DESIGN AND IMPLEMENTATION OF A BLIND STICK INTEGRATED WITH SENSORS AND AUDIO ASSISTANCE FOR VISUALLY IMPAIRED PEOPLE

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A Final Year Design Project (FYDP) submitted to the Department of Electrical and Electronic Engineering in partial fulfillment of the requirements for the degree of B.Sc. in Electrical and Electronic Engineering

Department of Electrical and Electronic Engineering
Brac University
December 2023

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December 2023

Declaration

It is hereby declared that

1. The Final Year Design Project (FYDP) submitted is our own original work while completing a degree at Brac University.
2. The Final Year Design Project (FYDP) does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The Final Year Design Project (FYDP) does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. I/We have acknowledged all main sources of help.

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Approval

The Final Year Design Project (FYDP) titled "Design and Implementation of a Blind Stick Integrated with Sensors and Audio Assistance for Visually Impaired People" submitted by

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of Fall, 2023 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Science (B.Sc) in Electrical & Electronic Engineering in December 2023.

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Ethics Statement

We thus state and certify that this Final Year Design Project titled "Design and Implementation of a "Blind Stick Integrated with Sensors and Audio Assistance for Visually Impaired" complies with requirements for completion of the Final Year Design Project set by the BRAC University Authority and the Department of Electrical and Electronic Engineering of BRAC University in partial fulfillment of the requirement for the degree of Bachelor of Science (B.Sc.) in Electrical & Electronic Engineering. All of the group members contributed to the compilation of this project report, which includes our designs, prototype details, test results, and conclusions. Under the direction of our ATC Panel, all the materials and literature reviews have been appropriately cited.

The plagiarism index of our project report is found to be 5% after consulting with the Ayesha Abed Library of BRAC University for a similarity check.

Abstract/ Executive Summary

Visually impaired individuals find it more challenging to move independently because of their compromised vision. Moreover, it is necessary to navigate in a given setting, along with their ability to organize their daily activities are vital to their health and wellbeing. The blind stick project aims to develop a lightweight, cost-effective, and easy-to-use device that utilizes ultrasonic and infrared sensors to detect obstacles above and below ground level and provide audio feedback to aid visually impaired users in navigating independently and safely. The encouraging news is that the rapid advancement in technology has seen the innovation of better systems for assisting the disabled, including the blind stick which can provide intelligent navigation capabilities to the visually impaired people. This paper reviews the design of a blind stick for the visually impaired people, equipped with obstacle recognition and giving feedback to the user by voice will add more virtual visibility in their journey. It shows that such a stick can be a significant boon to the visually impaired people.

Keywords: Object Detection, Blind Stick, Arduino Uno, YOLO, Navigational Aid.

Dedication

We want to express our gratitude to the Almighty Allah for completion of this project. Then, we want to remember our parents whose unwavering support and encouragement have been the driving force behind the completion of this project. Their belief in our abilities has been our greatest motivation. Finally, this achievement is a collective effort and we are thankful for the network of support that surrounds us.

Acknowledgement

We extend our heartfelt gratitude to the ATC panel whose invaluable insights and guidance have been instrumental in shaping the trajectory of our project. Their expertise and thoughtful contributions have greatly enriched our understanding and enhanced the overall quality of our work. We would also like to express our sincere appreciation to the stockholders whose constructive suggestions have played a pivotal role in refining and optimizing the basic functioning and intuitiveness of our project.

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Chapter 1: Introduction [CO1, CO2, CO10]

1.1 Introduction

In the contemporary landscape of technological progress, ensuring universal accessibility and autonomy is of paramount importance. The visually impaired encounter significant challenges in navigating their surroundings [1]. In response, developing the GPS GSM and audio feedback-based Blind Stick—a pioneering solution merging cutting-edge technologies.This innovative project integrates Global Positioning System (GPS) and Global System for Mobile Communications (GSM) technologies with real-time audio feedback mechanisms [2]. GPS facilitates precise location tracking, empowering users to comprehend their position accurately. The incorporation of GSM technology enables seamless communication, allowing users to swiftly connect with emergency services from their caregivers, enhancing their overall security[3].

Furthermore, this project introduces an intuitive audio feedback system employing voice prompts and sensory signals. This system offers real-time environmental information, identifying obstacles and guiding users safely through intricate spaces[4]. Functioning as the user's virtual eyes, this auditory interface imparts essential details about their surroundings, facilitating informed decision-making and nurturing a sense of independence.

1.1.1 Problem Statement

The development of a blind stick project for visually impaired individuals aims to address a myriad of challenges faced by the blind community in their daily lives. One primary concern is the need for efficient object detection, where the blind person must navigate through their surroundings without the ability to visually identify obstacles or potential hazards. Traditional canes lack the technological sophistication required for real-time detection of objects, making it difficult for users to navigate safely through crowded or unfamiliar environments. Furthermore, the blind face the peril of encountering potholes and uneven surfaces, posing a significant threat to their safety and mobility. Pothole detection becomes crucial in preventing accidents and ensuring a smooth and secure journey. Additionally, the blind often struggle with detecting slopes or changes in terrain, making it challenging to adapt their movement accordingly. The blind stick project aims to address this issue by incorporating slope detection technology, offering users a more comprehensive understanding of the ground they traverse. Moreover, the fear of getting lost is a constant worry for visually impaired individuals. The blind stick project endeavors to provide emergency assistance features to mitigate this concern. In cases of disorientation or being lost, the device can facilitate immediate help by establishing a connection with emergency services or providing location-based information to guide the user back to familiar surroundings. By tackling these fundamental challenges, the blind stick project aims to enhance the independence and safety of visually impaired individuals, allowing them to navigate the world with greater confidence and ease.

1.1.2 Background Study

Visually impaired people face challenges while navigating through unfamiliar environments. They heavily rely on their sense of touch and hearing to detect obstacles and determine the direction of their movement. As stated in B.N. and Y. Athave's research [1], vision is the most important aspect of human psychology and it accounts for 83% of the information obtained from the environment. In a research [2] conducted by Ayat A. Nada from Electronics Research Institute, Giza, Egypt, stated that WHO has reported that approximately 285 million people are visually impaired, 39 million of them are totally blind. This statistic mostly consists of African and other developing countries. In Bangladesh alone, around 1.5 million children are suffering from low vision, which can be avoided through intervention while around 250,000 people in Bangladesh risk losing eyesight because of diabetic retinopathy [3].

The most tedious aspect visually impaired people face is commuting on their own, because not all of them have guides or helpers with them at all times. Walking in heavily crowded areas and roads with unpredictable traffic like our country is highly challenging for them. They often encounter obstacles that are not in their reach or are too silent to be detected. Additionally, a standard white cane may not give a blind person enough information about their surroundings to allow them to travel properly. The cane can identify obstructions on the ground, but it cannot tell you about obstructions above you or obstructions that are not on the ground, including low-hanging trees or overhead signage. A white cane is also useless for determining how the height or slope of the ground has changed. [4]. In order to boost their freedom and safety, it is necessary to create a blind stick that can help individuals who are blind or visually impaired identify impediments above and below the ground and give them a more precise feeling of their surroundings.

As we talked with Md. Arif Hossen who is a visually impaired person is capacity development officer at VIPS (Visually Impaired People Society) states many challenges such as distinguishing objects when he walks in the streets. According to him, visually impaired people face difficulties pinpointing the exact type of object and obstacles[5]. They can not identify if the object is too large to avoid or too small to ignore. They need to tell if there is a half length or full length wall in front of them. They also can not tell if the object is obstructing their path only partially. They also can not identify if there is a moving object in front of them or how fast that object is passing by or coming towards them. They also face difficulties in uneven pathways, mud and potholes.Numerous items currently exist, but they either don't fulfill their demands or are too pricey for them to purchase.

Addressing the limitations of traditional white canes, the Blind Stick Project offers a comprehensive solution to enhance the navigation experience of visually impaired individuals in unfamiliar environments. These individuals face significant challenges in their daily lives, especially when moving from one place to another. Conventional blind walking sticks, with their inherent limitations, fail to provide adequate assistance[6]. Our research is motivated by the struggles faced by physically disabled individuals in their mobility. Through this project, we aim to simplify their everyday lives and make mobility effortless and trouble-free.

The Global Positioning System (GPS) and ultrasonic waves are only a few examples of the detecting technologies that are employed in research and commercial products to address the aforementioned issues. There have been several methods that employ GPS to locate and guide the blind in urban settings [7]. The GPS-based Navigation System is a commercial product that uses satellite signals to locate a user in an approximate range of 20 m. Electronic Travel Aids (ETAs) devices have recently been introduced as a mobility aid for the blind. ETAs are devices that contain sensors that alert the visually impaired people to the presence of obstacles via vibration and sound [8].

The Blind Stick Project creates an affordable, lightweight device with ultrasonic sensors and image processing to aid visually impaired individuals in safe, independent travel, addressing the limitations of conventional white canes.

1.1.3 Literature Gap

In the field of assistive technologies for the visually impaired, a significant literature gap exists in integrating audio feedback, precise location tracking, and emergency messaging via GSM. While previous efforts focused on individual aspects, none have successfully synthesized all three functionalities [1]. Current projects often address isolated components, leaving a void in providing a unified solution for the diverse needs of visually impaired users. Our groundbreaking innovation, the GPS GSM-enabled blind stick with integrated sensors and audio assistance, strategically bridges this gap by offering a holistic approach. By seamlessly combining real-time audio feedback for environmental awareness, GPS-based precise location tracking, and emergency messaging through GSM, our device represents a pioneering advancement in the field [2][3]. This comprehensive solution not only enhances safety and independence but also sets a new standard for efficiency in assistive technology for the visually impaired.

This integrated solution not only enhances the safety and independence of visually impaired individuals but also elevates the overall efficiency and effectiveness of mobility assistance technology. By bringing together these essential features, our project represents a significant leap forward, setting a new standard for comprehensive assistive devices[5]. In essence, our initiative not only identifies and acknowledges the existing literature gap but also establishes a pioneering benchmark for future innovations, demonstrating a commitment to empowering visually impaired users across various facets of their daily lives.

1.1.4 Relevance to current and future Industry

The GPS GSM based blind stick for visually impaired people holds immense relevance for both current and future industries. In the present context, as technology becomes more inclusive, industries are recognizing the importance of creating solutions that cater to diverse user needs. This innovative assistive device aligns perfectly with this trend, addressing a critical need in the visually impaired community. Moreover, as the global population ages, the number of visually impaired individuals is expected to rise, amplifying the demand for such assistive technologies. Industries focusing on accessibility and assistive devices are witnessing a significant paradigm shift towards incorporating smart, user-friendly solutions. The GPS GSM based blind stick not only enhances mobility and safety for visually impaired individuals but also presents opportunities for companies to invest in socially responsible technologies. Looking into the future, the industry is likely to witness further advancements and integrations, making such devices even more sophisticated and indispensable, thereby transforming the lives of visually impaired individuals on a broader scale.

1.2 Objectives, Requirements, Specification and Constraints

The objective of the blind stick project is to develop an assistive device that empowers visually impaired individuals to travel independently and safely. This device utilizes ultrasonic sensors to detect obstacles and provides audible feedback. Additionally, it incorporates image processing technology to accurately identify nearby objects. The stick is designed to be lightweight, portable, and affordable, ensuring usability for a diverse user base. It prioritizes simplicity and intuitiveness, enabling immediate adoption by blind users.

1.2.1. Scope and Objectives (CO1)

- Create a device that can detect obstacles, people, potholes and alert the user through sound or vibration feedback in any environment.
- To provide a superior aiding system for the visually impaired which makes them independent in terms of mobility.
- To reduce the risk of accidents and injuries for visually impaired individuals by providing them with an effective obstacle detection and navigation system.
- To create a cost-effective and portable solution that can be used by visually impaired individuals of all ages and backgrounds.
- To develop a system that can be easily integrated with existing assistive technologies and devices.
- To promote awareness and understanding of the challenges faced by visually impaired individuals and advocate for their inclusion in society.

1.2.2 Functional and Nonfunctional Requirements

Functional requirements

- The use of an ultrasonic sensor helps in understanding the reliable approximations of distance measurements. The sensing range lies between 40 cm to 130 cm.
- Correct angular placement of Ultrasonic sensor for obstacle detection which will rotate 0-180 degree to sense the surrounding obstacle and moving object.
- If any incident occurs with a user or for any emergency reason, the system will use an algorithm that will share the possible accurate location (±20m) of the user to send an SOS message to the user's supervisor if he/she wants help.
- User will hear the navigation sound through microphone/speaker within 0.05 second after detecting the obstacle
- Proper placement of sensor probes to ensure the best contact with the processing unit to get maximum accurate output to keep the user safe which can be at the bottom of the stick.

Non-functional requirements

- Sticks size can vary as per users height. Normally it is 3-4 feet.
- The stick's component should be covered properly as if it doesn't get any harm when rain occurs.
- The design should not be very complicated and it should be user-friendly to ensure overall usability.
- Intuitive user interaction features will be implemented as per request if it will be great help for them.
- According to stakeholder requirements, the design should be affordable and easy to use for them.

1.2.3 Specifications

Table 1.1 : System Level Requirement

SL No.	System level	Specifications
01	**Detecting obstacles**	The stick should be able to detect obstacles in the user's path in the range 40 cm to 130cm (2m) using sensors(i.e. ultrasonic sensor or cameras)
02	**Processing Unit**	The Arduino Uno microcontroller serves as the processing unit for the stick, overseeing the device's functionalities, handling sensor data processing, and generating haptic feedback. For optimal performance, the microcontroller features sufficient memory, high processing speed, and low power consumption, ensuring the seamless operation of the assistive device.

03	**Providing feedback**	The device needs to deliver feedback to the user within 0.5 seconds of obstacle detection, employing ultrasonic sensors for object and pothole identification. This feedback is facilitated through a combination with auditory signals, ensuring a swift and multi-sensory alert system.
04	**Navigation & Emergency Assistance**	The device is expected to provide navigation support by giving directions and distances. In emergencies, it utilizes GPS and GSM for functions like alerting emergency services or calling the user's supervisor for help. This integration enhances the device's ability to guide the user and ensures a prompt and effective emergency response.

Table 1.2: Component Level Specification

Sl.	Component	Model	Specification	Component Description
1.	Micro-controller	Arduino Uno R3/ Raspberry Pi 4	**Arduino Uno R3:** **Operating Voltage :** 5V. **Input Voltage (recommended) :** 7-12V. **Digital I/O Pins:** 14 (of which 6 provide PWM output). **Analog Input Pins :** 6 **Weight:** 28g (without cable) 54g(with cable)	Arduino Uno is used for small, low-power, and low-cost computing devices that is capable of processing sensor data in real-time and controlling the output to the user. It would receive input from the sensors (such as ultrasonic or infrared sensors), process this data using algorithms and provide feedback to the user using actuators (such as vibration and sound) .

			Raspberry Pi 4: Quad-Core 64-bit Broadcom 2711, Cortex A72 Processor **Weight: 5**2g WLAN 802.11 b/g/n/ac (2,4 + 5,0 GHz**)** **LAN** RJ45 10/100/1000 Mbit (Gigabit LAN over USB 3.0) **Operating Power** 5V, 3A via USB Type-C port **Dual-Display** Micro HDMI Ports which supports H 265 Decode for 4K Video,60p	Raspberry Pi is a single-board computer that is for some reasons in a blind stick: **Processing power:** Raspberry Pi has a powerful processor and can handle complex tasks such as image recognition, which can be useful in a blind stick. It can be used to identify and provide information about objects in the user's environment. **Connectivity:** Raspberry Pi has built-in Wi-Fi and Bluetooth connectivity, which can be useful in a blind stick. For example, it can be used to connect to a mobile app or other devices for additional functionality. **Expandability:** Raspberry Pi has a wide range of input/output (I/O) pins that can be used to connect to various sensors and actuators, making it a versatile platform for a blind stick. **Customization:** Raspberry Pi is an open-source platform, which means that it can be customized and programmed to suit the specific needs of a blind stick. This allows for greater flexibility in the design process and the ability to tailor the device to the user's needs

2.	GPS GSM GPRS	SIM808 Module	**Quad-band:** 850/900/1800/1900 MHz **GPRS multislot class12 connectivity:** max. 85.6kbps(down-load/up-load) **GPRS mobile station class:** Controlled by AT Command (3GPP TS 27.007, 27.005 and SIMCOM enhanced AT Commands) **Weight:** 17g **Supports Real-Time Clock** **Integrated GPS/CNSS and supports A-GPS** **Low power consumption, 10mA in sleep mode.**	**GPS:** GPS (Global Positioning System) is used to provide location-based information to the user. A blind stick with GPS can help the user navigate to a specific location, such as a store or a bus stop. It can also provide information about nearby points of interest, such as restaurants or landmarks. Additionally, GPS can be used to track the user's movements, which can be helpful in case of an emergency. **GSM:** GSM (Global System for Mobile Communications) is a mobile communication standard that allows devices to communicate wirelessly over a cellular network. It is used to send and receive text messages or make phone calls, which can be useful in emergency situations where the user needs assistance. **GPRS:** GPRS (General Packet Radio Service) is a packet-switched wireless data communication service that allows devices to transmit data over a cellular network. A blind stick with GPRS can send and receive data, such as location information or sensor data, to a remote server or caregiver. This can help caregivers monitor the user's movements and provide assistance as needed.

3.	Vibrator	Vibration Motor	**Voltage Range**: DC 2.5-4V. **Motor Diameter:** 10 mm. Motor **Thickness:** 3.4 mm. **Min. Rated Speed:** 9000RPM **Max. Rated Current:** 60mA **Weight:** 10g	Vibrator is used to provide feedback to the user when an obstacle is detected. For example, the vibrator might vibrate more strongly as the user gets closer to an obstacle, warning them to slow down or change direction
4.	Ultrasonic Sensor	HC- SR04	**Operating Voltage:** 5 V **Sonar Sensing Range:** 2-400 cm **Max. Sensing Range:** 450 cm **Frequency:** 40 kHz **Weight:** 9 g	Ultrasonic sensors can detect obstacles in the user's path and provide haptic feedback to the user, such as through a vibrating motor. By measuring the distance to the obstacle, the ultrasonic sensor can determine how strong the vibration should be to indicate the proximity of the obstacle
5.	Servo motor	SG90	**Model:** SG90 **Operating voltage:** 3.0V~ 7.2V **Servo Plug:** JR **Weight:** 9g	Servo motors are used in blind sticks to provide a rotational movement which is attached with Ultrasonic sensors. A servo motor is a type of motor that can rotate to a specific angle, based on the signal it receives from the microcontroller.
6.	Buzzer Module	PCB Mounted Passive	**Operating Voltage :** 1.5 ~ 15V DC **Working Current:**	A buzzer module is used in a blind stick to provide audible feedback to the user. Buzzer

		Buzzer Module	Less than 25mA **Tone Generation Range :** 1.5 ~ 2.5kHz **Dimensions (LxWxH):** 26 x 15 x 11 mm **Weight:** 1g	modules are small electronic devices that can emit a loud sound that gets louder as the user gets closer to a destination or obstacle, or it might emit a series of beeps to indicate the direction the user needs to go.
7.	Jumper Wire		**Male to Male** **Male to Female** **Female-Female** **2.54mm spacing pin headers**	Jumper wires are used to build a prototype of a blind stick on a breadboard, it is used to connect the components together. This will help to test and refine the design before finalizing it.
8.	Power Supply	Lithium Battery	1. 3.7V 18650 Sanford Rechargeable Battery **Current Capacity:** 1100 mAh (Approx) **Output Voltage:** 3.7 V **Weight:** 50g **Maximum Current Capacity**: 4 A 2. 18650 Lithium Battery Shield V8 Mobile Power Expansion Board Module 5V/3A 3V/1A Micro	Lithium batteries are used in blind sticks for many reasons: **High energy density:** Lithium batteries have a higher energy density than most other types of batteries, meaning they can store more energy in a smaller and lighter package. This is particularly important for a blind stick, as it is designed to be carried and used by the user, who may have limited mobility. **Longer lifespan:** Lithium batteries have a longer lifespan than most other types of batteries, meaning they can provide power for a longer period of time before needing to be replaced. This can reduce the need for frequent battery replacements and improve the overall reliability of the blind stick. **Faster charging time:** Lithium batteries can be charged more quickly than

			USB for Microcontroller. **Output Port:** USB or expansion **Output parameter:** 5V/3A or 3.3V/1A **Input Port:** Micro USB	most other types of batteries, meaning the blind stick can be ready for use more quickly. This is particularly important for users who need to rely on their blind stick for daily mobility. **Improved safety:** Lithium batteries are generally considered to be safer than other types of batteries, as they are less prone to leakage or overheating. This is particularly important for a device like a blind stick, which is designed to be used by individuals with disabilities.

