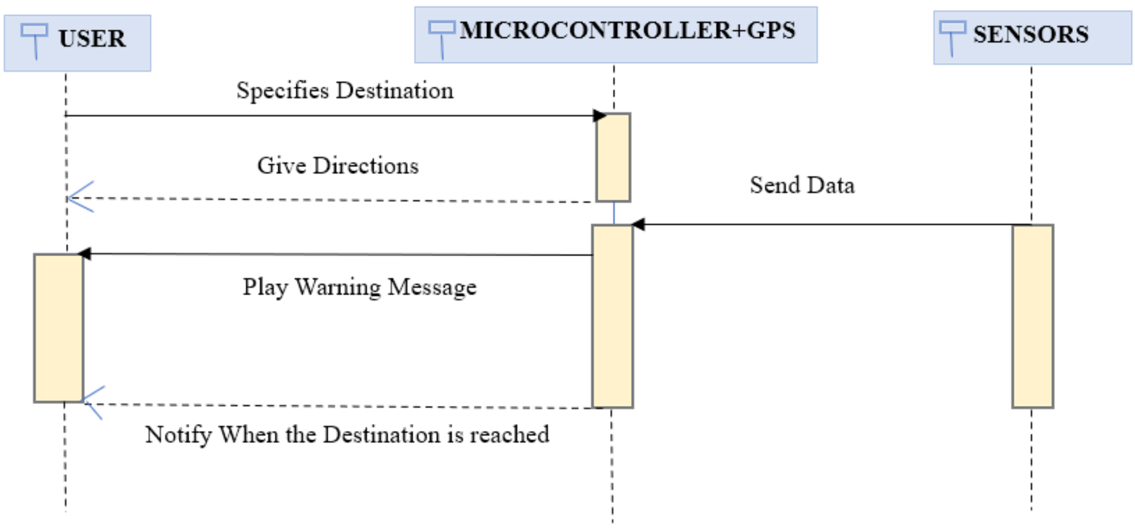

Figure 3.2 Sequence Diagram

Figure 3.2 illustrates the interactions between the user, the microcontroller with GPS capabilities, and the sensors integrated into the system. Initially, the user specifies a destination, which is sent to the microcontroller. In response, the microcontroller processes this information and provides directions to the user. As the user navigates, the system continuously communicates with the sensors, which send data regarding the user's surroundings.

When the user approaches their destination, the microcontroller activates a warning message to alert them. Finally, upon reaching the destination, the system notifies the user, completing the cycle. This sequence ensures that the user receives timely assistance and guidance, enhancing their navigation experience and overall safety. Thus, the smart assistive stick serves as an invaluable tool for independent mobility, particularly for individuals with visual impairments.

3.3 CIRCUIT DIAGRAM

The circuit diagram represents the implementation of a Smart Assistive Stick designed for visually impaired individuals. The system integrates multiple components to enhance mobility and safety.

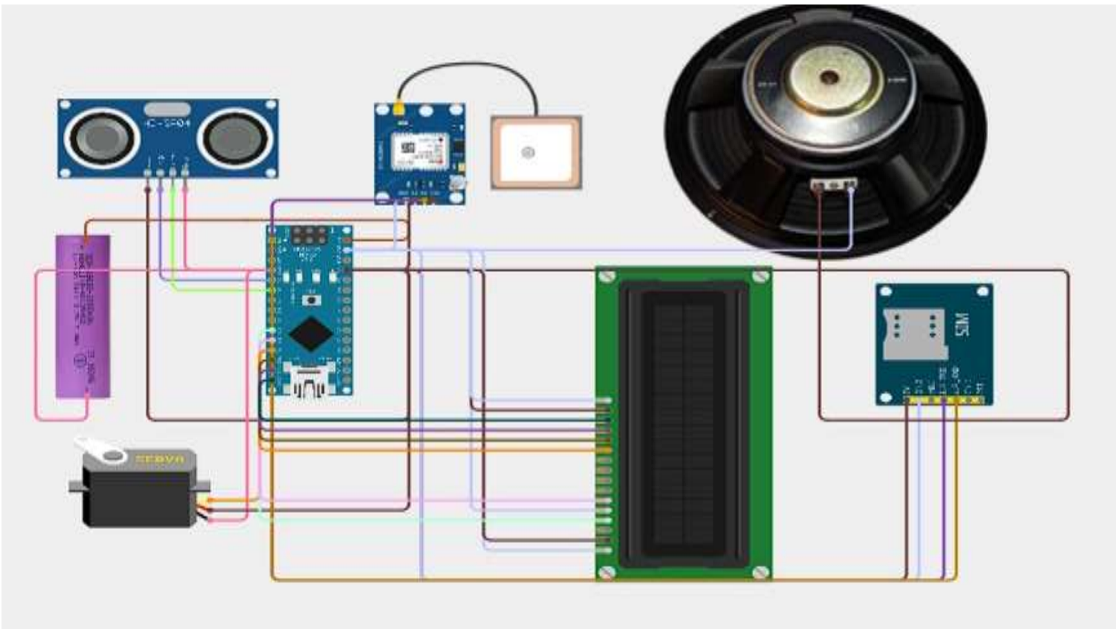

Figure 3.3 Circuit Diagram

Figure 3.3 represents the integration of an ultrasonic sensor for obstacle detection, connected to the microcontroller (Arduino Nano) to process data and provide alerts. A GPS module continuously tracks the user's location, transmitting the coordinates via the GSM module for real-time monitoring by caregivers. The LCD display is used to show vital information like alerts or system status, while the speaker provides audio feedback, guiding the user through voice commands or obstacle alerts.