1.2.4 Technical and Non-technical consideration and constraint in design process

Technical consideration

- Integration of GPS technology for accurate location tracking.
- Implementation of GSM modules for real-time communication and emergency messaging.
- Development of ultrasonic sensors for obstacle detection.
- Designing a user-friendly interface for intuitive interaction.
- Ensuring lightweight and portable hardware components for ease of use.
- Battery optimization for prolonged usage without frequent recharging.

Non-technical consideration

- Compliance with accessibility and disability regulations and standards.
- Affordability and cost-effectiveness for widespread adoption.
- User acceptance and ease of learning for visually impaired individuals.
- Collaboration with relevant organizations and institutions for user testing and feedback.

Constraints

- Need some time to get help from a Smartphone holder with GPS capability for receiving location data sent by the user.
- The blind stick's reliance on technology raises the question of whether visually impaired individuals may become too dependent on the device, potentially reducing their ability to navigate unfamiliar environments without it.
- If the device malfunctions or breaks down, it may leave the visually impaired user in a vulnerable position.
- The blind stick requires power to operate. It relies on a battery to power the device's sensors and audio feedback system. If the battery life is short, the device may not be reliable or practical for the visually impaired user to depend on.

1.2.5 Applicable compliance, standards, and codes

IEEE SA - P1451.99
This standard defines a method for data sharing, interoperability, and security of messages over a network, where sensors, actuators, and other devices can interoperate, regardless of underlying communication technology.

ISO/IEC 21989:2002
Information technology — Telecommunications and information exchange between systems — Private Integrated Services Network — Specification, functional model and information flows — Short message service.

IEEE SA - P3109
This standard defines a binary arithmetic and data format for machine learning-optimized domains. It also specifies the default handling of exceptions occurring in this arithmetic.

IEEE SA - P3123
The standard defines specific terminology utilized in artificial intelligence and machine learning (AI/ML). The standard provides clear definitions for relevant terms in AI/ML. Furthermore, the standard defines requirements for data formats.

IEEE SA - IEEE 2030.101-2018
The design, installation, and monitoring of time synchronization systems in power utility substations are covered. This includes time sources such as Global Positioning Satellite (GPS).

IEEE SA - IEEE 1625-2008
This standard establishes criteria for design analysis for qualification, quality, and reliability of rechargeable battery systems for multi-cell mobile computing devices.

IEEE SA - IEEE 802.11-2016
IEEE Standard for Information Technology--Telecommunications and information exchange between systems Local and metropolitan area networks—Specific requirements—Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications.

IEEE Std 29148-2018
Recommended Practice for Software and System Requirements Engineering

IEEE P1788/D
11.0 Standard for Interval Arithmetic

IEEE Std 802.15.4
Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low-Rate Wireless Personal Area Networks (WPANs)

IEEE Std 802.11
Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications

IEEE 802.3af-2003
Power over Ethernet (PoE) Standard

1.3 Systematic Overview/summary of the proposed project

The blind stick is a revolutionary project designed to enhance mobility and safety for visually impaired individuals. This assistive device integrates ultrasonic sensors, GPS, GSM, and an audio feedback system to provide real-time information and navigation assistance.

- **Sensor Data Acquisition**

The blind stick employs ultrasonic sensors for obstacle detection, another ultrasonic sensor for stairs and pothole detection offering tactile or auditory feedback creating a robust obstacle detection mechanism.

- **GPS (Global Positioning System)**

A built-in GPS module accurately determines the user's location, facilitating real-time mapping and providing audible instructions for seamless navigation. This feature is instrumental in optimizing routes and increasing spatial awareness.

- **GSM (Global System for Mobile Communications)**

The GSM module enables communication with a centralized system. In emergencies or predefined situations, it can send alerts and messages to caregivers for emergency services.

By pressing a push button the visually impaired individual can send the location through a SMS in the caregiver's mobile phone.

- **Audio Feedback System**

An integral component, the audio feedback system conveys critical information to users in a clear and understandable manner through a speaker or earphones. Through a combination of pre-recorded messages and synthetic speech, users receive guidance about obstacle proximity, directional changes, and other essential details.

- **Working Mechanism**

Sensors continuously scan the environment, relaying obstacle information to the control unit. The GPS module updates the user's location, providing navigational instructions. In the presence of obstacles, the audio feedback system guides users to navigate safely. The GSM module ensures communication for emergencies. The Sensor, GPS, GSM, and Audio Feedback-Based blind stick project is a significant stride in addressing the mobility challenges faced by the visually impaired. Regular refinement and user feedback will play a pivotal role in further enhancing the device's efficacy and user experience.

1.4 Conclusion

To conclude, the Blind Stick project, integrating Sensor, GPS, and GSM technologies with Audio Feedback, holds tremendous potential for transforming mobility and safety for individuals with visual impairments. The combination of ultrasonic and infrared sensors ensures a robust obstacle detection system, providing users with prompt feedback. The GPS module facilitates accurate navigation and real-time mapping, promoting spatial awareness. The incorporation of a GSM module establishes crucial communication capabilities for emergency alerts. The user-friendly Audio Feedback System, utilizing pre-recorded messages and synthetic speech, enhances overall usability. Looking forward, ongoing refinement guided by user feedback positions this blind stick as an innovative solution not only for immediate challenges but also as a platform for continual advancements in assistive technology, significantly improving the quality of life for those with visual impairments.

Chapter 2: Project Design Approach [CO5, CO6]

2.1 Introduction

We developed two design approaches which will give us the desired results. These two systems have different working methods but share similar outcomes. While designing these approaches, we maintained the design standards and integrity.

2.2 Identify Multiple Design Approach

The 'GPS GSM-enabled blind stick integrated with sensors and audio assistance' project explores two design approaches. The first utilizes Arduino Uno for central processing, relying on ultrasonic sensors for obstacle detection and integrating GPS/GSM for location data. In contrast, the second design employs Raspberry Pi with a camera module for image processing. This approach analyzes real-time visual data to detect obstacles, providing auditory guidance. Both designs aim to enhance the efficiency of the blind stick, catering to the diverse needs of visually impaired individuals through sensor-based and image processing-based methodologies.

2.2.1 Design Approach 1: Sensor Based Blind Stick

Our first design is based on Arduino Uno as the central processing unit and obstacle detection is performed through Ultrasonic Sensors. This approach is solely based on inputs processed from the sensors and location sharing from the GPS/GSM system.

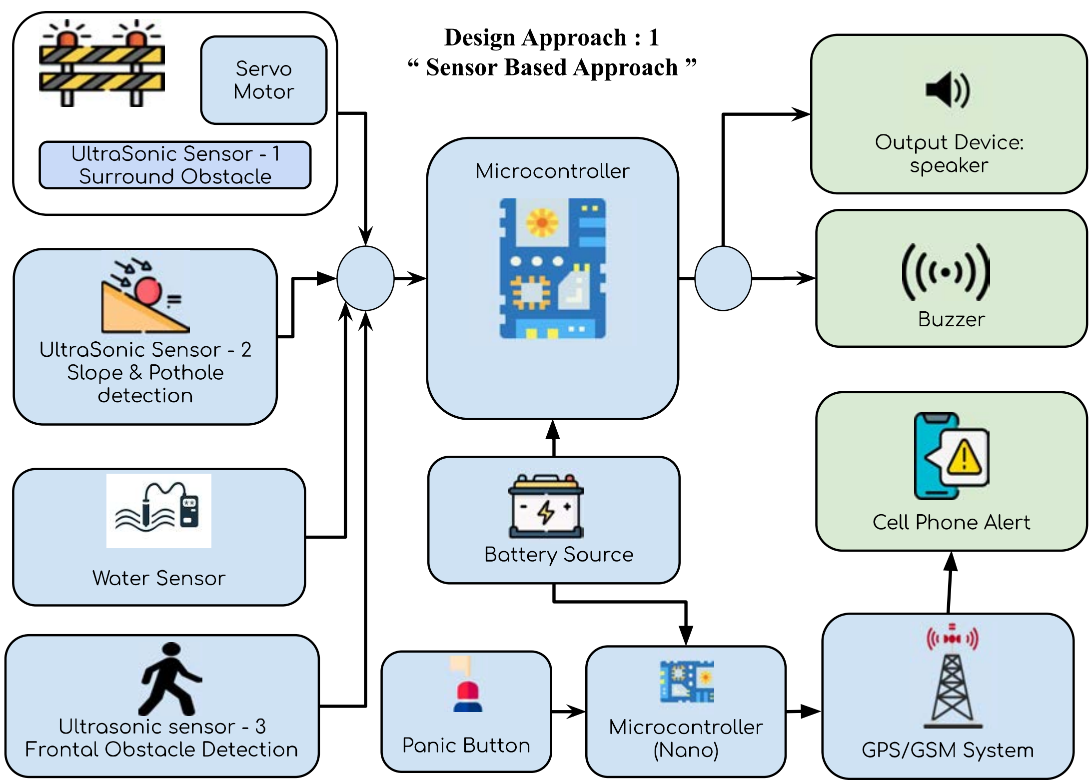

Figure 2.1: Sensor Based Blind Stick

2.2.2 Design Approach 2: Blind Stick using Image Processing and Data

Our second design is based on Image Processing where Raspberry Pi is used as the central processing unit. Here, a built-in camera module is used for object detection to indicate if there are any objects in front of the user and giving proper guidance through auditory output.

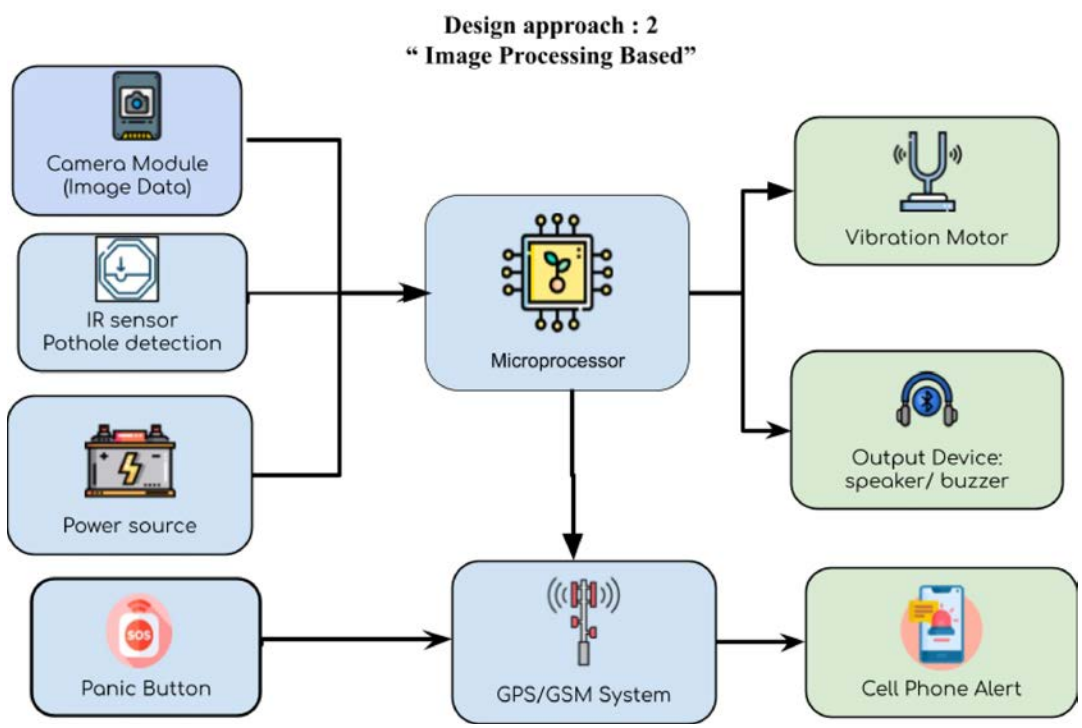

Figure 2.2: Blind stick using Image Processing and Data

2.3 Describe Multiple Design Approach

2.3.1 Design Approach 1:

For our first design, we choose to go with Arduino Uno as our central processing unit which will control all the sensors for the proper function of the stick. There are 2 ultrasonic sensors in this system, one is connected with a servo motor to sense objects on either side of the user, the other one will detect objects straight ahead of the user.[6] There are also vibrator motors in the handle and water detection sensor at the bottom of the stick to indicate the user if any moving object is getting near them or if they are moving towards any muddy or wet area.[7]
Moreover, the user can have auditory indication with the help of a bluetooth module and earpiece to get auditory feedback from the sensors. For the remote monitoring system, we have also implemented a GPS/GSM system for the helpers or relatives of the user to receive an emergency SOS signal through a message if the user faces any troubles, allowing them to share their exact location. This process will be done simultaneously at the press of a panic button in the handle area, which users can use if they are lost and need assistance. This whole process can be powered by a Li-ion battery which is rechargeable.

2.3.2 Design Approach 2:

In our second design, we plan to utilize Raspberry Pi as the central controller. As its capabilities are more advanced than that of Arduino UNO, we can use image processing in this design to better identify incoming and passing objects.[8]
We will use a front-facing camera for object detection through image processing which can let the user know through auditory output via bluetooth module and earpiece what exactly is in front of them. There is also a buzzer attached to the stick for instant alert. Just like the previous design, we utilize a GPS/GSM module to send location data through cell phone messages to emergency contacts at the push of the panic button.[9]
The most challenging aspect of this model is the system for better image recognition by giving various types of image data. Using Raspberry Pi can increase the cost of this project significantly, while also providing better navigation.

2.4 Analysis of Multiple Design Approach

Table 2.1: Comparison between Multiple Designs

Criteria	**Design Approach 1**	**Design Approach 2**
Efficiency	Sensor inputs and data processing is very simple computation.	Image processing method is much advanced even though relying very much on the environment and increasing computing power usage.
Usability	Higher response time, better precision, intuitive method.	Lower response time and complex working method.
Manufacturability	Easy to integrate and simple production with ready-to-go parts.	Components are more expensive, making repair works difficult and costly.
Maintainability	Robust, less processing overhead, minimal maintenance effort needed.	Complex algorithm development, resource intensive, environmental variability.

2.5 Conclusion

We have selected the most suitable approach keeping the above mentioned criteria in mind. Based on the research and facts presented, design approach 1 is the best option for physical implementation. The results from this design will be just according to our target and will serve better serviceability.

Chapter 3: Use of Modern Engineering and IT Tool. [CO9]

3.1 Introduction

To verify our plan to develop the prototype , we need to do some pre-calculation to find an appropriate approach to implement. Nowadays, there are thousands of software available to pre-calculate those methods to find out the best approach for engineering design. Moreover, while implementing the prototype, we had to use different engineering tools to demonstrate the design we selected. Though there are millions of engineering tools available everywhere, finding an accurate one is quite challenging. However, we came to find out a few software tools among those thousands and hardware tools to implement them .

3.2 Select appropriate engineering and IT tools

Hardware tools	Software Tools
Arduino UNO	Proteus
Ultrasonic Sensors	Arduino IDE
Speakers	PyCharm
DFplayer Mini	TinkerCAD
GPS GSM Module	

3.3 Use of modern engineering and IT tools

Combination of software and hardware tools has been used in the project to make it feasible. These tools help to figure out the easy way to do that.

3.3.1 Software Tools

To simulate our prototype and its circuit , we have used a few software's in the computer. these IT Tools are,

PROTEUS

We have used "Proteus 8 professional v8.15" to simulate the sensor and microcontroller mechanism. Proteus allows users to create electronic circuit designs using a graphical user interface (GUI). It provides an extensive component library that includes a wide variety of electronic components, such as resistors, capacitors, integrated circuits (ICs), and microcontrollers. One of the key advantages of Proteus is its simulation capabilities. Users can simulate their circuit designs and test their functionality before manufacturing or building the physical circuit. The simulation results help identify potential issues, validate the circuit's behavior, and optimize the design.

Arduino IDE

Internal code of the microcontroller was performed by “Arduino IDE v2.1.0”. The Arduino IDE (Integrated Development Environment) is a software application used for writing, compiling, and uploading code to Arduino microcontrollers. It provides a simplified and user-friendly platform for programming Arduino boards, making it accessible to both beginners and experienced developers. The Arduino IDE uses a simplified programming language based on C/C++. It abstracts many low-level details, making it easier for beginners to learn and use.The IDE provides built-in support for a wide range of Arduino boards, including the popular Arduino Uno, Arduino Nano, and Arduino Mega. It includes pre-configured settings for each board, simplifying the process of selecting the appropriate board and setting up the programming environment.

PyCharm

We used the “PyCharm 2023.1.3” to simulate voice feedback and to demonstrate image processing of design approach 2. PyCharm, as an integrated development environment (IDE), is primarily designed to provide a convenient and productive environment for software development.PyCharm has excellent support for Python, which is a popular programming language for image processing tasks. Python offers numerous libraries and frameworks, such as OpenCV, Pillow, scikit-image, and NumPy, that provide extensive functionality for image processing. PyCharm's Python integration allows developers to leverage these libraries effectively and write clean, well-structured code for image processing tasks. Moreover, PyCharm's code editor provides features like code completion, syntax highlighting, and code navigation that can significantly improve productivity when working with image processing code. These features help developers write and manage complex image processing algorithms, ensuring code correctness and reducing errors.

TinkerCAD

TinkerCAD is an open-source web application ,which provides Online facilitates to create 3D drawings, electronics, and coding projects. With basic forms and tools, we may design anything, from simple designs to intricate creations. Discover how to utilize Arduino, 3D printing, and Scratch. It allows users to export works to other platforms and formats or share them with the TinkerCAD community. That helps to mashup them to create a unique look by going through the millions of designs created by other users in the gallery.

3.3.2 Hardware Tools:

To make the project feasible , we have used a few electronic hardware. these things are:

Arduino UNO

The Arduino Uno is a popular microcontroller board, developed by Arduino, used for DIY electronics projects. It features the Atmel ATmega328P microcontroller chip and is known for its user-friendly design and open-source nature. It has digital and analog input/output pins, allowing interaction with sensors, displays, and actuators. Programming is simplified using the Arduino Integrated Development Environment (IDE). The Uno supports various libraries and shields, making it versatile for various projects. Its affordability, extensive online community, and rich documentation make it a popular choice for creative electronic enthusiasts.

Ultrasonic Sensor:

An ultrasonic sensor is a device that detects the distance between a sensor and an object in its area by using high-frequency sound waves that are typically beyond the range of human hearing. These sensors work by giving out ultrasonic pulses and measuring the time it takes for the sound waves to bounce back after hitting an item. The sensor can correctly measure the distance to the item by calculating the time it takes for the sound waves to travel to the object and back. Because of its precision, dependability, and ability to perform in a variety of environmental situations, ultrasonic sensors are widely employed in a wide range of applications, including robotics, automation, and proximity detection.

Speaker:

In our project, the auditory output is facilitated by a robust 5V, 3W speaker, carefully chosen for its efficiency and clarity. This speaker serves as a crucial component, delivering clear and discernible audio feedback to the user. Its 5V power requirement aligns seamlessly with the project's power specifications, ensuring optimal performance. The 3W output capability ensures that the auditory signals, ranging from obstacle alerts to navigation guidance, are loud enough to be perceptible in various environmental conditions. Its thoughtfully chosen specifications make it a reliable and integral part of the project, enhancing the auditory aspect of the user interface for individuals with visual impairments.

DFplayer Mini:

DFPlayer Mini MP3 Player for Arduino, a compact and cost-effective MP3 module is used to seamlessly integrate with the project. This versatile module simplifies audio output by connecting directly to the speaker, making it an ideal choice for our project's auditory feedback system. The DFPlayer Mini can operate as a stand-alone unit with a battery, speaker, and push buttons, or it can be seamlessly integrated with various microcontrollers such as Arduino, ESP32, Raspberry Pi, and others. With its streamlined design and compatibility, the DFPlayer Mini enriches our project's capabilities, offering a convenient solution for processing and delivering essential audio cues to enhance the overall user experience for individuals with visual impairments.

GPS GSM Module:

The GPS GSM GPRS SIM808 module, compatible with Arduino, is a versatile component designed to enhance the functionality of our project. This module seamlessly integrates GPS and GSM technologies, providing precise location tracking and communication capabilities. Its compatibility with Arduino makes it an ideal choice for our project, allowing for easy integration and control. The GPS feature enables accurate navigation assistance, while the GSM functionality facilitates emergency messaging and communication. With its compact design and reliable performance, the SIM808 module becomes the cornerstone of our project, enabling real-time location sharing and emergency alerts. In summary, this component serves as a vital link in our blind stick, empowering it with advanced navigation and communication capabilities for the benefit of visually impaired individuals.

3.4 Conclusion

To conclude, implementing an appropriate approach solely depends on the output of those software analyses. We perform all the simulation to test different approaches, to determine the most efficient process in terms of accuracy, cost-effectiveness and feasibility. These analyses results help us to figure out the appropriate way to develop the device or system.

Chapter 4: Optimization of Multiple Design and Finding the Optimal Solution. [CO7]

4.1 Introduction

For our blind stick we have developed two alternative solutions that can complete our required objective. In our design approach 1 which is sensor based and the design approach 2 which is image processing based, we make a clear understanding of the two procedures with software simulation and compare it by test values.

4.2 Optimization of multiple design approach

The blind stick integrated with sensors and audio assistance' project explores two design approaches. The first utilizes Arduino Uno for central processing, relying on ultrasonic sensors for obstacle detection and integrating GPS/GSM with Arduino Nano for location data. In contrast, the second design employs Raspberry Pi with a built-in camera module for image processing. This approach analyzes real-time visual data to detect obstacles, providing auditory guidance. Both designs aim to enhance the efficiency of the blind stick, catering to the diverse needs of visually impaired individuals through sensor-based and image processing-based methodologies.

4.2.1 Design Approach 01: Sensor Based Blind Stick

Design Approach 1 is mostly focused on aiding the visually impaired by obstacle detection using ultrasonic sensors. All the functionalities of this approach is strictly analog in nature as it does not have any processing requirements.

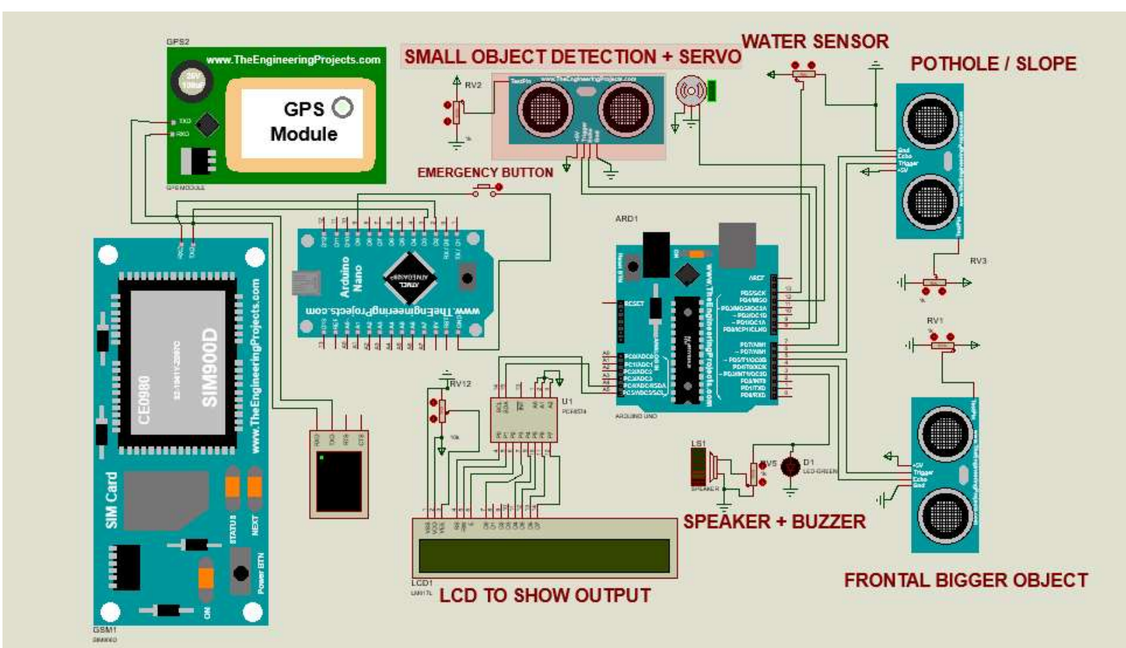

Figure 4.1: Proteus Simulation for Design Approach 01

There are three ultrasonic sensors used for detecting imminent obstacles, potholes and stairs. This is done by accurately measuring the distance between the receiver and reflector soundwave.

Subsystems

Obstacle, Pothole and Wet Surface Detection System: This subsystem utilizes two ultrasonic sensors for two different purposes. One is for stairs,pothole detection and the other will be used for obstacle,object detection. A water sensor is used to detect the wet surfaces to ensure the user's safety.

Navigation System: Integrating GPS technologies, this subsystem assists the user in determining their current location, providing turn-by-turn directions, and aiding in orientation. it increases the user's mobility and navigation without any supervision.

Battery and Power Management System: Responsible for monitoring the battery level of the blind stick and managing its power consumption to ensure optimal usage and prevent unexpected shutdowns.

Feedback and Communication System: This subsystem provides users auditory output as feedback about their environment and the status of the device.

Emergency Connectivity System Module:

The GSM (Global System for Mobile Communications) module enables communication between the blind stick and external devices, such as smartphones or servers, using cellular networks. It allows for remote monitoring and allows the user to seek help in emergency situations. By pressing a push button the user can send his/her location to the caretaker delivering a SOS message with the current location.

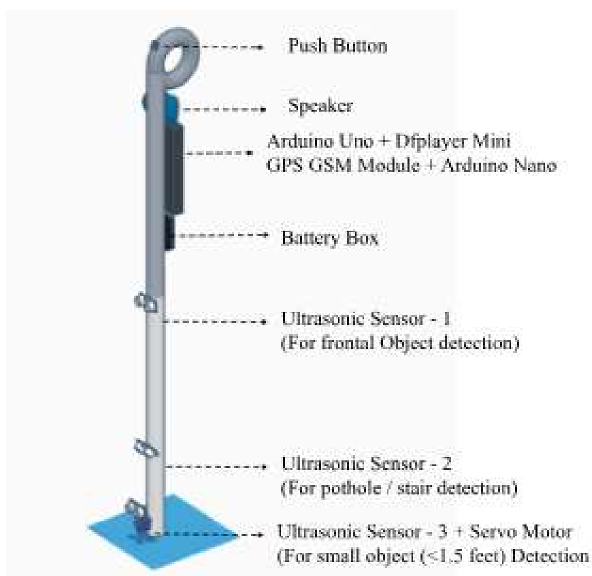

Figure 4.2: 3D diagram of blind stick

Object Detection

One of the ultrasonic sensors detects if there is an obstacle within its range by generating a high-frequency signal beyond the range of human hearing with an oscillator. The signal is then passed to a transducer which emits the signal in varying ultrasonic frequencies. If there are objects within the range of the sensor, the reflected sound will then be processed by the sensor. The delay between the transmission and reception of the sound gives an indication as to how far or how near an object is. The ultrasonic sensor is capable of detecting obstacles up to 10 to 400 cm.

As in it can calculate the distance from the sensor to the object up to that distance. We can configure it to make that distance even shorter. As the user approaches the object, the sensors will give an auditory output through the speaker or vibrate the handle with the buzzer to let the user know that there is an obstacle in their vicinity.

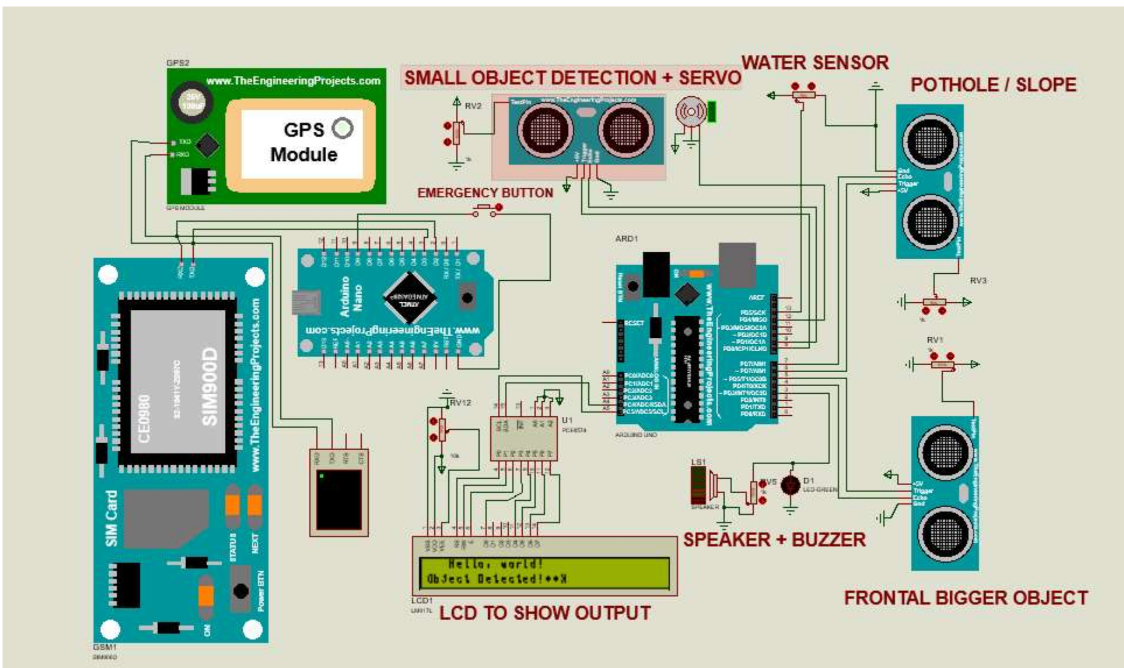

Figure 4.3: Proteus Simulation for Object Detection

Slope & Pothole Detection

We use the other ultrasonic sensor for slope & pothole detection. Ultrasonic sensors use sound waves above the 20 kHz range to detect objects in proximity, similar to how bats use echolocation to maneuver without colliding into obstacles. When a target is in the sensor's field of vision, the ultrasonic sensor (or transducer) creates and transmits ultrasonic pulses that are reflected back towards the sensor. The sensor can record the lag time between the sent and received echo. The measured round-trip time may be utilized to determine the separation between the sensor and the item because the speed of sound is a known quantity.

The time-of-flight measurement used in this ultrasonic sensing technique is based on the sound's propagation time.

In slope detection, ultrasonic sensors are used to detect changes in slope angle which helps to detect stairs such as in upward or downward directed stairs. The idea behind ultrasonic rangefinders is to time how long it takes a signal to travel from the transmitter to the receiver. An ultrasonic sensor uses ultrasonic frequencies, as the name suggests. Ultrasonic frequencies are those frequencies that go outside of our audible range.

This sensor also senses the distance between the stick and the pothole. This sensor provides the distance information to the microcontroller. This is how the system senses potholes and humps and which quantity the height and depth of the potholes based on the acknowledged signals. The projected system is able to classify road surfaces with potholes and non-pothole.

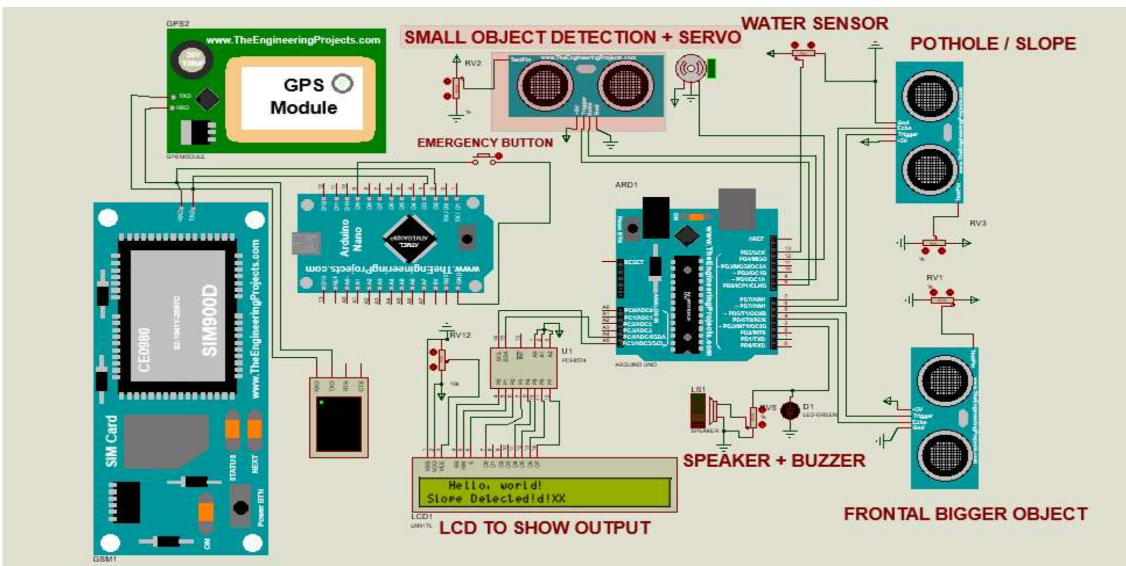

Figure 4.4: Proteus Simulation for Slope Detection

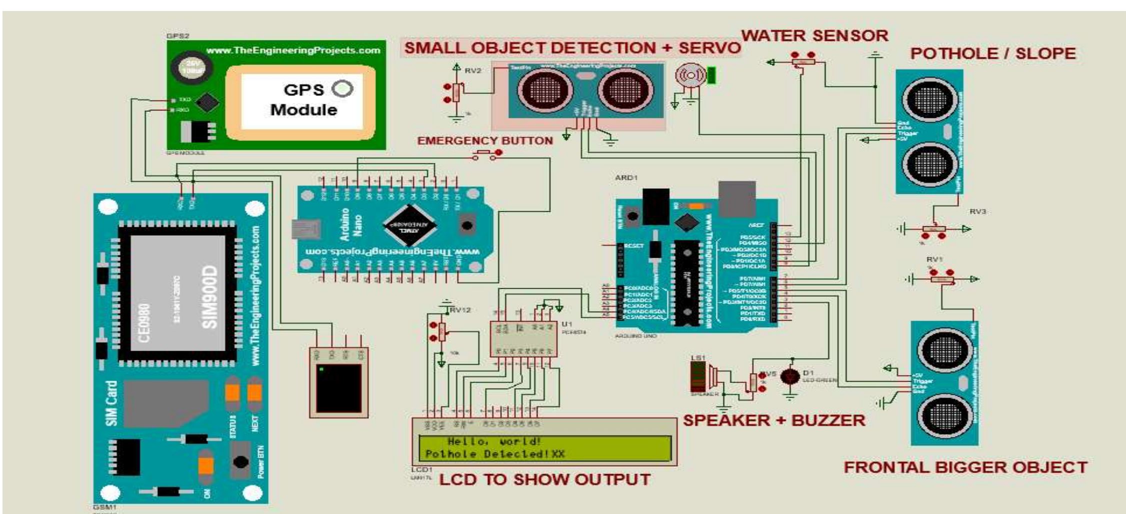

Figure 4.5: Proteus Simulation for Pothole Detection

Wet Surface Detection

There is also a water sensor for muddy roads and watery surfaces. It uses resistance for measuring wet surfaces. In this sensor, we utilize a basic short circuit technique using a microcontroller. We have used one i/o_pin from the microcontroller. We used the pin as an input pin which is also connected with the ground point of the microcontroller, on the other hand a 3.3V wire placed closely (distance in between 2mm). The sensor creates a short circuit while those GND and 3.3V points touch the wet surface and therefore microcontrollers take pulse from the water content of the surface. The sensor takes 5 pulses in a second and then decides the detection of water. While there is no water, resistance between the points becomes infinite whenever those points the water surface creates a short circuit and pulse sends to the microcontroller to decide. Thus the customized water sensor works.

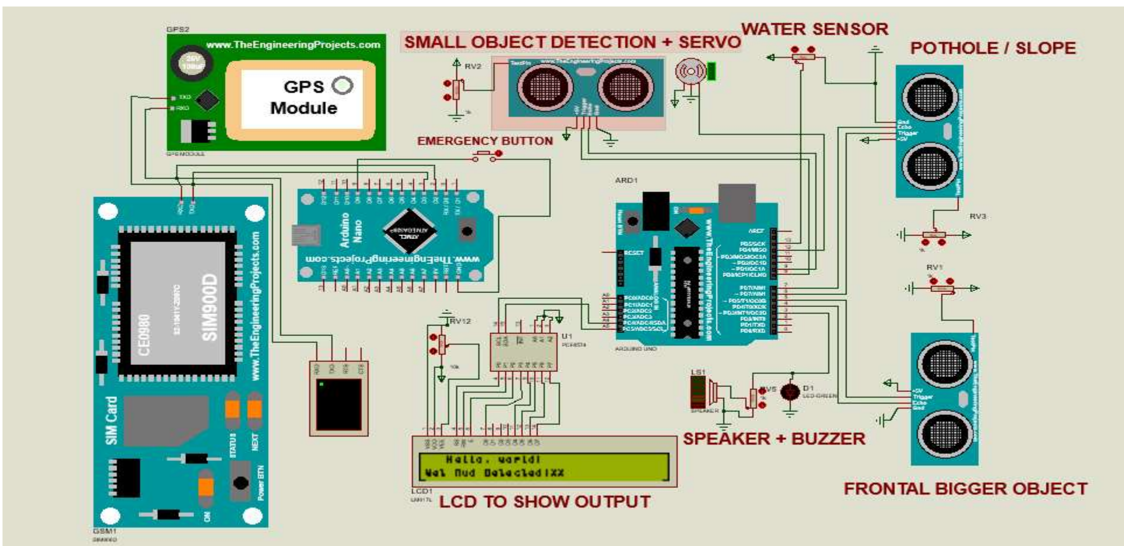

Figure 4.6: Proteus Simulation for Wet Mud Detection

Sending GPS Location Through SMS

A GPS module is installed inside the circuit, which will be detecting the location of the stick continuously. While the user is moving around with the stick and facing some difficulties (i.e: health issue, lost navigation or any unwanted situation) he/she can push the SOS / Emergency button on the stick. Afterwards, the internal GSM module will be activated immediately and collect data from the GPS module to send an urgent message to his relative/guardian phone number. That message will contain the exact location of the user which has been collected from the GPS module. Thus the emergency assistance service will be provided through the blind stick.

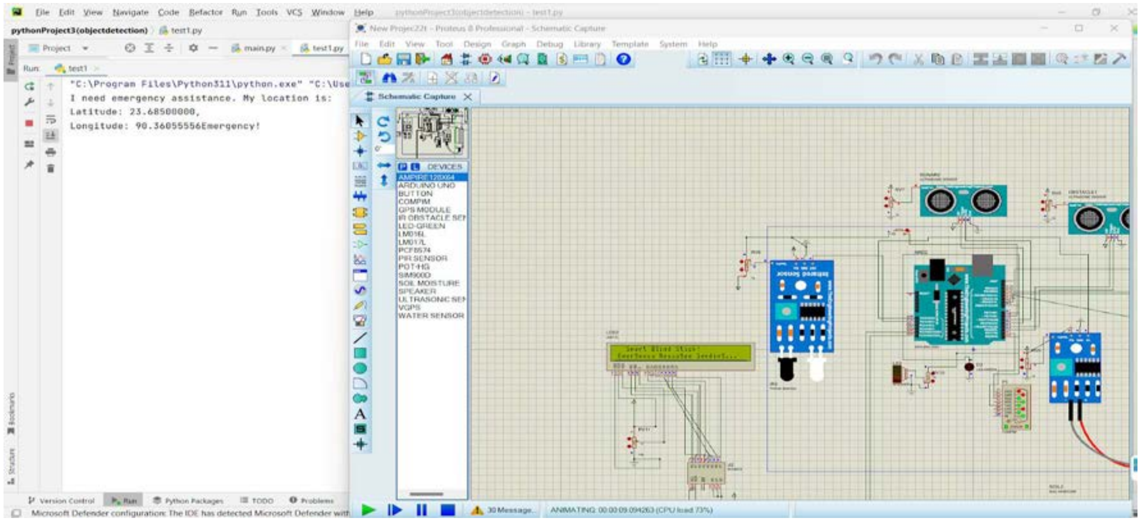

Figure 4.7: Sending location by message in emergency

Battery Charge Level Indication

Enhancing the utility of blind sticks, battery level indication simulation emerges as a crucial feature. For individuals with visual impairments, these sticks are vital for navigation and safety. Simulated battery indication offers predictive awareness, preventing sudden disruptions and optimizing charging routines. Users gain confidence in navigation, emergency preparedness, and enhanced user experience. This feature ensures that individuals can plan their routes effectively, avoid unexpected shutdowns, and confidently navigate their surroundings. That is why we have developed a system that is capable of indicating the battery percentage and will be able to alert the user whenever the charge of the battery is low so that the user can seek help in emergency situations.