A servo motor adds functionality to the stick, such as movement signaling or interaction with the environment. A rechargeable lithium-ion battery powers the entire system, ensuring portability and longevity. The Arduino Nano serves as the main controller, connecting all components and enabling smooth operation. The design is compact, energy-efficient, and user-friendly, catering to the needs of visually impaired individuals by improving their independence and safety.

The main blocks of this project are:

1. Arduino Nano
2. Ultrasonic Sensor
3. GPS Module
4. GSM Module
5. Power Supply
6. Servo Motor
7. LCD Module
8. Speaker

1. Arduino Nano:

It is a Microcontroller board developed by Arduino.cc and based on Atmega328p / Atmega168. Each of these digital and analog pins has several functions assigned, but its basic function must be configured as input or output. They are acted as input pins when they are interfaced with sensors, but if you are driving some load then use them as output.

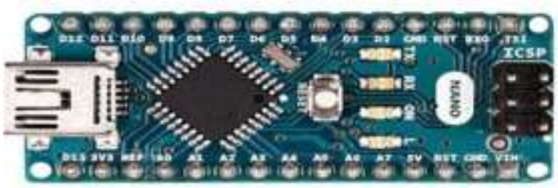

Figure 3.4 Arduino Nano

2. Ultrasonic Sensor:

Ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic waves. It uses transducer to send and receive ultrasonic pulses. It is easy to use, can easily interface with microcontroller and they are not dangerous to operate, it has longer life, high accuracy. It is an analog sensor.

Figure 3.5 Ultrasonic Sensor

3. GPS Module:

The Global Positioning System (GPS) is a satellite-based navigation technology that provides accurate location and time information anywhere on Earth. It works by receiving signals from a network of satellites and calculating the receiver's exact position using trilateration. GPS is widely used in various applications, including navigation, mapping, tracking, and geolocation services.

Figure 3.6 GPS Module

4. GSM Module:

The GSM (Global System for Mobile Communications) module is a widely used technology in telecommunications that facilitates voice, text, and data communication over cellular networks. It allows devices to send and receive messages, make calls, and connect to the internet by using a SIM card to access the mobile network.

Figure 3.7 GSM Module

5. Power Supply:

The power supply is a crucial component in any electronic system, providing the necessary energy to operate the device. It converts electrical energy from a source, such as a battery or mains power, into the required voltage and current levels needed by various components.

Figure 3.8 Power Supply

6. Servo Motor:

A servo motor is a precision-controlled motor commonly used in applications requiring accurate positioning, speed, and torque control. It consists of a motor coupled with a sensor for feedback and a control circuit to regulate movement. Servo motors are widely used in robotics, automation, and mechanical systems due to their ability to rotate to specific angles with high precision.

Figure 3.9 Servo Motor

7. LCD Module:

An LCD (Liquid Crystal Display) module is a flat-panel display technology commonly used to visually present information in a wide range of devices. It works by using liquid crystals that modulate light to produce images or text, often with a backlight for visibility in various lighting conditions.

Figure 3.10 LCD Module

8. Speaker:

A speaker is an essential output device that converts electrical signals into audible sound, making it a critical component in systems requiring audio feedback. In a smart blind stick project, the speaker plays a vital role in providing real-time voice alerts, navigation instructions, or obstacle detection warnings to assist visually impaired users.

Figure 3.11 Speaker

3.4 FLOW CHART

A flowchart is a graphical representation of a process, algorithm, or workflow. It uses various shapes and symbols connected by arrows to illustrate the steps or actions involved in completing a task. The process begins with the initialization of the microcontroller, which sets up the core system components and ensures the device is ready to operate. This step involves configuring the sensors, actuators, and any necessary communication protocols. Following initialization, the user or the system sets a distance threshold, which defines the minimum safe distance between the user and obstacles. This threshold acts as a reference point for triggering alerts and can be adjusted based on environmental conditions or user preference.

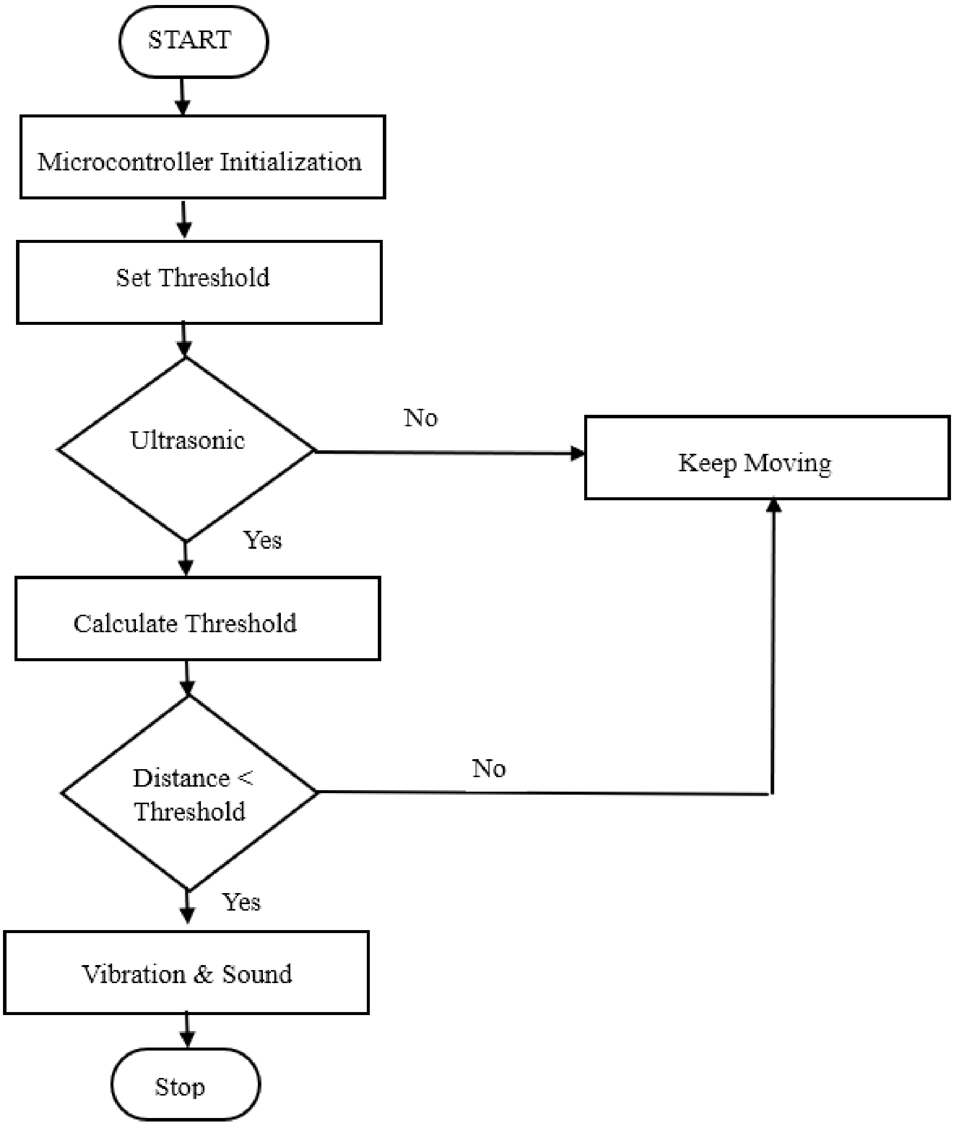

Figure 3.12 Flowchart

This Figure 3.12 illustrates the functioning of a smart assistive stick in a step-by-step logical flow. The smart assistive stick functions as an obstacle detection and alert system for visually impaired users.

Next, the system engages the ultrasonic sensor, which continuously scans the surroundings. The ultrasonic sensor emits sound waves and measures the time it takes for the echoes to return after bouncing off nearby objects. This data serves as the input for the next step.

The system then processes this input to calculate the distance to any detected object. This calculation is based on the speed of sound in air and the time delay of the echoes. The calculated distance is then compared to the predefined threshold.

If the detected distance is less than the threshold, the system triggers an alert mechanism. This alert typically involves both vibration and sound notifications to ensure the user is promptly and effectively informed of the obstacle in their path. The vibration allows for silent yet tactile feedback, while the sound serves as an additional auditory cue, especially in noisy environments. Conversely, if the distance is greater than or equal to the threshold, the system advises the user to keep moving. In this case, no alert is triggered, and the system continues monitoring the surroundings in real-time. This ensures seamless and uninterrupted assistance for the user as they navigate.

The cycle repeats continuously, with the ultrasonic sensor providing constant input, the system recalculating distances, and the alerts being triggered as needed. This simple yet effective process helps ensure the safety and independence of users in dynamic and potentially hazardous environments.

CHAPTER 4

IMPLEMENTATION

This chapter includes the software tools used and implementation details.

4.1 SOFTWARE TOOLS USED

The development of the Smart Assistive Stick for visually impaired individuals involved the use of the following software tools:

- **Arduino IDE:**

  Used for programming the Arduino Nano microcontroller, which controls the sensors and processes their outputs.

- **SolidWorks:**

  Utilized for designing the 3D model and simulating the structure of the smart Assistive stick to ensure mechanical robustness.

- **Serial Monitor**:

  Integrated with the Arduino IDE for debugging and testing the system. Enables real-time communication with the microcontroller to validate inputs and outputs.

- **Simulation Tools (e.g., Proteus):**

  For testing circuit designs and ensuring proper integration of components like ultrasonic sensors and power systems.

- **Embedded C/C++:**

  The primary programming languages for implementing the logic in the microcontroller.