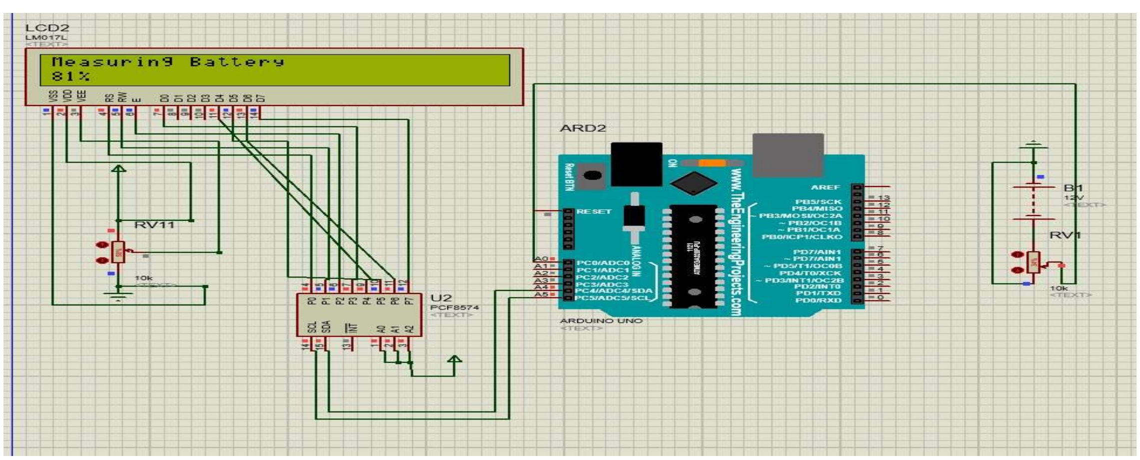

Figure 4.8: Battery percentage level showing and it will be heard by voice

4.2.2 Design Approach 02: Image Processing Based Object Detection

Introduction

Image processing involves manipulating and analyzing digital images to extract useful information or enhance their visual quality. It encompasses a wide range of techniques that can be used to process images acquired from various sources, such as cameras, scanners, satellites, and more. Image processing techniques can be applied to tasks like image enhancement, image restoration, object detection and recognition, image segmentation, and more.

In the context of implementing a blind stick, image processing can play a significant role in enhancing the capabilities of the device to assist individuals with visual impairments. A blind stick is a mobility aid used by people who are blind or visually impaired to detect obstacles and navigate their surroundings more safely. By incorporating image processing technology into a blind stick, its functionality can be greatly improved.

Image Processing Implementation theory

In our design approach here's how image processing will be implemented is described below:

Collecting Image Data:

Collecting image data through cameras involves capturing scenes and objects, converting light into electronic signals. These signals form images, represented as 2D grids of pixels in various color spaces like RGB. These images may have noise and distortion due to factors like lighting and camera quality. The captured data serves as input for diverse image processing tasks, such as filtering, segmentation, and object recognition. Pre-processing techniques can enhance image quality. Challenges include lighting variations, camera quality, and ethical considerations. High-quality image data is crucial for effective image processing outcomes. Here, we have used PiCamera to collect image data.

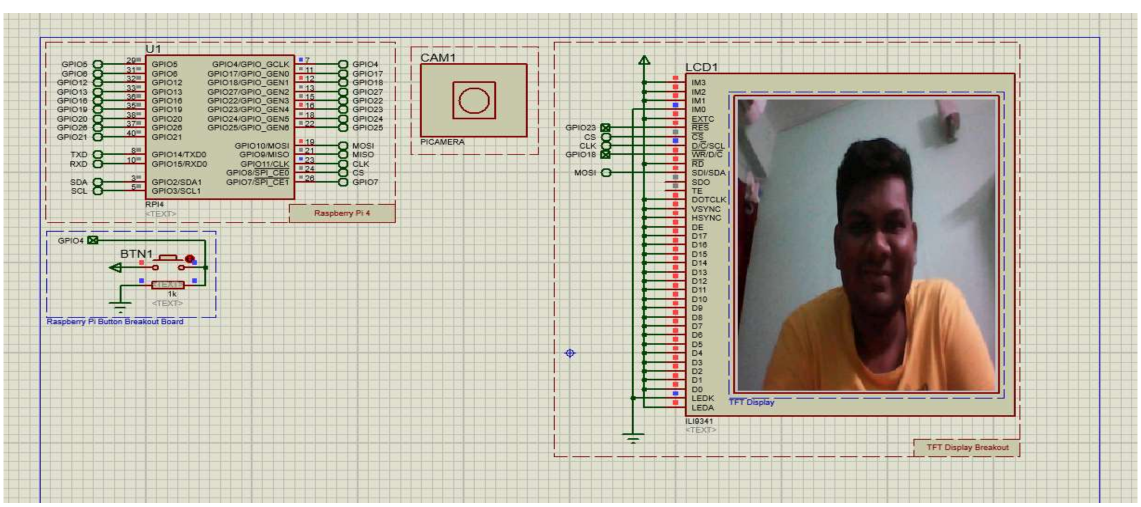

Figure 4.9 : Camera added to Raspberry Pi for collecting Image

Obstacle Detection and Avoidance: Image processing can enable the blind stick to capture images of the user's immediate surroundings using a camera. These images will be analyzed in real-time to identify obstacles such as cars, trees,bicycles, dogs, and people. Once an obstacle is detected, the device will provide feedback to the user, such as vibrating or emitting sound signals, to alert the user about the presence of the obstacle.

Object Recognition: Using image processing techniques like object recognition and machine learning, the blind stick will identify and categorize objects in the environment. This could include recognizing different sizes of people, car, dog or even distinguishing between different types of indoor and outdoor spaces.

At its core, image processing deals with the manipulation of images in two dimensions - rows and columns of pixels that collectively form an image. These pixels, often represented by numerical values, encode the colors, intensities, and textures of the visual content. The techniques used in image processing will be broadly categorized into two main types: image enhancement and image analysis.

Figure 4.10: Object Detection

Image Enhancement:

Image enhancement techniques focus on improving the visual quality of images, making them clearer, more informative, and visually pleasing. This can involve adjusting brightness and contrast, reducing noise, and sharpening edges. One common technique is histogram equalization, which redistributes pixel intensities to enhance image contrast.

Figure 4.11: Image Enhancement for clarify object

Image Analysis:
Image analysis techniques involve extracting useful information from images, requiring the use of complex algorithms and machine learning. Image segmentation divides an image into meaningful regions, allowing individual objects or structures to be analyzed separately. Object recognition and classification are crucial tasks where machine learning algorithms learn to identify specific objects or patterns within images, enabled in blind stick.

(a) (b)

Figure 4.12: An example of images: an image contains a single object (a) and an image contains multi objects (b).

Image Processing Techniques for Object Detection

There are several image processing techniques can be utilized for object detection in a blind stick system which are described below:

Haar Cascades: This is a machine learning object detection method used to identify objects by their features. It's efficient for real-time applications.

YOLO (You Only Look Once): YOLO is a deep learning-based technique that can detect objects in real-time with a single forward pass of the neural network.

Semantic Segmentation: This technique assigns a label to each pixel in the image, effectively outlining object boundaries.

Edge Detection: Detecting edges in an image can help identify the presence of objects based on changes in intensity.

Optical Flow: It's used to track the movement of objects over consecutive frames, aiding in identifying moving obstacles.

Method Comparison:

Table 4.1: Method Comparison

Technique	**Advantages**	**Limitations**
Haar Cascades	Fast processing, suitable for simple object detection	Struggles with complex object variations
YOLO	Real-time performance, high accuracy	Requires significant computational resources
Semantic Segmentation	Detailed object boundaries	Computationally intensive, may not be real-time
Edge Detection	Efficient edge highlighting, useful for object shape	Might miss objects with similar intensity changes
Optical Flow	Tracks moving objects, aids in motion-based detection	Sensitive to noise, may require complex preprocessing

For our design approach we choose YOLO which is an extremely fast multi-object detection algorithm which uses convolutional neural network (CNN) to detect and identify objects. It divides the input image into a grid and predicts bounding boxes and class probabilities for each grid cell. YOLO is known for its real-time performance and accuracy, making it a popular choice for various applications. The object detection accuracy is very high in this technique.
You Only Look Once (YOLO) is a state-of-the-art object detection technique that has revolutionized real-time computer vision applications, including object recognition and tracking. Unlike traditional methods that involve multiple steps and complex pipelines, YOLO approaches object detection as a single end-to-end process, making it highly efficient and accurate for blind sticks for recognizing objects and obstacles.

The YOLO Concept

The fundamental concept of YOLO is to simultaneously predict bounding boxes and class probabilities for multiple objects within an image. This is achieved through a convolutional neural network (CNN) architecture that divides the input image into a grid and performs object detection within each grid cell.

- Grid Division:

The input image is divided into a grid of cells. Each cell is responsible for predicting objects that fall within its boundaries. The size of this grid determines the granularity of object detection. If a given object spans multiple cells, only one cell (the one containing the object's center) is responsible for detecting it.

- Bounding Box Prediction:

For each cell, YOLO predicts bounding boxes that tightly enclose the objects present within the cell. Each bounding box is defined by its coordinates (center x, center y, width, and height) relative to the cell's boundaries. The bounding boxes are adjusted to the original image's size to locate objects accurately.

- Class Prediction:

In addition to predicting bounding boxes, YOLO predicts class probabilities for the detected objects. Each cell's prediction includes a probability distribution across all classes. The class with the highest probability is assigned to the object. This allows YOLO to not only detect objects but also categorize them into different classes.

- Non-Maximum Suppression:

Since multiple bounding boxes may overlap for a single object, a post-processing step called non-maximum suppression (NMS) is applied. NMS removes redundant bounding boxes by selecting the one with the highest class probability and suppresses others that significantly overlap with it.

Figure 4.13: Detecting Object with bounding box with class

Pothole Detection By Using IR

In image processing pothole detection by camera module will be challenging as any shadow dark scene might be detected as a pothole. Which will not be a convenient solution for pothole detection. For this reason we have used pothole detection using infrared (IR) technology on a Raspberry Pi. It involves employing IR sensors to identify road potholes. These sensors emit IR radiation, which reflects differently off the road surface and potholes due to varying textures and depths. The Raspberry Pi processes the received signals, recognizing fluctuations in IR reflection that signify potholes. This data will be used to alert users.

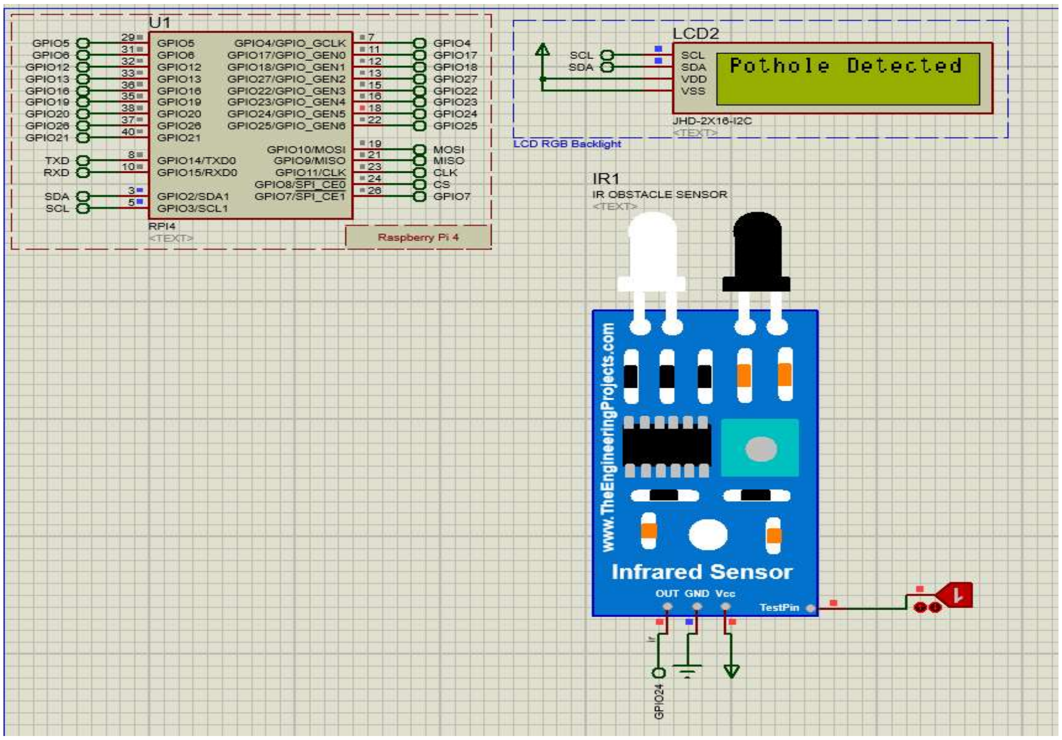

Figure 4.14: Raspberry Pi added with IR sensor for detecting potholes.

Result of our Simulation

In our image processing technique we determined and distinguished different types of objects such as pedestrians, chairs, tools, bikes, bicycles, cars, trucks, trees etc. With the help of voice recognition the system will tell what object is in front.

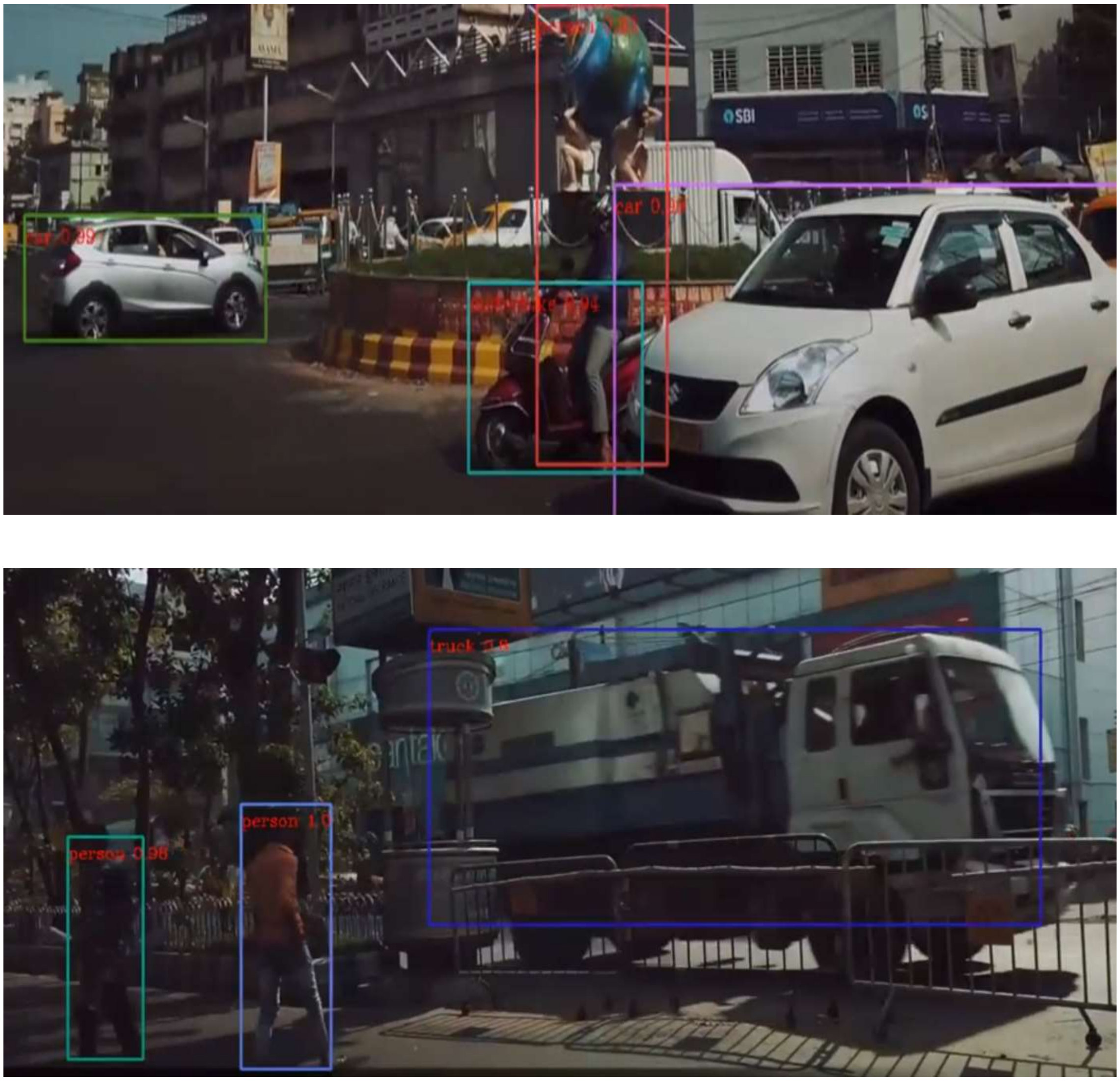

Figure 4.15: Results of Image Processing

4.3 Identify optimal design approach

4.3.1 Efficiency

Design Approach 1: Sensor Based

The sensor-based design method for the Blind Stick for the visually impaired makes use of a variety of sensors to deliver real-time information about the surroundings and potential hazards. To improve the functioning of the stick, this method integrates ultrasonic sensors for obstacle, slope, pothole detection and a water sensor. Here is a thorough explanation of why this strategy is effective.

Experimental Test Values:

Table 4.2: Experimental test value of Design Approach 1

Test	Ultrasonic (Object)	Ultrasonic (Stair & Pothole)	Water Sensor	Emergency Button	GPS Coordinates	System Response
1	125cm	15cm	Dry	No	N/A	No Obstacles, No Stair.
2	140cm	78cm	Dry	No	N/A	No Obstacles, Stair Detected.
3	110cm	125cm	Wet	No	N/A	Object Detected, Pothole Detected
4	180cm	5cm	Dry	No	N/A	No Obstacles, No Stair.
5	45cm	10cm	Dry	Yes (Button)	23°41'39.52"N 90°20'39.6" E	Object Detected, No Stair. Button Pressed
6	200cm	80cm	Wet	No	N/A	No Obstacles, Stair Detected.
7	160cm	10cm	Wet	No	N/A	No Obstacles, No Stair.
8	88cm	140cm	Dry	No	N/A	Object Detected, Pothole Detected
9	150cm	2cm	Dry	Yes	23°41'39.53"N 90°20'39.7" E	No obstacles, No Stair. Button Pressed

Ultrasonic Sensors for Object and Slope Detection:

High-frequency sound waves are emitted by ultrasonic sensors, which determine how long it takes for the waves to return after striking an item. This information aids with obstacle detection and distance calculation. The sensor is very effective for navigation because of its simplicity, precision, and capacity to detect a variety of things. It can give the user immediate feedback, enabling them to maneuver securely and prevent collisions. By supplying details regarding elevation changes, such steps or ramps, it can also aid with slope detection. The blind person may adjust their mobility accordingly to avoid accidents and have a more comfortable navigation experience by recognizing slope

Water Sensor for Wet Mud and Watery Surface Detection:

The functioning of the blind stick is given a special dimension by the incorporation of a water sensor. It can identify slick or muddy roads, warning the user about potential dangers and enabling them to plan their journey wisely.

Location Sharing and Vibration and Auditory Feedback:

With this method, users may instantly communicate their position information with their designated assistance or acquaintances by pressing an integrated panic button. The users may require assistance from their designated assistants or acquaintances, therefore this is vital for them. When they encounter impediments or muddy roads, the vibration sensors and bluetooth module can provide them feedback. For the convenience of the user, the bluetooth module relays audio output to any bluetooth earphone.

Pothole detection using Ultrasonic sensors:

The blind stick utilizes ultrasonic sensors for potholes in the immediate vicinity of the user. It can distinguish between the uneven pavement which can hamper the user’s smooth travel. It will send analog data to the microcontroller which then transmits the data to the user through vibration sensor or audio output.

Design Approach 2: Image Processing Based

In the context of image processing and machine learning, accuracy refers to the measure of how well a trained model is able to correctly classify or predict the labels of input images. Accuracy is typically expressed as a percentage and represents the ratio of correctly predicted instances to the total number of instances in the dataset. However, there are two specific terms that are important in evaluating the performance of a model: "accuracy on training data" and "accuracy on validation data."

i) Accuracy on Training Data:

This refers to the accuracy of a machine learning model when it is evaluated on the same dataset that it was trained on. In other words, the model is making predictions on examples it has already seen during the training process. A high accuracy on training data can suggest that the model has learned to fit the training data well. However, an excessively high accuracy on training data might also indicate overfitting, where the model has learned to memorize the training examples instead of generalizing to new, unseen data.

ii) Accuracy on Validation Data:

Validation data is a separate subset of the data that the model has not seen during training. It's used to assess the model's performance on unseen examples and to tune hyperparameters during the training process. Accuracy on validation data provides a more realistic measure of how well the model is likely to perform on new, unseen data. A high accuracy on validation data indicates that the model has learned to generalize and is capable of making accurate predictions on new instances.