4.2 Implementation Details

```
#include
<SoftwareSerial.h>
```

```
#include
<TinyGPS.h>
// Pins
#define trigPin 9
#define echoPin 10
#define buzzerPin 6
#define buttonPin 2

// Threshold distance for
obstacles (in cm) #define
distanceThreshold 20

// Create instances for GPS and
GSM TinyGPS gps;
SoftwareSerial gpsSerial(3, 4);  // RX, TX for GPS
module SoftwareSerial gsmSerial(7, 8);  // RX, TX
for GSM module

long duration;
int distance;
bool emergencyFlag = false;

// Set your emergency contact number
String emergencyContact = "+91-8618526574";

void setup() {
  // Initialize pins
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);
  pinMode(buzzerPin,
  OUTPUT);
  pinMode(buttonPin, INPUT_PULLUP);   // Using internal pull-up resistor
```

```
  for the button

  // Initialize Serial for debugging
  Serial.begin(9600);

  // Initialize Serial for GPS and GSM
  gpsSerial.begin(9600);  // GPS module
  baud rate gsmSerial.begin(9600);  // GSM
  module baud rate

  // Initialize GSM module (wait a little before
  sending SMS) delay(1000);
  Serial.println("Initializing...");
}

void loop() {
  // Check for obstacle using ultrasonic
  sensor checkForObstacle();

  // Check if button is pressed
  if (digitalRead(buttonPin) == LOW)
   { sendEmergencySMS();
    delay(2000);  // Debounce delay
  }

  // Check if there is GPS data available while
  (gpsSerial.available()) {
    char c = gpsSerial.read();
    if (gps.encode(c)) {
      // GPS data is ready
      displayGPSData();
    }
```

```
  }
}

  void checkForObstacle() {
  // Send pulse from ultrasonic
  sensor digitalWrite(trigPin,
  LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);

  // Read the echo pin
  duration = pulseIn(echoPin, HIGH);

  // Calculate the distance in cm
  distance = duration * 0.034 / 2;

  // If the distance is less than threshold, sound the buzzer
   if (distance < distanceThreshold) {
  digitalWrite(buzzerPin, HIGH);
  } else {
    digitalWrite(buzzerPin, LOW);
  }
}

void
  sendEmergencySMS()
  { float flat, flon;
  unsigned long age;

  // Get GPS data (latitude and longitude)
```

```
  gps.f_get_position(&flat, &flon, &age);


  if (age == TinyGPS::GPS_INVALID_AGE) {
    Serial.println("No GPS data available");
  }
  else {
    String message = "Emergency! The blind person needs help. Location:
https://maps.google.com/?q=";
    message += String(flat, 6) + "," + String(flon, 6);
    Serial.println("Sending
    SMS...");
    sendSMS(emergencyContact,
    message);
  }
}
void sendSMS(String number, String text) {
  gsmSerial.println("AT+CMGF=1");     // Set SMS
  mode to text delay(1000);
  gsmSerial.println("AT+CMGS=\"" + number + "\"");  // Send the emergency contact
  number delay(1000);
  gsmSerial.println(text);  // SMS
  body delay(100);
  gsmSerial.write(26);  // End AT
  command with a ^Z delay(5000);   //
  Wait for the SMS to be sent
  Serial.println("SMS Sent");
}
void displayGPSData() {
  float flat, flon;  unsigned
  long age;
  // Get GPS data (latitude and longitude)
  gps.f_get_position(&flat, &flon, &age);
```

```
  if (age == TinyGPS::GPS_INVALID_AGE) {
    Serial.println("No GPS data available");
  } else { Serial.print("Latitude:
    "); Serial.print(flat, 6);
    Serial.print(", Longitude: ");
    Serial.println(flon, 6);
  }
}
```

CHAPTER 5

TESTING

This section describes scope and testing details of our project.

5.1 SCOPE

- **Enhanced Mobility:** Aims to assist visually impaired individuals in navigating their surroundings safely and independently.

- **Obstacle Detection:** Uses ultrasonic sensors to identify obstacles and alert the user in real-time.

- **Navigation Assistance**: Incorporates GPS technology for location tracking and guiding users effectively.

- **User-Friendly Feedback:** Provides voice-guided alerts to ensure intuitive interaction with the device.

- **Cost-Effective Design:** Ensures affordability and accessibility, especially in developing countries.

- **Future Improvements:** Plans to include extended sensor range, motion detection, and sensor rotation for better performance.

- **Widespread Applicability:** Designed to cater to a global audience with a focus on inclusivity and usability.

5.2 UNIT TESTING:

Unit testing for the Smart Assistive Stick project involves systematically testing individual components, such as sensors, GPS, and GSM module, to ensure they function as intended. This process verifies obstacle detection, location tracking, communication, and safety features, ensuring the system performs reliably under various conditions.

Table 5.1 Unit Testing

Component	Test Scenario	Test Input	Expected Output	Pass/Fail
Ultrasonic Sensor	Detect obstacle within threshold distance	Object at 20cm distance	Distance detected as 20cm	Pass
GSM Module	Send location-based SMS alert	Emergency trigger event	SMS sent to guardian with location details	Pass
GPS Module	Fetch current location coordinates	GPS module activated	Latitude and Longitude values returned	Pass
Servo Motor	Perform action based on signal input	Signal input for specific movement	Signal input for specific movement	Pass
LCD Display	Display essential information	Valid/invalid input data	Displayed correct and readable information	Pass
SOS Alert Button	Send emergency alert to guardian	SOS button press	Emergency notification sent successfully	Pass
Power Supply	Operate system for extended hours	Continuous usage for 8 hours	Stable power supply maintained	Pass
Voice Alert System	Generate alert for detected obstacle	Obstacle detected at 20cm ahead	Voice alert: "Obstacle ahead, 20cm away"	Pass

Table 5.1 illustrates how each test focuses on a specific aspect of the system, such as obstacle detection, location transmission, or emergency alerts, ensuring that each component performs its role accurately. For instance, tests are conducted to confirm that ultrasonic sensors detect obstacles and relay information via the speaker, the GPS module tracks the user's location, and the GSM module sends emergency notifications reliably. Unit testing also ensures that the device remains operational under various conditions, such as low battery or poor network connectivity, and verifies that the device meets design goals like energy efficiency, portability, and user-friendliness. By rigorously testing each component, unit testing helps identify and fix issues early in the development process, ensuring the overall reliability and safety of the smart stick system.

5.3 INTEGRATION TESTING

Integration testing verifies the interactions and interfaces between different components or modules of the system. It ensures that individual units work together as expected when integrated. In our project, integration testing would ensure that all individual components of the smart Assistive stick (hardware modules and software functionalities) work together as intended, delivering the desired output without errors. This includes testing the interaction between the ultrasonic sensors and the speaker to ensure obstacle detection results in immediate audio feedback, as well as ensuring the GPS module transmits location data correctly to the GSM module for caregiver updates. Another key aspect is verifying the integration of the SOS button with the GSM module to send emergency alerts promptly. The LCD display is tested to ensure it works harmoniously with the other components, displaying system information accurately. Another key aspect is verifying the integration of the SOS button with the GSM module, ensuring that pressing the button triggers an emergency alert with the correct GPS coordinates to predefined contacts without delays. The LCD display functionality is also tested to confirm that it correctly interacts with other components, displaying real-time system status, battery level, and alert messages as needed.

Table 5.2 Integration Testing

Component	Test Scenario	Test Input	ExpectedOutput	Pass/Fail
Ultrasonic Sensor + Voice Alert	Detect obstacle and generate voice alert	Obstacle at 20cm distance	Obstacle detected, voice alert: "Obstacle ahead, 20cm away"	Pass
GPS Module + GSM Module	Send location via SM	GPS activated, emergency trigger event	SMS with accurate GPS coordinates sent to guardian	Pass
Ultrasonic Sensor + LCD Display	Display distance of detected obstacle	Obstacle at 15cm distance	LCD displays: "Obstacle detected at 15cm"	Pass
Power Supply + Servo Motor	Operate motor without power interruptions	Continuous signal input	Servo motor operates as expected without power issues	Pass

Table 5.2 represents how integration testing verifies the seamless collaboration of various components in the Smart Assistive Stick. Additionally, the servo motor's functionality is validated in scenarios where it interacts with external elements, such as signaling or extending the stick's capabilities. Integration testing ensures that these interconnected components work cohesively, addressing any interface issues and guaranteeing that the system meets its design objectives of enhancing safety, mobility, and usability for visually impaired individuals.

5.4 FUNCTIONAL TESTING

Functional testing evaluates the functionality of the system as a whole to ensure it meets the specified requirements. It focuses on testing the system's features and capabilities from an end-user perspective.

In our project, functional testing would verifies that the stick provides accurate alerts, real-time location updates, enhancing user safety and independence.

Table 5.3 Functional Testing

Component	Test Scenario	Test Input	Expected Output	Pass/Fail
Ultrasonic Sensor	Detect obstacle within threshold distance	Object at 20cm distance	Distance detected and audio alert generated	Pass
GPS Location Tracking	Fetch and update current location	User moves to a new location	Accurate latitude and longitude values updated	Pass
SOS Alert Button	Send emergency SMS to guardian	SOS button pressed	Emergency SMS sent successfully	Pass
LCD Display	Display essential details	Valid and invalid input data	Correct and readable information displayed	Pass
Power Supply	Ensure system stability over extended usage	Continuous operation for 8 hours	System operates without power interruptions	Pass

Table 5.3 represents how functional testing evaluates the core operations of the Smart Assistive Stick to ensure that it performs as intended. This includes testing the ultrasonic sensors to confirm they accurately detect obstacles and trigger audio feedback via the speaker, ensuring the GPS module tracks the user's location, and validating that the GSM module sends location updates and emergency alerts to

caregivers. The SOS button is tested to verify it triggers alerts reliably, while the LCD display is evaluated to ensure it provides the necessary system information.

5.5 SYSTEM TESTING

System testing involves evaluating the entire software system as a whole to ensure that it meets the specified requirements and functions correctly in its intended environment. This comprehensive testing phase verifies the system's functionality, performance, reliability, security, and usability. Table 5.4 represents System Testing.

Table 5.4 System testing

Component	Test Scenario	Test Input	ExpectedOutput	Pass/Fail
Obstacle Detection and Alerts	Detect obstacle and provide alerts	Object at 20cm distance	Voice alert "Obstacle ahead, 20cm away" and log entry	Pass
Navigation Assistance	Detect direction of obstacle	Object at left side	Voice alert "Obstacle to your left"	Pass
Emergency SMS Alerts	Send location-based SMS in emergencies	Emergency button pressed	SMS sent to guardian with location	Pass
Servo Motor Movement	Scan all directions for obstacles	Servo motor initialized	Servo Motor rotates , and obstacles detected in all directions	Pass

Table 5.4 represents how system testing ensures the overall functionality and performance of the Smart Assistive Stick. This involves testing the entire device as a whole, including all integrated components like ultrasonic sensors, GSM and GPS modules, LCD display, speaker, servo motor, SOS button, and the power supply. The system is tested under real-world conditions to validate features such as obstacle detection and audio feedback, accurate location tracking and transmission, emergency alert functionality, and information display on the LCD.