It's important to note that the accuracy on validation data is a better indicator of a model's generalization ability compared to the accuracy on training data. The ultimate goal is to have a model that performs well on unseen data, which is why models are often evaluated based on their performance on validation or test datasets.

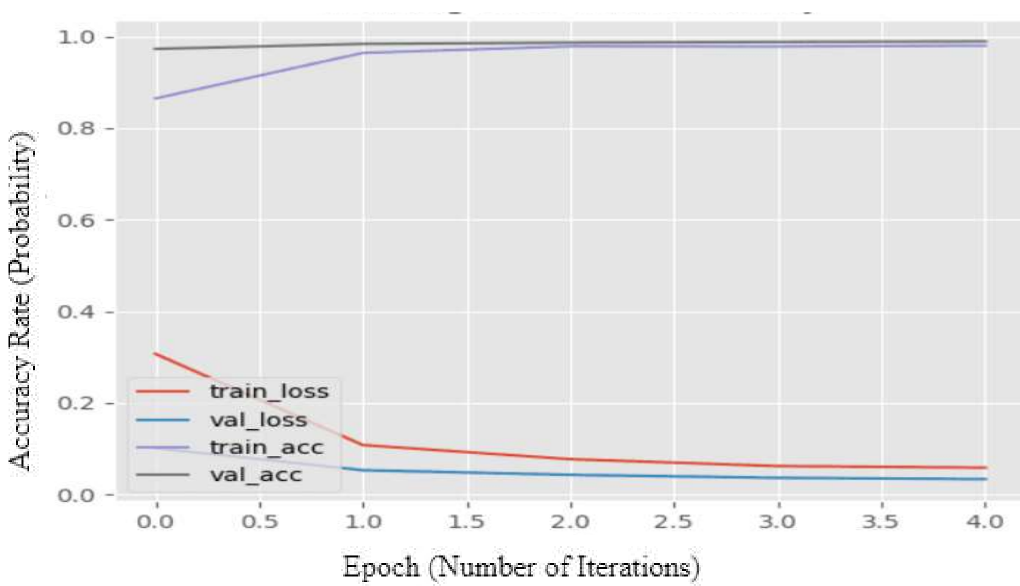

Figure 4.15: Training loss and validation loss comparison graph

In image processing and machine learning, various metrics are used to assess the performance of models during training and validation.

iii) Training Loss and Accuracy: During the training phase, a model is optimized to minimize a loss function. The training loss quantifies the difference between the model's predictions and the actual target values (ground truth) for the training data. Common loss functions for image processing tasks include mean squared error (MSE) for regression problems and categorical cross-entropy for classification problems. As the model trains, it aims to reduce this loss by adjusting its internal parameters.

- **Training Accuracy:** Training accuracy measures the percentage of correctly classified samples in the training dataset. For classification tasks, it indicates how well the model is fitting the training data. However, high training accuracy doesn't necessarily guarantee good generalization to new, unseen data. A high training accuracy coupled with a significantly lower validation accuracy might indicate overfitting, where the model has memorized the training data but doesn't generalize well.
- **Validation Accuracy:** Validation accuracy is a performance metric used to evaluate the accuracy of a machine learning model on a validation dataset. The validation

dataset is separate from the training dataset and contains examples that the model has not seen during the training process. This separation allows for assessing the model's ability to generalize to new, unseen data. Validation accuracy is calculated by dividing the number of correctly predicted instances (true positives and true negatives) by the total number of instances in the validation dataset. A high validation accuracy indicates that the model is capable of generalizing well and making accurate predictions on data that it hasn't been trained on. On the other hand, a large difference between training accuracy and validation accuracy might suggest overfitting, where the model performs well on the training data but poorly on unseen data.

- **Validation Loss:** During training, it's crucial to evaluate the model's performance on data it hasn't seen before to assess its ability to generalize. The validation loss is computed similarly to the training loss but using the validation dataset. This loss provides an indication of how well the model is performing on unseen data. The goal is to find the model that achieves a low validation loss while maintaining good performance on the validation dataset.
- **Overfitting:** Overfitting occurs when a model performs exceptionally well on the training data but poorly on the validation or test data. This happens when the model has learned to capture noise and specific details in the training data rather than the underlying patterns that generalize to new data. Monitoring the gap between training and validation loss is a common way to detect overfitting. A widening gap suggests overfitting, and appropriate steps, such as regularization techniques, should be taken to mitigate it.
- **Early Stopping:** Early stopping is a technique used to prevent overfitting. It involves monitoring the validation loss during training. If the validation loss stops improving or starts increasing after a certain number of epochs, training is stopped early to prevent the model from becoming too specialized to the training data.

In summary, training loss and accuracy are metrics that reflect the model's performance on the training data, while validation loss provides insights into its ability to generalize to new, unseen data. Monitoring these metrics helps in training models that strike a balance between fitting the training data and avoiding overfitting.

Comparison between Two Design Approaches:

- **Complexity:**

Sensor-based approach: It includes interacting with sensors and processing their output, therefore it is relatively easier.

Image processing approach: More complicated, needing complex algorithms and powerful computing to identify objects in real-time.

- **Real-time Performance:**

Sensor-based approach: Provides immediate feedback as a result of direct sensor data without a noticeable processing lag.

Image processing approach: Due to the recording, processing, and interpretation of images, delay could be introduced.

- **Environmental Dependence:**

Sensor-based approach: Less impacted by external factors such as weather, lighting, and shadows.

Image processing approach: Sensitive to changes in the weather and illumination, which might produce errors.

- **Energy Consumption:**

Sensor-based approach: Typically uses less electricity due to the efficiency of each individual sensor.

Image processing approach: Due to the demands of picture collection and processing, it can require additional power.

- **Adaptability:**

Sensor-based approach: Easily adaptable to a variety of circumstances, yet may have trouble recognizing complicated forms or minute details.

Image processing approach: May provide improved flexibility by picking up on more complex object traits, although it may suffer under difficult circumstances.

Conclusion:

The sensor-based technique is a good option for the blind stick since it provides effective and trustworthy real-time input. It is a better choice than the image processing-based strategy for giving visually impaired people increased navigation capabilities and improved safety because of its benefits in terms of precision, simplicity, and independence from external factors.

4.3.2 Usability

Usability Comparison between Two Design Approaches:

Any technology created for people who are blind or visually impaired must be easy to use for it to be useful and have an influence in the real world. To determine if the sensor-based method and the image processing-based approach are suitable for boosting the mobility and safety of people who are visually impaired, their usefulness in the context of the blind stick project must be thoroughly assessed.

- **Real-Time Feedback:**

The availability of real-time feedback is one of the most important factors affecting usability. The sensor-based method succeeds in this area because of its quick response system. When integrated into the blind stick, ultrasonic sensors quickly identify obstructions, slopes, and immediately relay this information to the user. Individuals who are blind or visually challenged may respond quickly, change their course, and travel safely thanks to this fast input. As a result of the computing time needed for picture analysis, image processing-based techniques, on the other hand, unavoidably include processing delays. As delayed input may result in mishaps, collisions, or difficulties in making prompt modifications to the user's movement, it can have a substantial influence on usability.

- **Accuracy and Reliability:**

The quality and dependability of the information that the technology provides are closely related to usability. In the sensor-based technique, ultrasonic sensors provide accurate distance measurements that allow the user to judge the closeness of objects with great precision. For competent navigation, this precision is necessary. Additionally, the use of water sensor guarantees that those with visual impairments may consistently identify wet or muddy regions. Contrarily, due to variables like changes in lighting conditions, the angle of capture, and the complexity of the surroundings, image processing algorithms might be prone to mistakes. The usefulness of the system as a whole may be jeopardized by these issues, which might result in false positives (identifying items that aren't present) or false negatives (missing objects or risks).

- **Simplicity and Intuitiveness:**

The ease of use and intuitiveness of the technology also have an impact. The sensor-based method is fundamentally simpler and easier to grasp for individuals who are visually impaired due to its direct interpretation of sensor data. Through auditory feedback or vibration inputs, ultrasonic sensors offer simple feedback on distance or the presence of obstacles. Pushing the panic button is also a very easy operation that sends location information to a colleague. This ease of use and rapid adaptability are encouraged by this simplicity. The image processing-based technique, in contrast, relies on sophisticated algorithms that may have a challenging learning curve and need regular upgrades to be successful. Usability may suffer as a result of the increased complexity since users may find it difficult to understand and believe the data the system provides.

- **Adaptability to Environmental Changes:**

Variable external factors shouldn't affect a technology's usefulness for those with visual impairments. This is where the resilience of the sensor-based technique is shown. When exposed to a variety of weather and illumination situations, ultrasonic sensors can operate with dependability. They are appropriate for use indoors and out since they can identify things in all lighting conditions. On the other hand, image processing is impacted by outside variables such as light level, shadows, and weather, which may result in uneven performance and decreased usefulness in difficult circumstances.

Conclusion: It is clear from comparing the blind stick's usability of the sensor-based technique and the image processing-based approach that the former has a sizable advantage.

For those who are blind, the sensor-based approach's real-time feedback, precision, simplicity, and flexibility make it user-friendly. These qualities immediately support safer and more assured navigation. The user is able to make prompt judgments and modifications thanks to the rapid and accurate information supplied by water and ultrasonic sensors, which lowers the risk of accidents and improves overall mobility. So, for the blind stick project, the sensor-based technique turns out to be the most workable and useful option.

4.3.3 Manufacturability

Comparison between Two Design Approaches:

Sensor-Based Approach:

- **Ease of Integration:** The necessary parts for the sensor-based approach are easily accessible on the market and include ultrasonic sensors, water sensor, GPS/GSM modules, servo motors, and vibration sensors. Since these parts are standardized, production is made easier and the quality is guaranteed to be constant.
- **Simplified Production Process:** The Sensor-Based Approach's assembly procedure is not too complicated. Manufacturers can use predetermined parameters to calibrate the sensors, link them to a central processing unit, and arrange them in certain locations on the stick. This simplicity makes mass production easier and lowers the possibility of manufacturing mistakes.
- **Reduced Computational Overhead:** The Sensor-Based Approach only needs a little amount of computing power. Basic calculations required for processing distance measurements, slope values, and water data are manageable even on low-power microcontrollers. It uses very little power to send GPS location information to another receiver. This lessens the requirement for intricate hardware and software setups, increasing the effectiveness of the production process.
- **Lower Cost:** Due to their widespread use across numerous industries, ultrasonic sensors, water sensor, GPS/GSM modules, servo motors, vibration sensors, and Li-ion batteries are affordable components. The cost-effectiveness of these parts directly influences how much less the blind stick costs to produce overall.
- **Consistency and Reliability:** The Sensor-Based Approach is based on technologies that have a track record of success. This comfort level guarantees consistency in performance and dependability, two essential elements for any assistive technology aimed at vulnerable user groups.

Image Processing-Based Approach:

- **High Complexity:** Object detection and terrain analysis image processing systems can be complex and computationally taxing. The manufacturing process becomes more complex as a result of the need for trained engineers and specialized hardware to implement and fine-tune these algorithms.

- **Hardware Requirements**: Real-time high-quality image capture from cameras is necessary. These cameras can be rather pricey, and they might need more processing technology, which would raise the cost of production.
- **Calibration and Maintenance:** To ensure proper picture analysis, cameras need to be calibrated precisely. Calibration methods must be taken into account during the production process, adding to the time and labor needed to assemble each unit. Additionally, to guarantee consistent operation, routine maintenance may be required.
- **Resource-Intensive Processing:** Strong processors and enough memory are necessary due to the intense computational demands of image processing techniques. Due to the need for unique hardware components and potential compatibility difficulties, this can make production more difficult.
- **Higher Development Costs:** Complex image processing algorithms require a large amount of research and development to build and optimize. These expenses could raise the total cost of manufacturing.

In conclusion, for the creation of a blind stick, the sensor-based approach offers higher manufacturability compared to the Image Processing-Based Approach. The Sensor-Based Approach is a more practical and effective choice for mass manufacturing due to its simplicity, reliability, reduced computing overhead, and ease of integration. The Image Processing-Based Approach has advantages, but obtaining high manufacturability levels is difficult due to the approach's complexity, hardware requirements, and associated difficulties. As a result, from the perspective of manufacturing, the Sensor-Based Approach is the more sensible and workable option for the goal of constructing a blind stick.

4.3.4 Impact

Impact Comparison between Two Design Approaches:

- **Reliability and User Experience:** Due to immediate sensor feedback, the sensor-based approach is intrinsically more trustworthy. Lighting, image quality, and algorithm accuracy can all have an impact on image processing, which could result in false positives or negatives.
- **Power Efficiency:** The user can use the device for longer because of the sensor-based approach's reduced power consumption. Higher computational demands associated with image processing result in shorter battery life and more frequent charging requirements.
- **Adaptability and Maintenance:** Because sensors are less sensitive to environmental factors, the sensor-based approach can be applied in a variety of settings with little upkeep. To ensure accuracy and relevance, image processing algorithms may need ongoing upgrades and fine-tuning.
- **Cost-Effectiveness:** Due to lower development, production, and maintenance expenses compared to the complicated software and hardware requirements of the Image Processing-Based Approach, the Sensor-Based Approach is typically more cost-effective.

4.3.5 Maintainability

Comparison between Two Design Approaches:

Sensor-Based Approach:

- **Robustness and Reliability**: Sensor-based systems are less subject to environmental variables, such as shifting lighting conditions or complicated backgrounds, that might influence image processing processes.
- **Reduced Processing Overhead:** Compared to image processing methods, sensor-based systems often have lower processing demands. This lessens the load on the processing unit and increases the lifespan of the gadget.
- **Minimal Maintenance Effort:** Because they are made for specific purposes, sensors operate more simply than image processing algorithms. Once calibrated properly, they have fewer components and don't need frequent updates or tweaks.
- **Less Vulnerable to External Factors:** The processing of images may be impacted by adjustments in illumination, visibility, and background clutter. Conversely, sensors function more consistently because they are less affected by these variables.
- **Easier User Interface Integration:** The information can be more easily interpreted by users who are blind or visually handicapped when sensor data is directly transformed into straightforward feedback methods, such as vibrations or aural signals..

Image Processing-Based Approach:

- **Complex Algorithm Development:** To effectively handle a variety of settings, image processing algorithms, especially those designed for real-time object recognition, need to be continuously improved and updated.
- **Resource-Intensive:** It takes a lot of computer power to process images. The camera module, GPS/GSM module, and LIDAR sensors all require a significant amount of power from the Raspberry Pi microcontroller in this setup. This might cause the battery to deplete fast and increase the need for maintenance, such as making sure the gadget is routinely charged.
- **Environmental Variability:** Systems for processing images are susceptible to variations in weather, illumination, and backdrop complexity. The algorithms must be updated and maintained continuously to accommodate such fluctuations. We also need to think about employing higher megapixel camera modules of acceptable quality. Additionally, a LIDAR sensor must be employed to guarantee that users receive correct navigation in order to boost usability at night or when there is inadequate lighting. Costs are also increased by this sensor.
- **Regular Calibration:** Due to mechanical changes or environmental variables, cameras might lose their calibration over time. To achieve precise detection and interpretation, this needs routine maintenance.

- **Software Vulnerabilities:** Image processing systems are prone to software bugs and vulnerabilities that may require frequent updates to maintain security and performance.

Conclusion: When compared to the image processing-based technique, the sensor-based solution for the blind stick project clearly displays improved maintainability. The sensor-based method is a more dependable and sustainable solution because of its inherent resilience, less complexity, fewer resource requirements, and limited vulnerability to external forces. These features directly affect how long-lasting, simple to use, and generally useful the gadget is in assisting visually impaired people with their movement and safety.

4.3.6 Cost

Cost Comparison between Two Design Approaches:

In the sensor-based method, the blind stick employs several sensors to acquire real-time data from the surroundings and deliver feedback to the visually impaired user. This technique is noted for its simplicity, dependability, and comparatively cheap cost.9000, 25800

- **Cost of the components:**

Sensor components such as ultrasonic sensors for object identification and water sensor are easily accessible in the market at cheap rates. These sensors are particularly built for these applications and are optimized for accuracy and efficiency. The cost of deploying these sensors, even in combination, is often cheaper compared to the cost of high-quality cameras and computational systems necessary for image processing. For our design approach 1, Sensor based the total cost is 9000 TK on the other hand for our design approach 2, image processing based the total budget is 25,800 TK. Here we see the big difference for the costing.

- **Hardware Requirements:**

For the sensor-based method, the hardware needed is restricted to the sensors themselves, together with a microcontroller or a tiny processing unit to acquire and interpret the sensor data. For design approach 1, our assigned microcontroller is an Arduino Uno. These microcontrollers are quite affordable and utilize very little power. As the ultrasonic sensors and water sensor, vibration motors, GPS/GSM modules do not need significant processing power, this solution doesn't involve considerable computing power, resulting in cheaper hardware prices.

- **Processing Power:**

Image processing needs tremendous computing resources. Implementing an image processing-based technique would need a powerful CPU such as a Raspberry Pi, camera module, LIDAR sensor. These components lead to a greater total cost for the gadget.

- **Maintenance and Upkeep:**

Sensor-based systems generally have fewer components and are less complicated, leading to cheaper maintenance costs. The sensors employed in this technique are robust and need minimum calibration and modification over time, resulting in decreased maintenance efforts and costs. After analyzing different aspects of the two design approaches we come up with the SWOT analysis on the basis of four criteria: strength, weakness, opportunity and threat. For choosing the optimal solution we need to think from the perspective of blind and visually impaired people because they are the main users for our designed stick and our main concern is to provide them with such a stick that they can use easily and get more sufficient enough to walk through the footpath. For this reason, we also represented the justification of the two design approaches which will help us to find the optimal solution.

Table 4.3: Comparison of two design approaches

Criteria	Design-1	Design-2
Efficiency	Sufficient	Less sufficient
Usability	User friendly	Complexed for some user
Manufacturability	Complex	Comparatively easy
Cost	9000 TK	25800 TK

4.3.7 SWOT Analysis

SWOT Analysis for Design Approach 1

Strength	Weakness
1. Accurate Object Detection 2. Real-time Feedback 3. Simple User Interface 4. Low Power Consumption	1. Limited Object Information 2. Complex Terrain Challenges 3. Technology is relatively not very advanced

Opportunity	Threat
1. Integration with Other Technologies 2. Customization 3. Learning and Improvement 4. Budget friendly option	1. Competing Technologies 2. Regulatory and Safety Concerns 3. User Acceptance

Strengths:

1. **Accurate Object Detection:** Ultrasonic sensors are noted for their dependable and precise object detection capabilities, allowing the blind stick to identify obstacles and possible dangers effectively.
2. **Real-time Feedback:** The sensor-based technique may offer real-time input to the user, enabling them to make rapid modifications and avoid obstructions swiftly.
3. **Simple User Interface:** The interface for this method may be quite simplistic, consisting of auditory or haptic signals that are easy for visually impaired individuals to comprehend and interpret.
4. **Low Power Consumption:** Ultrasonic sensors and water sensor are typically built to be energy-efficient, helping to extend the battery life of the device.

Weaknesses:

1. **Limited Environmental Adaptability:** Ultrasonic sensors could struggle with detecting translucent or extremely soft objects, and their effectiveness might be impacted by environmental conditions such as wind, rain, or humidity.
2. **Limited Object Information:** Ultrasonic sensors give distance measurements but lack the capacity to provide precise information about the kind, size, or nature of obstacles.
3. **Technology is relatively not very advanced:** Sensor based solution is confined to the employment of ultrasonic ray to determine distance from or to an item and their position, while image processing may even notify the user precisely in front of the user.

Opportunities:

1. **Integration with Other Technologies:** The sensor-based technique may possibly be linked with additional technologies like GPS or navigation applications to increase the entire usefulness of the blind stick.
2. **Customization:**The system might be developed to deliver configurable notifications depending on user choices, enabling users to adjust the gadget to their individual requirements.
3. **Learning and Improvement:** As technology progresses, there's a possibility to increase sensor accuracy and dependability, consequently boosting the overall performance of the blind stick.
4. **Budget Friendly Option:** Mass producing this design is very much inexpensive as the required ultrasonic sensors, water sensor, GPS/GSM modules and the required chassis for the framework of the design can be very cheap, making it more budget friendly than other designs.

Threats:

1. **Competing Technologies:** Image processing and AI-based solutions for object recognition are advancing quickly and can represent a threat by giving more comprehensive and adaptive solutions.
2. **Regulatory and Safety Concerns:** Any assistive equipment has to fulfill high safety and regulatory criteria to protect user well-being, which could offer obstacles throughout the development and testing stages.
3. **User Acceptance:** Some visually impaired users would prefer more intuitive and familiar ways, and the effectiveness of the sensor-based approach would rely on how well it corresponds with user requirements and desires.

SWOT Analysis for Design Approach 2

Strength	**Weakness**
1. Capability of Multiple Object Detection 2. More Advanced Functioning System	1. Complex Algorithm Development 2. Computational Resources 3. Environmental Dependence 4. Power Consumption 5. Maintenance and Updates

Opportunity	Threat
1. Continuous Improvement 2. Collaboration with AI-researchers 3. Customization 4. Data Collection and Learning	1. Privacy Concerns 2. Limited Generalization 3. Reliability Challenges 4. Initial Implementation Cost

Strengths:

1. **Capability of Multiple Object Detection:** Image processing algorithms may recognise several and various sorts of item all at the same time.
2. **More Advanced Functioning System:** Image processing can provide real-time feedback to the user about the environment, helping them avoid obstacles and hazards immediately. This approach is much more advanced than just using sensors for object detection.

Weaknesses:

1. **Complex Algorithm Development:** Developing and fine-tuning image processing algorithms may be complicated and time-consuming, requiring skills in computer vision and machine learning.
2. **Computational Resources:** Image processing generally needs substantial computing resources, which can restrict the viability of implementing the solution on resource-constrained devices.
3. **Environmental Dependence:** Image processing's accuracy may be impacted by variables such as lighting conditions, weather, and camera quality, possibly leading to false positives or negatives.
4. **Power Consumption:** Running image processing algorithms continually may deplete the device's battery fast, necessitating effective power management measures.
5. **Maintenance and Updates:** Regular updates and maintenance are required to maintain the image recognition models up to date and functional.

Opportunities:

1. **Continuous Improvement:** As machine learning and computer vision methods evolve, the accuracy and reliability of image processing for object recognition will undoubtedly increase over time.
2. **Collaboration with AI Researchers:** Collaborating with AI researchers and developers may lead to novel ideas and breakthroughs in object detection algorithms.
3. **Customization:**The solution may be adjusted to specific user preferences and demands, boosting the user experience.
4. **Data Collection and Learning:** The technology can continually learn from user interactions and give more tailored and accurate advice.

Threats:

1. **Privacy Concerns:** Image processing includes acquiring and interpreting visual data, which may generate privacy concerns and data security challenges.
2. **Limited Generalization:** Image processing methods could fail to generalize to all conceivable circumstances, resulting in potential safety issues in specific instances.
3. **Reliability Challenges:** The system can experience challenges in recognising things properly in constantly changing settings or uncommon circumstances.
4. **Initial Implementation Cost:** Developing and deploying sophisticated image processing systems might involve substantial initial commitment in terms of money, knowledge, and technology.
5. **Competition:** There can be competition from other assistive technology or solutions catering to the visually impaired population.

After performing all the possible benefits and drawbacks of the two design approaches we come to the conclusion that design approach-1 will be the final optimal solution of our project.

4.4 Performance evaluation of developed solution

Evaluating the performance of a sensor-based solution for a blind stick involves assessing various aspects such as accuracy, reliability, user experience, and robustness. Here are some key parameters and methods for evaluating the performance of a blind stick :

Accuracy:

- Distance Measurement Accuracy: Evaluate how accurately the ultrasonic sensor measures distances to obstacles. This will be done by comparing the sensor readings with actual measured distances.
- Direction Detection Accuracy: Assess the precision of the sensor in detecting the direction of obstacles. This is crucial for guiding the user away from obstacles.

Reliability:

- Consistency: Measure the consistency of sensor readings over time and under various conditions (different lighting, weather, and obstacle types).
- False Positive/Negative Rate: Evaluate how often the system gives incorrect obstacle alerts (false positives) or misses real obstacles (false negatives).

User Experience:

- Ease of Use: Conduct user testing to evaluate how easily the blind user can interpret the signals provided by the blind stick.
- Feedback Speed: Measure the time taken by the system to detect an obstacle and provide feedback to the user. Faster response times lead to better user experience.
- Alert Mechanism: Evaluate the effectiveness of the alert mechanism, such as vibrations and sounds, to convey information to the user without causing confusion.

Robustness:

- Obstacle Type: Test the system against various obstacle types (walls, poles, moving objects) to ensure it can detect different objects effectively.
- Range: Evaluate the sensor's performance at different ranges to ensure it provides accurate feedback for both near and distant obstacles.
- Battery Life: Assess the blind stick's battery life under normal usage conditions to ensure it lasts throughout the day.

Technical Aspects:

- Sensor Calibration: Check if the sensors need regular calibration and assess how easy it is for the user to perform this calibration.
- Sensor Interference: Evaluate if the sensor readings are affected by interference from other electronic devices or environmental factors.

Real-World Testing:

- Field Testing: Conduct tests in real-world scenarios, such as busy streets or crowded areas, to evaluate the system's performance in practical situations.
- User Feedback: Gather feedback from blind or visually impaired users who have used the blind stick in their daily routines to understand its practical usability.

Data Analysis:

- Data Logging: Before implementing we perform various data analysis to record sensor data over time. By analyzing this data we identify patterns, issues, or areas of improvement.

Durability and Maintenance:

- Durability: Assess the physical durability of the blind stick to ensure it can withstand daily usage and occasional falls.

- Maintenance: Evaluate how easy it is to maintain and repair the device, including sensor replacement.

By evaluating based on these parameters we can confirm that sensor based design performance is satisfactory and user friendly.

4.5 Conclusion

In conclusion, we can experimentally say that the sensor based design approach will perform better than the image processing base design approach because of the limitations of camera vision. our desired requirement will be fulfilled by the design approach 1. So, we will precede our project to focus on the sensor based design and developing it.

Chapter 5: Completion of Final Design and Validation. [CO8]

5.1 Introduction

We investigated two design approaches for the blind stick for visually impaired, sensor-based and image processing, and chose the sensor-based design due to its more efficient operation. This chapter represents the highest point of our project, as we move from theoretical discussions to the creation of an actual prototype. Our goal is to improve precision and dependability in assisting visually impaired individuals by emphasizing the sensor-based approach. This report goes into the results of our simulations and provides an assessment of the final design. Our prototype intends to provide a streamlined and effective solution to the navigation issues faced by the visually impaired by focusing on sensor and audio assistance integration.

5.2 Completion of final design

To build the prototype considering the sensor based design as a better solution, we have used various components for the haptic feedback through audio assistance, emergency situation assistance and collecting sensor data.

5.2.1 Components Description

Arduino UNO: The Arduino Uno R3, operating at 5V, serves as the processing unit for ultrasonic sensors in the blind stick. With a recommended input voltage range of 7-12V, the Uno efficiently powers and controls the sensors. It features 14 digital I/O pins, six of which offer PWM output, enhancing flexibility in signal modulation. Additionally, the Uno provides six analog input pins, facilitating precise data acquisition from sensors. Utilizing these technical specifications, the Arduino Uno processes ultrasonic signals for obstacle and pothole detection. As the central hub, it interprets sensor data, calculates distances, and triggers audio alerts through speakers, ensuring the blind stick's rapid and reliable response to potential hazards during navigation.

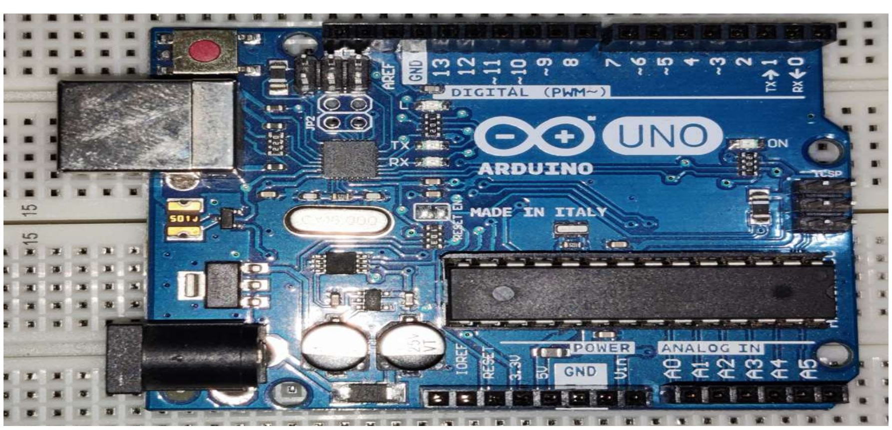

Figure 5.2.1: Arduino UNO R3

Ultrasonic Sensor (US100): The sensor-based blind stick for object identification relies heavily on the US100 ultrasonic sensor. The sensor is mounted on the stick and measures distances using ultrasonic waves to identify objects in the user's path. The technology utilizes auditory assistance to notify the visually impaired person as soon as an obstacle is detected, giving them input on the object's location and closeness in real time. By preventing potential dangers and collisions, this integration improves the stick's usefulness and helps users move safely.

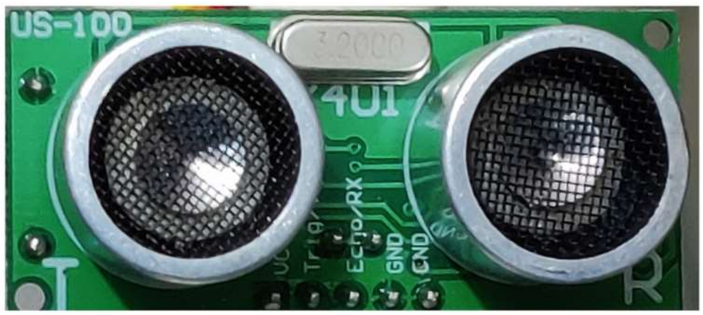

Figure 5.2.2: Ultrasonic Sensor (US100)

Another US100 is used for pothole detection which is mounted downward in the stick which measures the depth of the pothole or manhole and gives alert through audio assistance. It is also used to calculate the distance and make a conclusion whether there is a slope, a staircase or a pothole so that the visually impaired individual avoids such danger by getting audio feedback.

Ultrasonic Sensor (HC04): A HC04 ultrasonic sensor is attached to a servo motor for detecting moving objects near the user. It is mounted in the lower part of the stick to detect obstacles like sleeping dogs, bricks etc. The servo continuously rotates from 0 to 180 degrees to detect obstacles on both sides of the user. The user gets the proper location of the obstacle through the audio assistance whether the obstacle is on the left or right side of the user. It increases the mobility and confidence to roam around for the user.

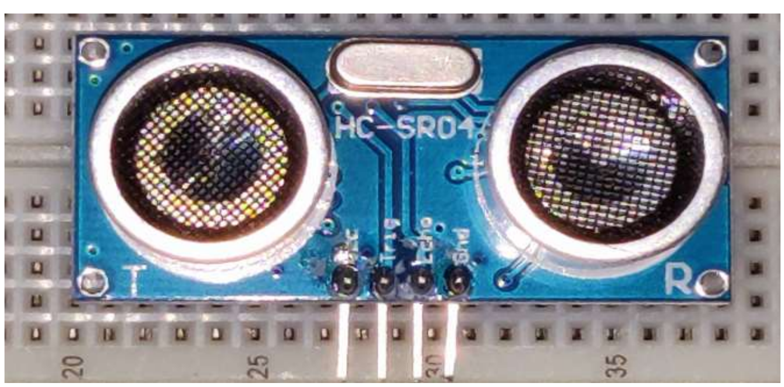

Figure 5.2.3: Ultrasonic Sensor (HC04)

Servo Motor: Servo motors with voltages ranging from 3.0V to 7.2V drive rotating movement in the blind stick having an ultrasonic sensor attached to it. It rotates at specific angles of 0 to 180 degrees in response to microcontroller commands. They are integrated into the stick and improve obstacle recognition by scanning the surroundings at exact directions for both left and right sides.

Figure 5.2.4: Servo Motor

DFplayer Mini: The DFPlayer Mini, a small and inexpensive mp3 module, integrates seamlessly into our project to improve the audible feedback system of the blind stick. This adaptable module connects directly to the speaker, making audio output easier. Whether used independently with a battery, speaker, and push buttons, or in connection with an Arduino. It serves as the auditory interface in our project, giving critical audio signals for obstacle and pothole identification. The DFPlayer Mini's streamlined design and compatibility provide efficient audio alert processing and transmission, considerably improving the entire user experience for those with visual impairments and making navigation safer and more straightforward. To provide a clear auditory feedback sound we used an amplifier.

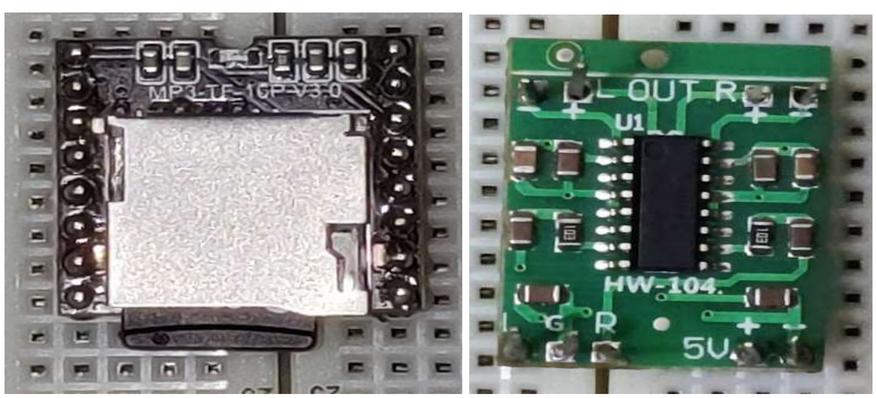

Figure 5.2.5: DFplayer Mini (left), Amplifier (right)

Speaker: Our project includes an important 5V, 3W speaker that was carefully chosen for its efficiency and clarity in auditory output. This powerful speaker is an essential component, providing users with clear and detectable audio feedback. Its 5V power consumption is in accordance with project standards, ensuring peak performance. The speaker's 3W output capabilities ensures that audio signals, ranging from obstacle alarms to navigation directions, are audible in a variety of environmental circumstances.

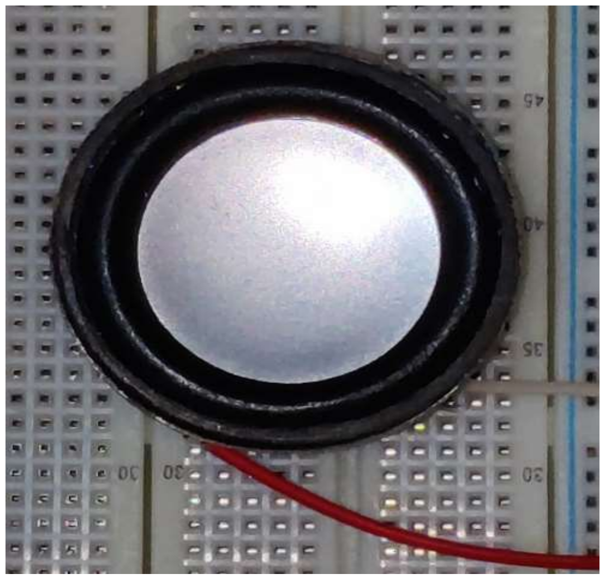

Figure 5.2.6: Speaker

Arduino Nano: The Arduino Nano serves as the processing powerhouse in our blind stick, seamlessly connecting with the SIM808 GPS GSM module. This compact microcontroller efficiently manages communication, enabling real-time tracking and precise location data. Its small form factor ensures unobtrusive integration within the blind stick, optimizing portability. The Arduino Nano's versatility makes it an ideal choice for handling complex functionalities, including GPS-based navigation and GSM-enabled communication.

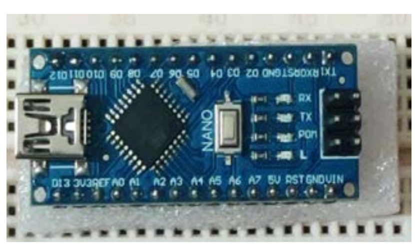

Figure 5.2.7: Arduino NANO

GPS GSM module: (SIM808 EVB v3.2.2): The SIM808 GPS GSM module serves distinct purposes in our blind stick project. Its GPS functionality enables real-time tracking and precise positioning, providing accurate location information to enhance navigation. Additionally, the GSM connectivity facilitates communication, allowing the blind stick to transmit the stick's accurate position with a SOS message to the caregiver's device. It ensures the safety of the user in any emergency situation. The module's extremely low power consumption and integrated charge circuit ensure extended battery life, a critical feature for prolonged usage.

Figure 5.2.8: SIM808 GPS GSM module (left), GPS Antenna (right)

Push Button: An integrated push button with the GPS GSM module is allocated for sending the location of the user to the caregiver. When the button is pressed, a SOS message is sent including the location of the user to the caregiver so that the safety is ensured in emergency situations.

Figure 5.2.9: Push Button

Buck Converter: A buck converter serves as a vital component in our project, efficiently transforming the supply voltage from 12V to the required 5V. This compact device ensures a stable and regulated power supply, enabling seamless integration with various components such as microcontrollers, sensors, and communication modules. Its role is fundamental in optimizing the power compatibility of diverse elements within the project, enhancing overall functionality and reliability by providing a consistent 5V output.

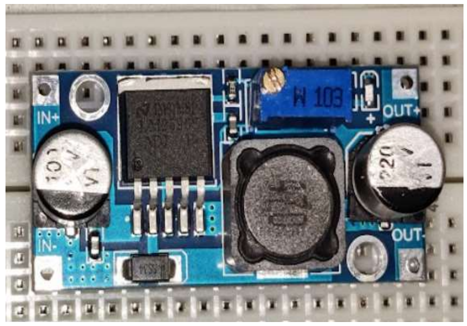

Figure 5.2.10: Buck Converter

Battery: The Sony 18650 Li-ion battery is a preferred power source for high-drain devices like blind sticks, boasting high capacity and energy density in a compact form. Its reliability and safety features, including protection against overcharging and short circuits, make it ideal for sensitive electronics. Utilizing four batteries in parallel provides a robust total capacity of around 2100 mAh, ensuring extended operation for a long time. This versatile battery powers various components in the blind stick, including ultrasonic sensors, the microcontroller and the GPS GSM module. Conveniently, the battery can be charged through a USB-C port while the device is in use. Depending on usage, the Sony 18650 Li-ion battery is a sound choice, contributing to the efficiency and longevity of the blind stick project.

Figure 5.2.11: Sony 18650 Li-ion battery

5.2.2 Construction of Final Prototype: In Blind Stick we have added all the systems together with each of the components we have been using.

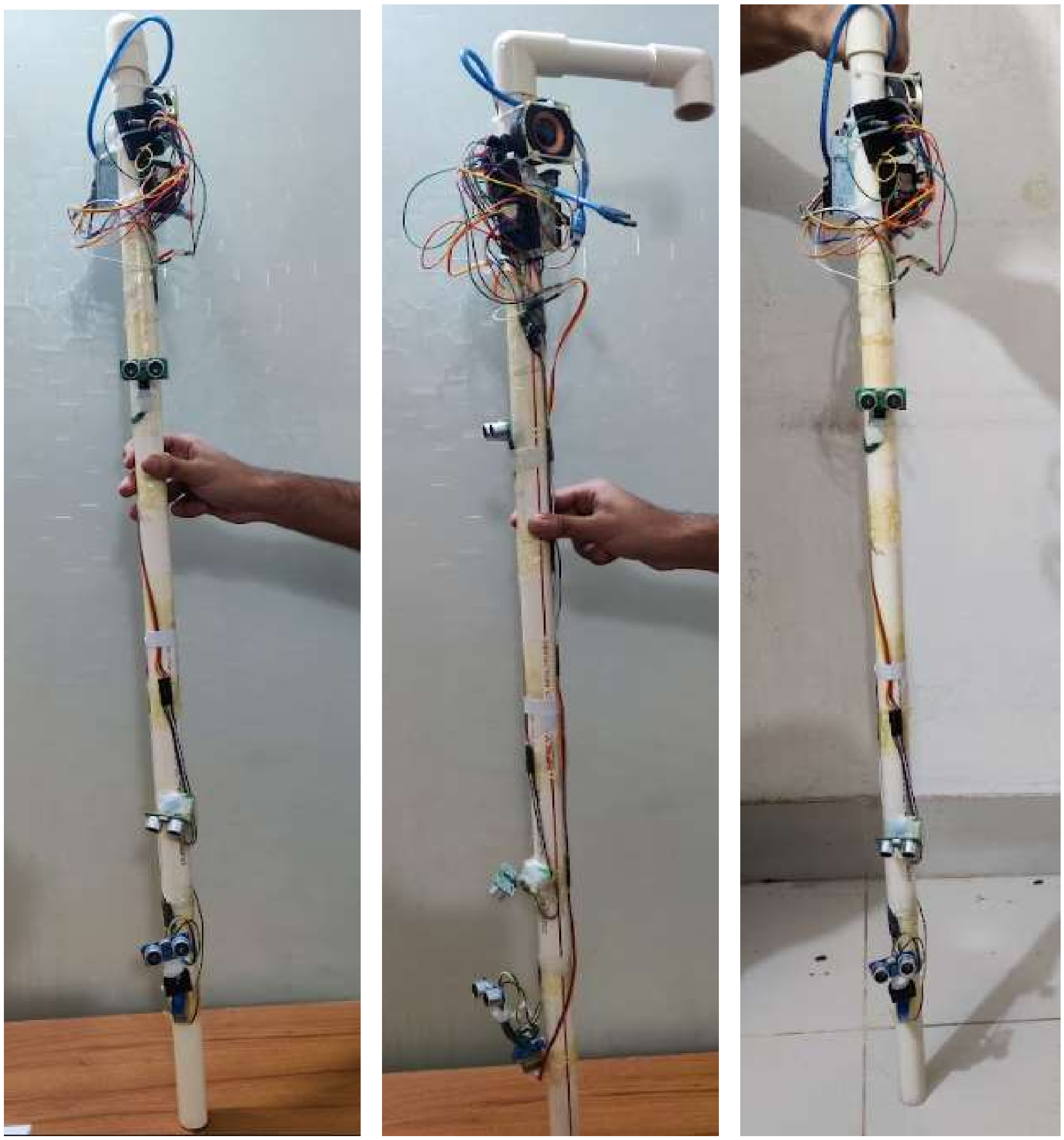

Figure 5.2.12: Initial Prototype of Blind Stick

First, we built an initial prototype to analyze the performance of all the three sensors. Then, we ensure their performance on the basis of real time performance. Afterwards, we built our final prototype with all the systems together.