Scenarios such as navigating in complex environments, operating under low battery, or handling poor network connectivity are simulated to ensure the device's reliability and robustness. Additionally, system testing evaluates non-functional requirements like energy efficiency, portability, and ease of use. By testing the fully integrated device, system testing ensures that all components work together cohesively and meet the design objectives, providing a safe, efficient, and user-friendly solution for visually impaired individuals.

CHAPTER 6

SNAPSHOTS OF THE PROJECT

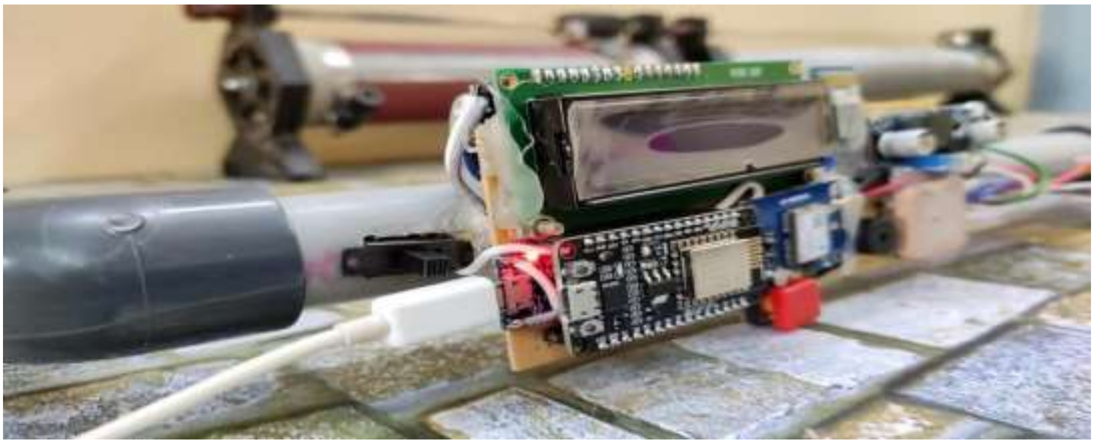

Figure 6.1 Integrated Sensors

Figure 6.1 represents the prototype of the Smart Assistive Stick, showcasing its integrated components, including an ultrasonic sensor, microcontroller (NodeMCU), GPS module, and an LCD display.

Figure 6.2 Disassembled View

Figure 6.2 represents the disassembled view of the Smart Assistive Stick, highlighting key components such as the ultrasonic sensors, NodeMCU, GPS module, and servo motor. It showcases the internal wiring and modular design for easier inspection and maintenance.

Figure 6.3 Abnormal Depth Front Side

Figure 6.3 represents an LCD that displays alerts such as “ABNORMAL DEPTH FRONT SIDE”. The system integrates an Arduino Nano, a SIM800L GSM module for communication, and a battery pack for portability. It is designed to assist visually impaired individuals by detecting obstacles and providing real-time feedback.

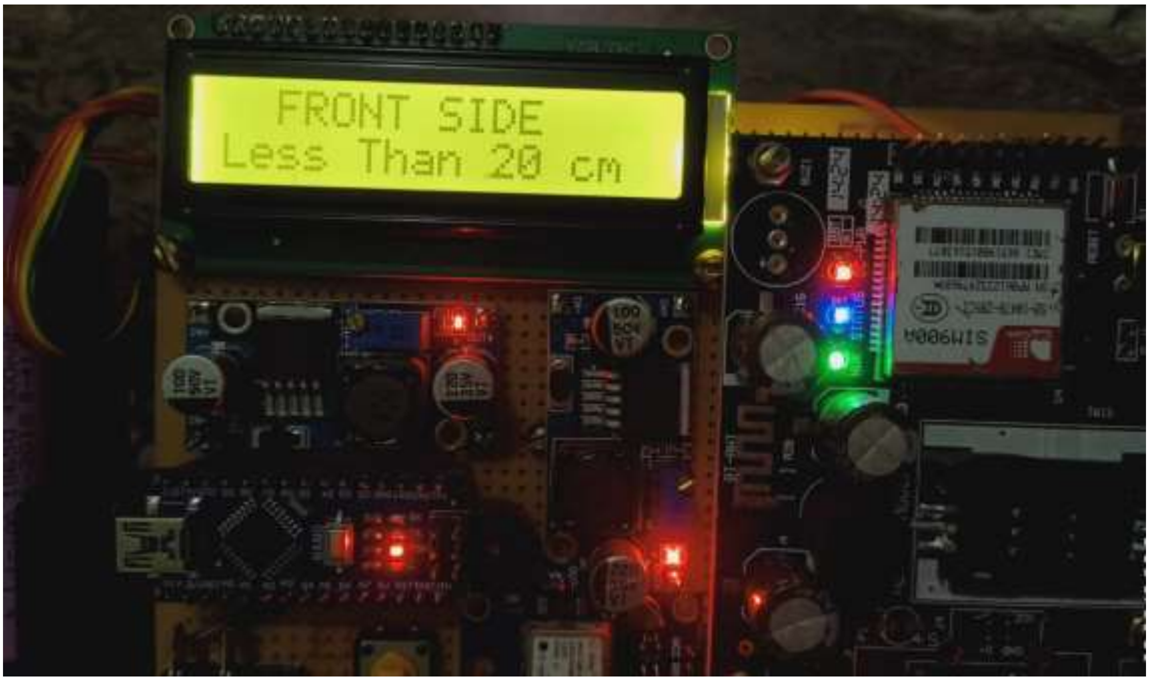

Figure 6.4 Obstacle on the Front side

Figure 6.4 represents an ultrasonic sensor used to measure the distance to obstacles, as shown on the LCD screen, which displays "Front Side Less Than 20 cm."

Figure 6.5 Obstacle on the Left Side

Figure 6.5 represents an LCD display that provides real-time obstacle detection feedback. The screen shows the message "Left Side Less Than 20 cm," indicating the detection of an obstacle within close proximity on the left side.

Figure 6.6 Obstacle on the Right Side

Figure 6.6 represents an LCD screen that provides real-time feedback about obstacle detection. The screen displays the message "Right Side Less Than 20 cm," indicating the detection of an obstacle within close proximity on the right side.

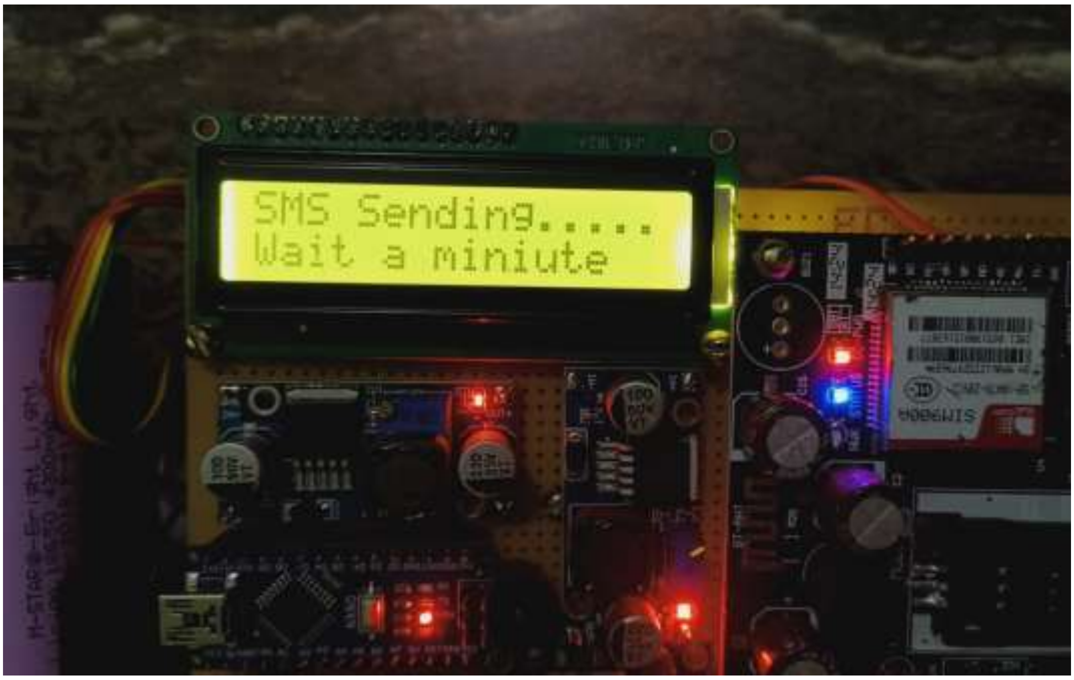

Figure 6.7 SMS Sending Module

Figure 6.7 illustrates the SMS communication module integrated within a smart assistive stick. The stick's system sending an SMS alert, with a status display on the LCD screen reading, "SMS Sending... Wait a minute."

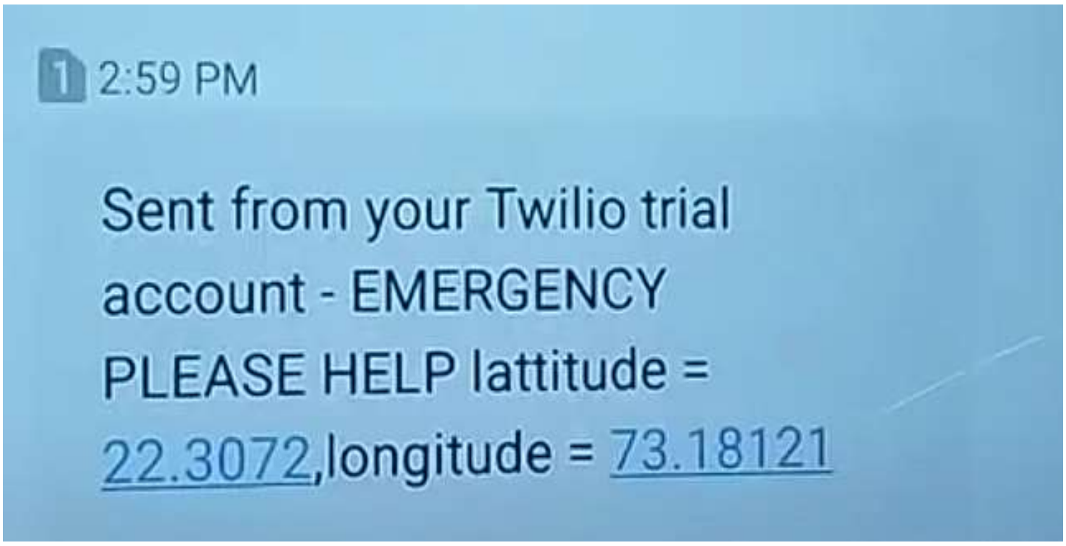

Figure 6.8 Emergency Alert Message

Figure 6.8 shows an emergency alert, the message indicates an urgent situation and includes the user's geographic coordinates: latitude 22.3072 and longitude 73.18121.

This feature allows visually impaired individuals to send their location during emergencies, ensuring timely assistance.

Figure 6.9 Smart Assistive Stick

Figure 6.9 provides a complete view of the Smart Assistive Stick prototype, showcasing its fully assembled design. The stick integrates key components such as the ultrasonic sensors for obstacle detection, a GPS module for location tracking, and an LCD screen for displaying relevant information.

CHAPTER 7

CONCLUSION

7.1 CONCLUSION

This system can be applied in the straight path, right angle path and the curved path. At least 1m width is required for the proper management of the stick. The broad beam angle ultrasonic sensors enable wide range obstacle information. The Smart Assistive Stick project successfully addresses the challenges faced by visually impaired individuals by providing a reliable and cost-effective assistive tool. Equipped with ultrasonic sensors for obstacle detection, GPS for location tracking, and voice guidance for feedback, the stick enhances mobility and independence. Its lightweight and durable design, combined with low manufacturing costs, makes it practical for use in developing countries. With a high success rate in experimental tests, the device demonstrates its effectiveness in real-world scenarios. This project serves as a foundation for future advancements in assistive technology, enabling visually impaired individuals to navigate their surroundings with confidence and ease.

7.2 FUTURE SCOPE

- **Extended Sensor Range:** Enhancing the range of ultrasonic sensors to detect obstacles from greater distances, ensuring improved navigation for users.

- **Motion-Based Obstacle Detection**: Incorporating technology to determine the speed of moving obstacles for more dynamic and real-time decision-making.

- **Rotational Sensor Mechanisms:** Adding a servo motor to rotate the ultrasonic sensor, enabling a broader field of detection and adaptability to varied environments.

- **Feedback Enhancements:** Integrating a vibration mechanism alongside the voice guidance system to offer multi-modal feedback, which is particularly useful in noisy environments.

- **Wider Application in Market**: Expanding the product's features while maintaining low cost to appeal to a broader market, especially in developing countries.

APPENDIX-A

1. Hardware Components and Specifications:

- **Ultrasonic Sensors:** Enable obstacle detection and depth measurement to ensure safe navigation for the user.
- **GSM Module:** Sends emergency notifications and location details to caregivers or guardians via SMS.
- **GPS Module:** Continuously tracks the user's location for real-time monitoring and enhanced security.
- **LCD Display:** Provides the user with visual feedback and essential information in real-time.
- **Speaker:** Delivers audio feedback and alerts to guide the user effectively during navigation.
- **Servo Motor:** Adds extended functionality to the stick, such as signaling or environmental interactions.
- **SOS Alert Button:** Allows the user to send an emergency notification promptly in case of distress.
- **Reliable Power Supply:** Includes rechargeable batteries to ensure the system is lightweight and energy-efficient.

2. Software Tools:

- **Arduino IDE:** Used to program and integrate the sensors, modules, and other hardware components with the microcontroller.
- **Embedded C:** Utilized to develop low-level, efficient, and real-time control code for managing the microcontroller and hardware modules.

3. System Operations:

- **Obstacle Detection and Navigation:** Ultrasonic sensors detect obstacles and measure depth, providing audio feedback to guide the user around hazards.
- **Location Tracking:** The GPS module continuously tracks the user's position, transmitting it to caregivers or guardians through the GSM module for real-time monitoring.
- **Emergency Alerts:** The SOS button triggers an immediate notification, including the user's GPS location, to pre-configured contacts.
- **Information Display:** The LCD screen displays essential data, such as navigation

status or system updates, for added convenience.

- **Extended Functionality:** The servo motor is used for signaling or interacting with the environment as needed.

4. Testing and Calibration:

- **Component Testing:** Verified individual hardware modules like ultrasonic sensors, GSM module, GPS module, and servo motor for accurate performance.
- **Integration Testing:** Ensured smooth communication between the microcontroller and all hardware components.
- **Functional Testing:** Tested the stick's navigation, emergency alert, and connectivity functionalities in controlled and real-world environments.
- **User Trials:** Conducted trials with visually impaired individuals to validate user-friendliness, reliability, and safety of the system.

5. Challenges and Solutions:

- **Obstacle Detection Accuracy:** Improved sensor placement and fine-tuned detection thresholds to enhance obstacle identification.
- **Connectivity Stability:** Resolved GSM module connectivity issues by optimizing network configurations and ensuring a robust power supply.
- **Energy Efficiency:** Integrated a low-power microcontroller and optimized Embedded C algorithms to extend battery life.
- **System Integration:** Addressed initial synchronization issues between hardware components by refining circuit design and firmware.

6. User Feedback and Improvements:

- Suggestions from user trials led to the addition of enhanced voice feedback options and adjustable sensor sensitivity to improve usability and adaptability.

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