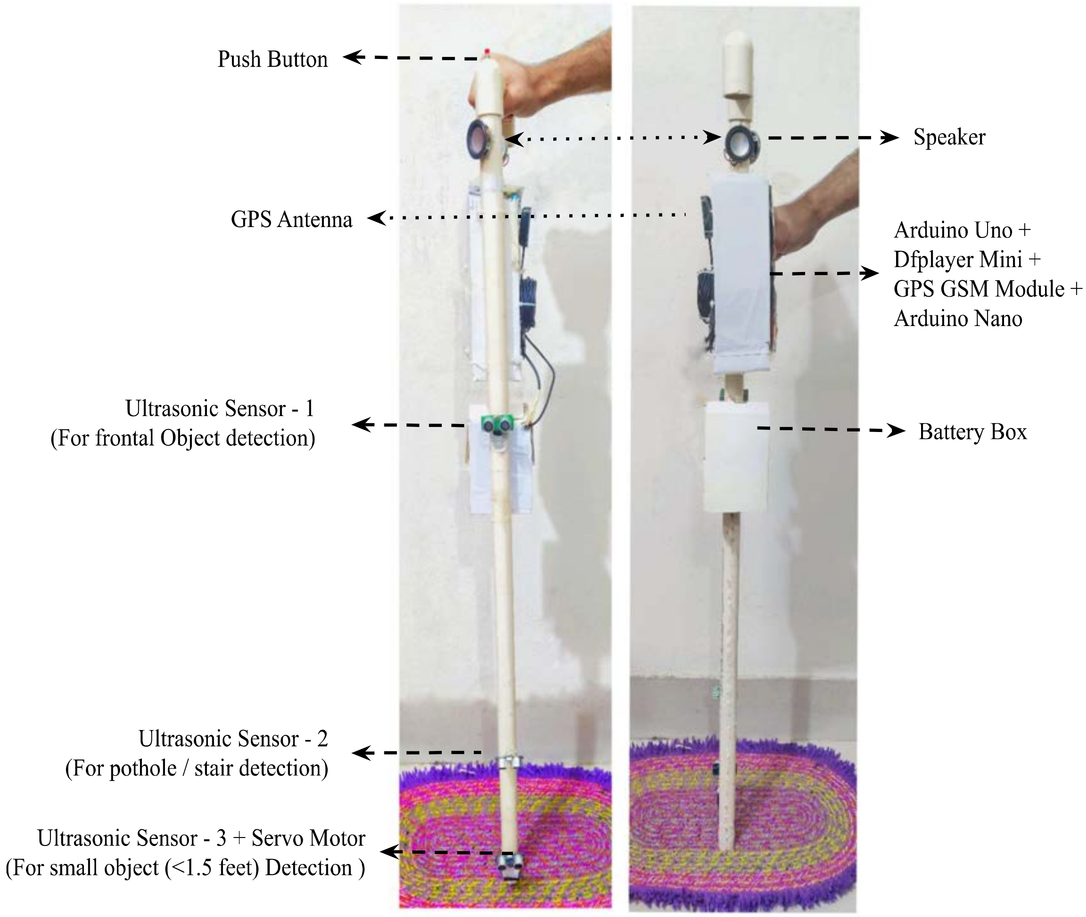

Figure 5.2.13: Final Prototype of Blind Stick with Sensors, Speaker, GPS GSM & Microcontroller Box and Battery Box

Above we can see our front and backwards view of blind stick where all the systems are added in. After that, we measured the weight of the stick, it is around 1.1 kg, which is very much light weighted.

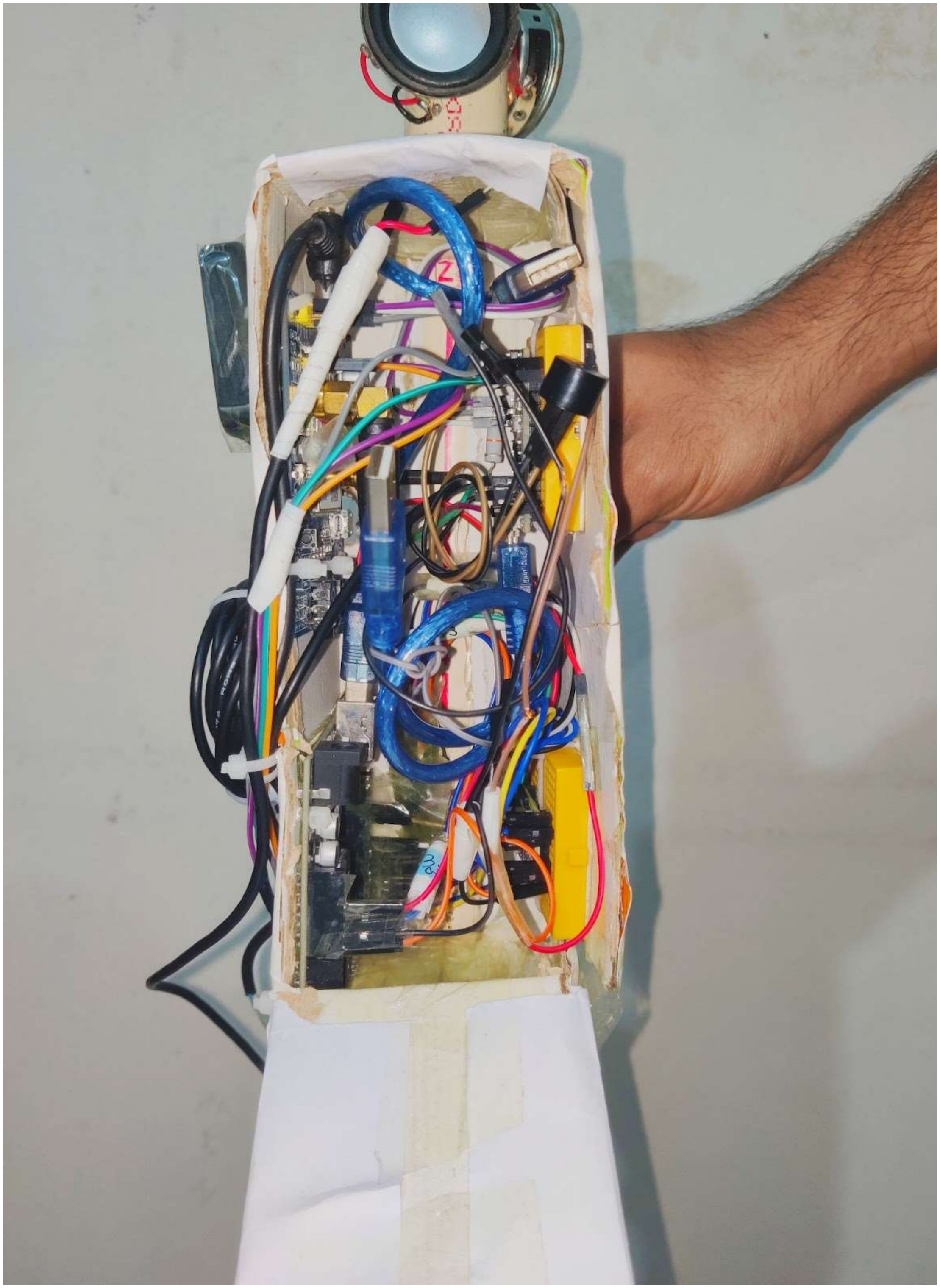

Figure 5.2.14: Inside view of GPS GSM & Microcontroller Box

5.2.3 Required Measurements

In order to function the audio voice output for several cases, we needed some calculation to find out appropriate scaling of the sensors. Those are :

- x (US-100 sensor): This sensor is used for object detection within the range of 120 cm. If x detects an obstacle, the user gets an auditory output through a pair of speakers saying, "Frontal Object detected."

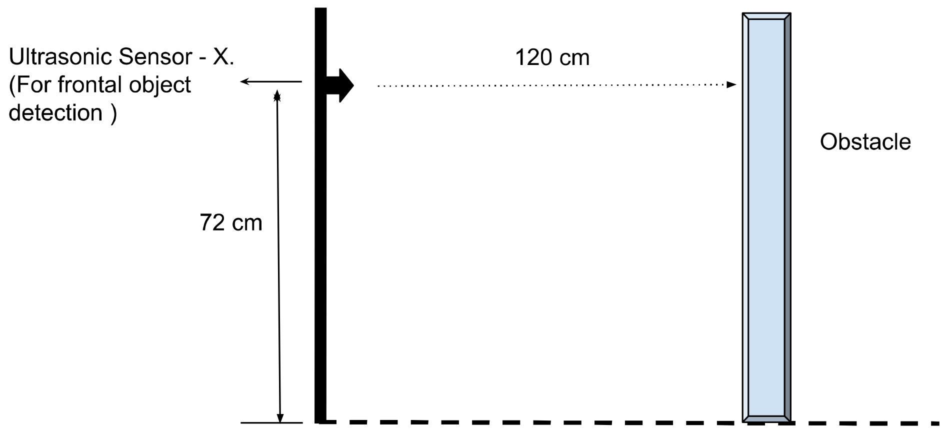

Figure 5.3.15: Measurement of frontal object detection.

- y (US-100 sensor): This sensor is used for pothole and slope detection to ensure the safety of the user. If the sensor range is greater than or equal to 70 cm, the sensor

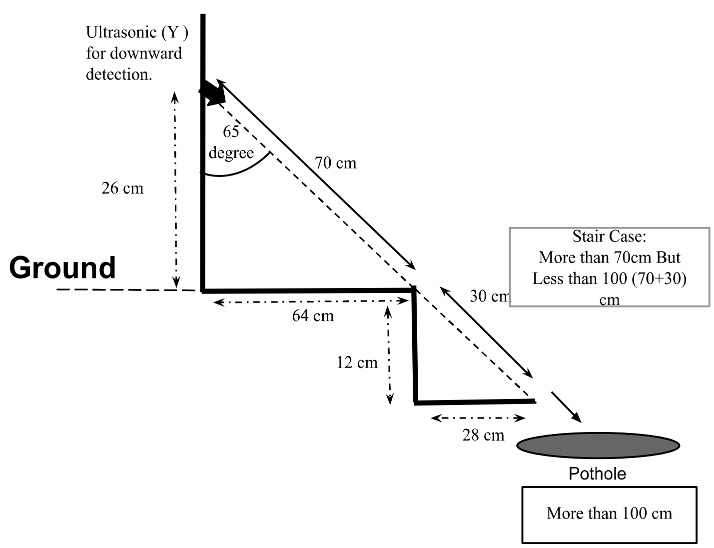

Figure 5.3.16: Measurement of staircase and pothole detection.

senses it as a staircase. If the distance is greater than 100 cm, it senses it as a pothole. When y senses a staircase, the speaker says "Downward Stair Ahead." When y detects a pothole, the speaker says "Maybe Pothole Ahead."

To measure the staircases and pothole detection individually, we have attached the Ultrasonic (Y) sensor 26cm above the ground and made it 65 degree angled. Later, according to the distance we divided our voice command individually to give the feedback accordingly. A diagram is given below to demonstrate the overall calculation .

- z (HC-04 sensor): This sensor is used for small objects as well as the obstacles roaming in the left and right sides. It is attached to a servo motor for continuously scanning the obstacles by rotating from 0 to 180 degrees. When the servo rotates from 0 to 90 degrees and z detects an obstacle, the speaker gives an auditory output of "Small Obstacle Left" and when it rotates from 91 to 180 degrees it alerts saying "Small Obstacle Right."
  The HC-04 (z) sensor attached to the servo motor is located at 4 cm above from the ground. US- 100 (y) is located at 26 cm above the ground and angled towards the ground for detecting the pothole more accurately and the US-100 (x) is attached at a distance of 72 cm from the ground for detecting obstacles in the front.

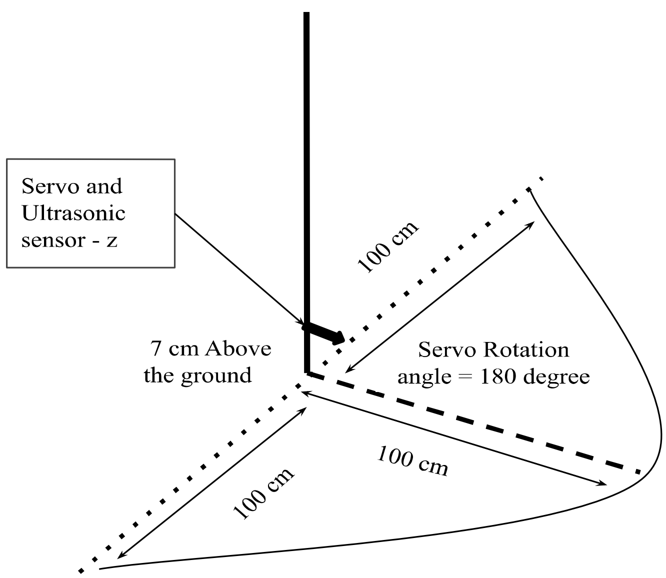

Figure 5.3.17: Measurement of surround angle of small object.

5.3 Evaluate the Solution to Meet Desired Need

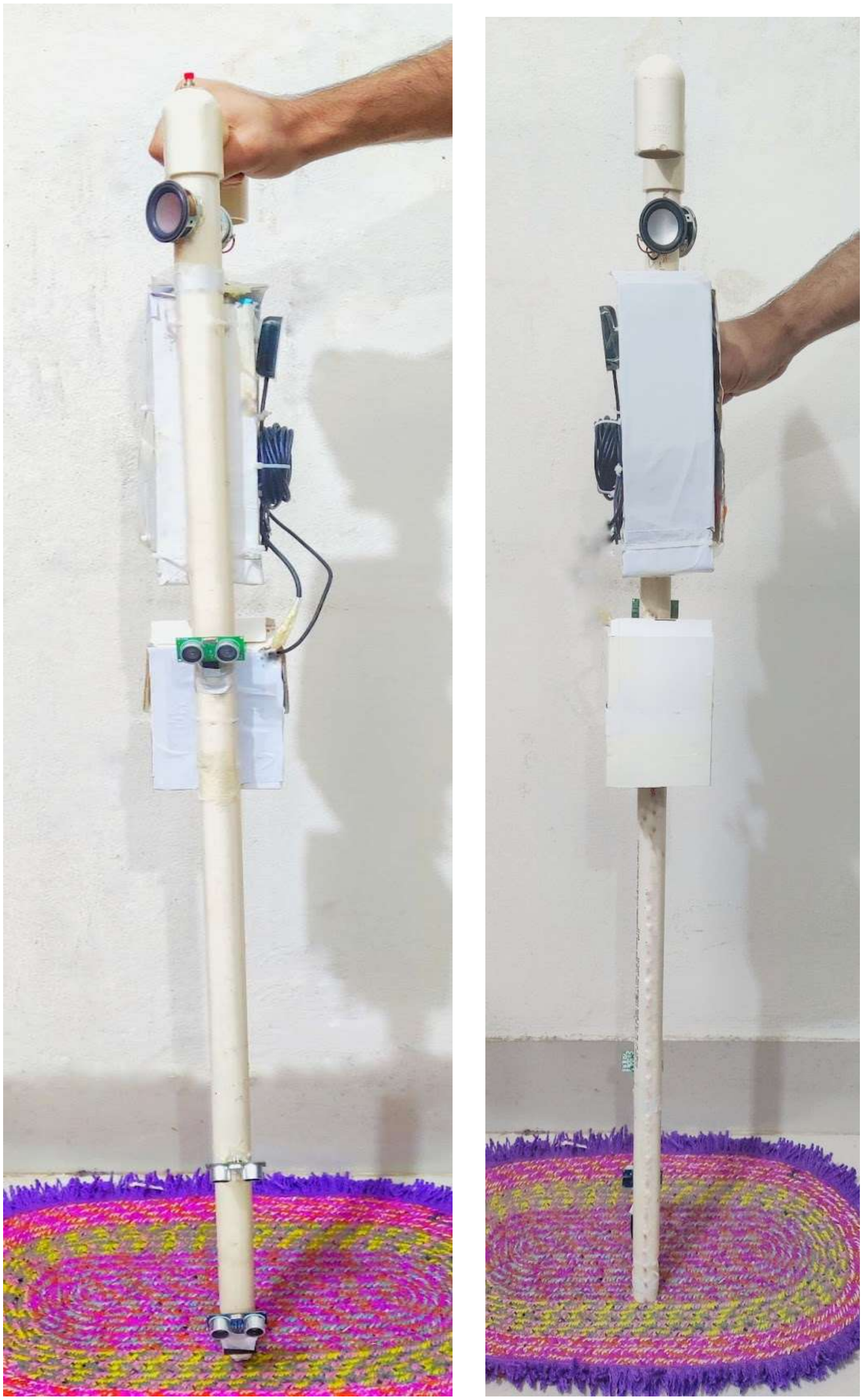

Figure 5.3.1: Blind Stick Obstacle. Moving Object and Stairs Detection

5.3.1 Data Analysis of Sensors

In order to test the prototype performance , we have collected sensor data from the serial monitor . These are some sample data given below:

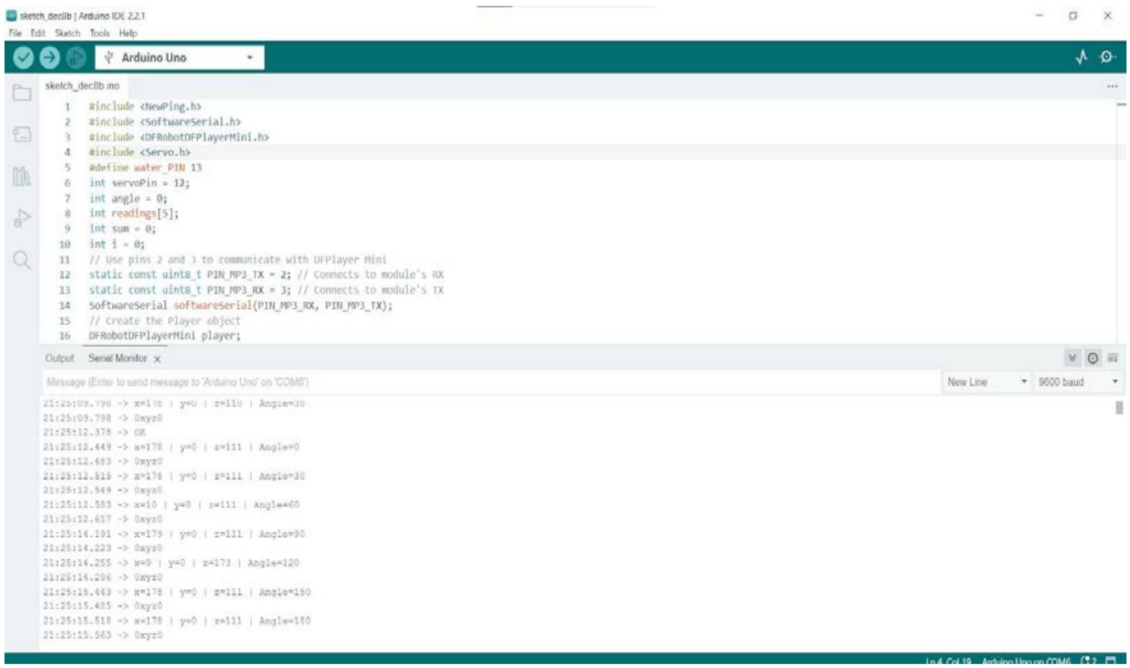

Figure 5.3.2: Collected data from Three Sensors

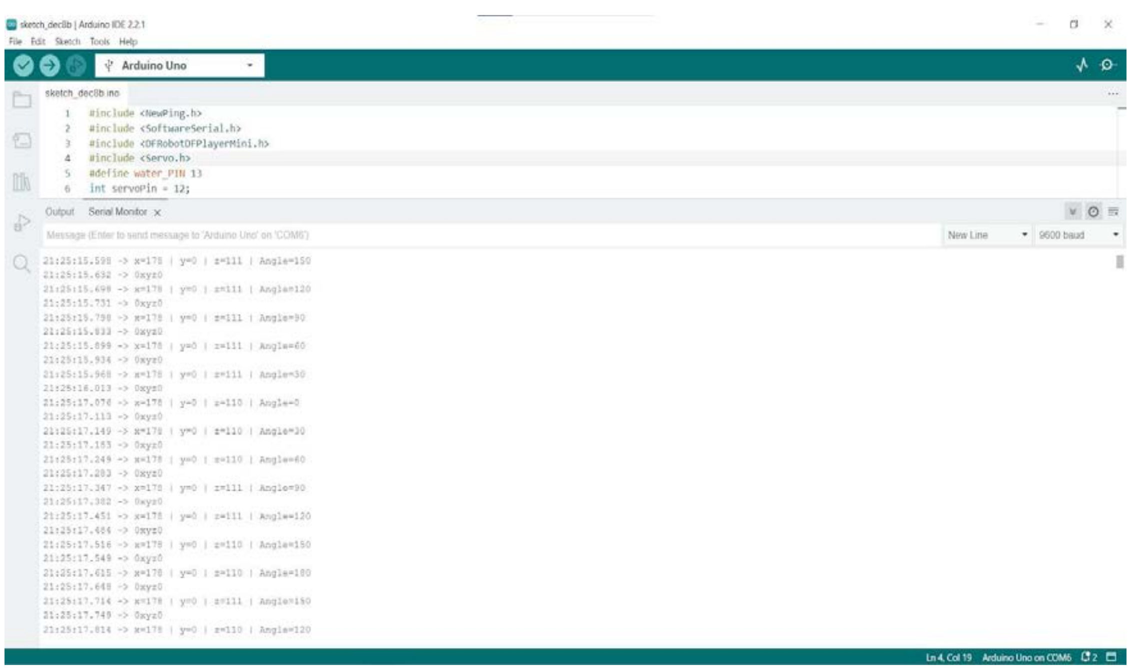

Figure 5.3.3: Collected data from Three Sensors (Continuation)

```
Output    Serial Monitor ×
Message (Enter to send message to 'Arduino Uno' on 'COM6')
21:25:17.113 -> 0xyz0
21:25:17.149 -> x=178 | y=0 | z=110 | Angle=30
21:25:17.183 -> 0xyz0
21:25:17.249 -> x=178 | y=0 | z=110 | Angle=60
21:25:17.283 -> 0xyz0
21:25:17.347 -> x=178 | y=0 | z=111 | Angle=90
21:25:17.382 -> 0xyz0
21:25:17.451 -> x=178 | y=0 | z=111 | Angle=120
21:25:17.484 -> 0xyz0
21:25:17.516 -> x=178 | y=0 | z=110 | Angle=150
21:25:17.549 -> 0xyz0
21:25:17.615 -> x=178 | y=0 | z=110 | Angle=180
21:25:17.648 -> 0xyz0
21:25:17.714 -> x=178 | y=0 | z=111 | Angle=150
21:25:17.749 -> 0xyz0
21:25:17.814 -> x=178 | y=0 | z=110 | Angle=120
21:25:17.848 -> 0xyz0
21:25:17.881 -> x=178 | y=0 | z=110 | Angle=90
21:25:17.915 -> 0xyz0
21:25:17.981 -> x=178 | y=0 | z=110 | Angle=60
21:25:18.015 -> 0xyz0
21:25:18.079 -> x=178 | y=0 | z=110 | Angle=30
21:25:18.115 -> 0xyz0
21:25:19.124 -> x=15 | y=0 | z=111 | Angle=0
21:25:19.160 -> 0xyz0
21:25:20.272 -> x=10 | y=0 | z=110 | Angle=30
21:25:20.315 -> 0xyz0
```

Figure 5.3.4: Collected data from Sensors in Serial Monitor.

```
Output    Serial Monitor ×
Message (Enter to send message to 'Arduino Uno' on 'COM6')
21:36:10.154 -> 0xyz0
21:36:10.225 -> x=177 | y=136 | z=0 | Angle=30
21:36:10.261 -> 0xyz0
21:36:10.327 -> x=177 | y=134 | z=0 | Angle=60
21:36:10.360 -> 0xyz0
21:36:10.433 -> x=177 | y=134 | z=200 | Angle=90
21:36:10.482 -> 0xyz0
21:36:12.054 -> x=177 | y=134 | z=0 | Angle=120
21:36:12.098 -> 0xyz0
21:36:12.174 -> x=176 | y=134 | z=0 | Angle=150
21:36:12.210 -> 0xyz0
21:36:12.275 -> x=176 | y=134 | z=0 | Angle=180
21:36:12.308 -> 0xyz0
21:36:12.382 -> x=177 | y=134 | z=0 | Angle=150
21:36:12.413 -> 0xyz0
21:36:12.491 -> x=176 | y=135 | z=0 | Angle=120
21:36:12.526 -> 0xyz0
21:36:12.595 -> x=176 | y=134 | z=0 | Angle=90
21:36:12.626 -> 0xyz0
21:36:12.693 -> x=177 | y=134 | z=0 | Angle=60
21:36:12.739 -> 0xyz0
21:36:12.806 -> x=177 | y=134 | z=0 | Angle=30
21:36:12.841 -> 0xyz0
21:36:13.935 -> x=176 | y=135 | z=0 | Angle=0
21:36:13.949 -> 0xyz0
21:36:14.050 -> x=177 | y=185 | z=0 | Angle=30
21:36:14.050 -> 0xyz0
```

Figure 5.3.5: Collected data from Sensors in Serial Monitor (Continuation)

5.3.2 Result Analysis

For object and obstacle detection we examine around 60 test cases where we measure distance with ultrasonic sensor as well as real time distance with measuring tape. from there we get these values where we can see that the object detection is almost close which is accurate in ultrasonic sensor object detection.

Table 5.1: Accuracy of ultrasonic sensors for distance measurements

Real Distance	Detected Distance	Real Distance	Detected Distance	Real Distance	Detected Distance
125	132	83	85	43	44
123	130	81	83	41	41
121	127	79	80	39	38
119	125	77	80	35	35
117	124	75	78	31	31
115	120	73	76	30	30
113	117	71	74	29	29
111	116	69	70	27	27
109	113	67	68	25	25
107	110	65	67	23	23
105	109	63	64	21	21
103	108	61	61	17	18
101	106	59	60	15	14
99	101	57	56	13	14
97	97	55	55	10	10
95	97	53	52	8	9
93	96	51	52	7	7
91	93	49	48	6	6
89	85	47	49	5	5

As we can see our ultrasonic sensor provides stable and accurate distance measurements from 2cm to 150 cm.
we know,
Sound travels at approximately 340 meters per second.
This corresponds to about 29.412µs (microseconds) per centimeter.
To measure the distance the sound has traveled we use the formula:
Distance = (Time x Speed Of Sound) / 2.

The "2" is in the formula because the sound has to travel back and forth. First the sound travels away from the sensor, and then it bounces off of a surface and returns back.
The easy way to read the distance as centimeters is to use the formula:
Centimeters = ((Microseconds / 2) / 29).

For example, if it takes 100µs (microseconds) for the ultrasonic sound to bounce back, then the distance is ((100 / 2) / 29) centimeters or about 1.7 centimeters.

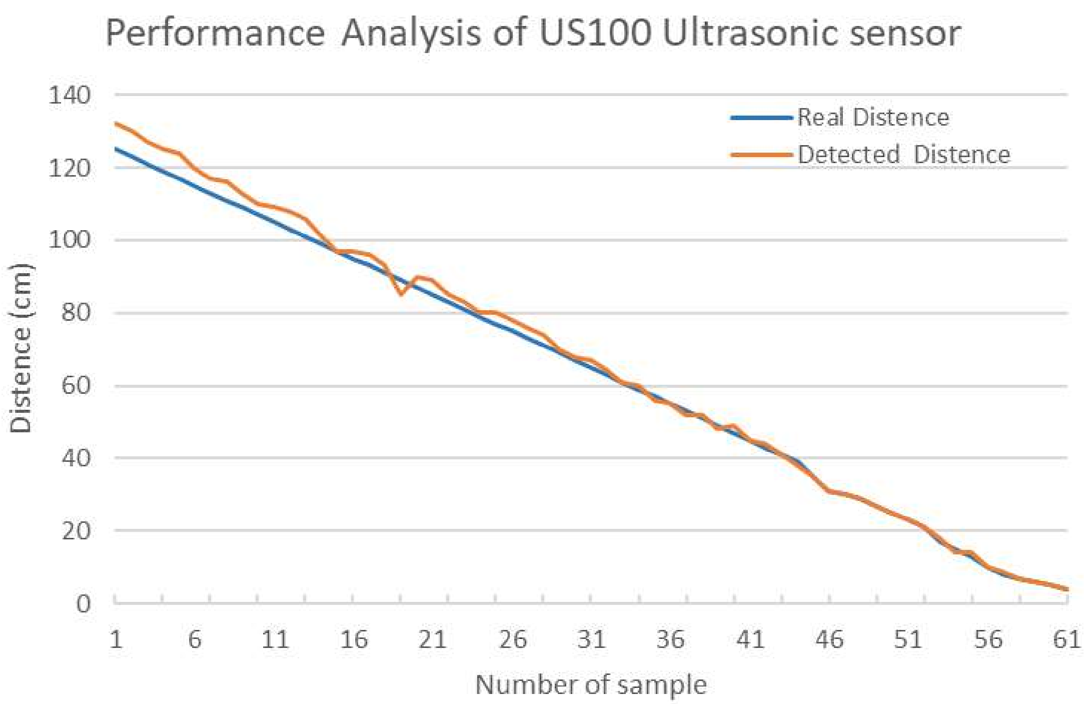

Figure 5.3.6: Performance analysis of ultrasonic sensors

We measured the response time of blind stick when all the systems are running together. Here we added twenty test cases scenarios where object detection and wet surface detection are running and giving feedback time.We collected these data from software simulation of Arduino IDE and matched with real time on stopwatch, which almost gives accurate time for software test cases.

Table 5.2: Comparison of different sensors with response time

Number of cases	**Frontal object detection time**	**Stair detection time**	**Small object detection time**	**Wet surface detection time**
1	1.156	0.987	0.854	2.352
2	1.178	0.821	0.977	2.391
3	1.215	1.487	0.879	2.679
4	1.210	1.785	0.987	2.976
5	1.256	1.078	0.889	1.689
6	1.246	1.565	0.877	2.674
7	1.267	1.548	0.874	2.497
8	1.326	1.065	0.891	2.178
9	1.233	1.068	0.698	2.468
10	1.156	1.037	0.899	2.874
11	1.189	1.057	0.897	1.874
12	1.450	0.965	0.982	1.684
13	1.266	0.866	0.974	1.548
14	1.268	0.898	0.988	1.789
15	1.245	0.985	0.945	2.164
16	1.267	0.898	0.897	2.184
17	1.326	0.895	0.877	2.676
18	1.238	0.987	0.989	2.461
19	1.115	0.887	1.445	2.484
20	1.087	0.983	1.175	2.474

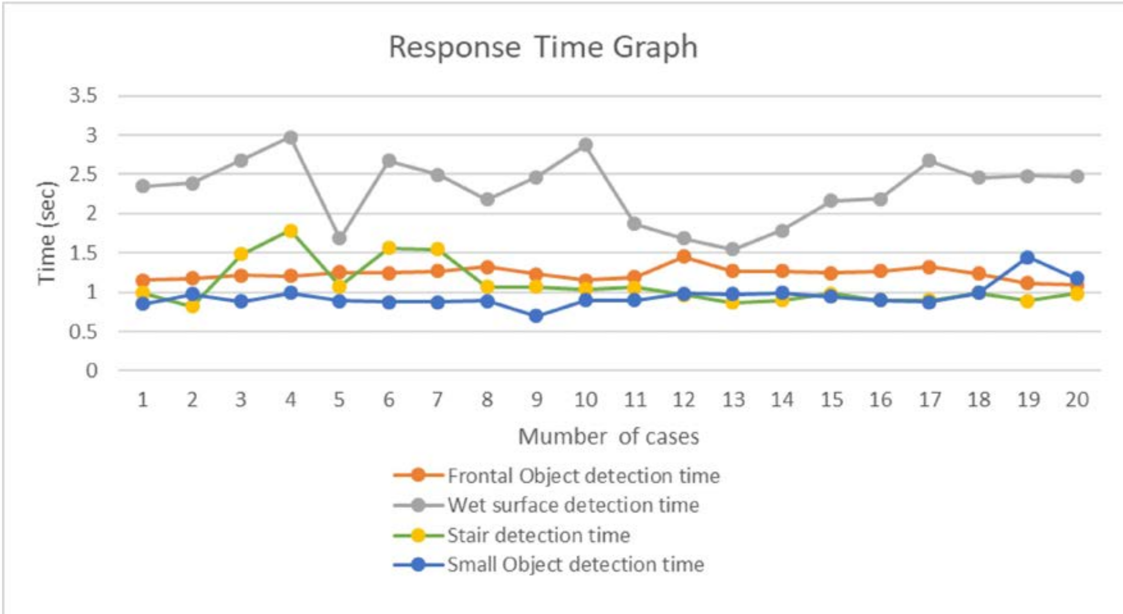

Figure 5.3.7: Response time graph

5.4 Conclusion

In conclusion, the data analysis for the sensor integrated blind stick highlights a user-centric approach to assistive technology combining ultrasonic sensors. The project achieves a balance between functionality and user safety. The sensor provides real-time environmental awareness, delivering clear auditory alerts for obstacle detection, pothole sensing, and continuous scanning for small obstacles. The 2100 mAh battery capacity, derived from a parallel configuration, meets the high-energy demands of the ensemble. The project's adaptability to stakeholder needs demonstrates a commitment to user satisfaction. This data-driven design signifies a significant stride in blind assistive devices, showcasing transformative potential in accessibility technology for the visually impaired.

Chapter 6: Impact Analysis and Project Sustainability. [CO3, CO4]

6.1 Introduction

A cutting-edge solution has been proposed to address the challenges faced by blind individuals in their daily lives. This innovative blind stick represents an evolution of the traditional blind stick, serving as a supportive companion for walking. Equipped with ultrasonic and water sensors, the system sends audio alerts to the user through connected headphones, notifying them of obstacles like walls, water bodies, stairs, or muddy terrain. The device, integrated into a white cane, functions similarly to a white cane by aiding the visually impaired in scanning their surroundings for potential obstacles or landmarks. Additionally, the blind stick facilitates communication by allowing the user to make phone calls for assistance, enhancing their independence and safety in navigating various environments.

6.2 Assess the impact of solution

The advent of technology has heralded a new era of possibilities in addressing challenges faced by individuals with visual impairments. Among the innovative solutions, the blind stick has emerged as a promising aid, seeking to revolutionize the way visually impaired individuals navigate their surroundings. Such as

i. Reliability and User Experience:

The integration of GSM, GPS, and audio feedback with sensor-based blind sticks ensures reliable real-time feedback to users, enhancing their overall experience. With immediate alerts about obstacles and location information, users can confidently navigate their surroundings, fostering trust in the device.

ii. Power Efficiency:

GSM and GPS technologies optimize power consumption in the blind stick, prolonging battery life. This efficiency allows users to rely on the device for extended periods, reducing the frequency of recharging and enhancing its usability as a dependable mobility aid.

iii. Adaptability and Maintenance:

The sensor-based approach, complemented by GPS for location awareness, requires minimal maintenance, ensuring consistent performance in various settings without the need for frequent adjustments.

iv. Cost-Effectiveness:

The integration of GSM, GPS, audio feedback, and sensors contributes to cost-effectiveness by streamlining development and maintenance. The cohesive system simplifies production processes and reduces long-term expenses, making the blind stick an economically viable solution for individuals with visual impairments

v. Response Time:

Immediate alerts to obstacles and real-time location updates ensure swift user feedback, allowing for quick and informed navigation, which is crucial for the safety and efficiency of the blind stick.

vi. Data Privacy:

The integrated system prioritizes data privacy by relying on GSM and GPS technologies for location-based information without extensive image processing. This approach minimizes concerns related to visual data capture and storage, ensuring user privacy and compliance with privacy regulations.

vii. Durability and Scalability:

The blind stick, with integrated GSM, GPS, audio feedback, and sensors, exhibits enhanced durability. The robustness of sensor-based technologies, combined with the resilience of GSM and GPS components, ensures the device remains reliable and effective even in challenging environmental conditions. Additional functionalities or improved sensor capabilities can be seamlessly incorporated, allowing for future enhancements and ensuring the device evolves with technological advancements.

viii. User Training:

The integrated system simplifies user training by providing intuitive audio feedback and clear information through GSM and GPS. Users can quickly adapt to the device, as the integrated technologies enhance the stick's usability without requiring extensive training, promoting a user-friendly experience.

6.3 Evaluate the sustainability

The blind stick has the potential to provide visually impaired people with a sustainable solution. As opposed to conventional blind sticks constructed of non-renewable materials, it is made to use the least amount of renewable energy possible, making it an environmentally responsible alternative. The device's impact is also noteworthy. It contains a range of functions, including obstacle detection, GPS, and voice alarms, which can assist people who are blind or visually impaired in navigating their environment effectively and safely. As a result, there may be a decrease in the likelihood of accidents, and people with impairments may feel more liberated and independent. The quality of life for people who are blind or visually impaired could also be improved by the blind stick. It would successfully ensure equal opportunity and reduce inequalities, which is the 10th goal of Sustainable Development Goal (SDG) set by the United Nations(UN).They may become more involved in their communities and interact better with their environment as a result. In the long run, this might contribute to a general improvement in the accessibility and inclusion of cities and public areas. In addition, The blind stick can improve the quality of life, safety, and sustainability for people who are blind or visually impaired.

6.4 Conclusion

The solution, based on sensor technology, brings inherent advantages in terms of reliability and user experience by providing immediate feedback. This approach contributes to a longer device lifespan through reduced power consumption and ensures adaptability with minimal maintenance requirements in diverse environments. A notable strength lies in cost-effectiveness, attributed to lower development and maintenance costs. On the other hand, the alternative sensor-based approach faces challenges related to factors such as lighting, image quality, and algorithm accuracy, which may lead to inaccuracies. This approach also requires higher power consumption, ongoing maintenance for algorithm upgrades, and may involve higher overall development and production costs. Evaluating the technical trade-offs between the two methods emphasizes the sensor-based solution as a more robust, scalable, and cost-effective choice for addressing the specified issues.

Chapter 7: Engineering Project Management. [CO11, CO14]

7.1 Introduction

Project management is commonly defined as the process of determining the objectives, deliverables, strategy, and procedures of a project. A project's scope and timeline must be established and revised frequently in order for it to succeed. We also need to evaluate the project plan and the resources we have available. It's also critical that team members and the parties involved communicate effectively. Finally, in the event of an emergency, we should be ready with backup plans.

7.2 Define, Plan and Manage Engineering Project

We have organized our tasks in alignment with the timeline established for the Final Year Development Project (FYDP). The delineation of our work corresponds to specific milestones and deadlines outlined within the project's timeline. Below, we present a detailed breakdown of our planned activities and their respective timeframes, ensuring a systematic and structured approach to the FYDP:

Define (Initiation):

During the initial phase, which aligns with the "Define" aspect of engineering project management, our team focuses on key activities such as project initiation. This involves forming the project team, allocating necessary resources, and conducting a thorough review of project requirements to establish a clear understanding of the scope and objectives.

Plan (Research, Design, Development, Testing):

The "Plan" phase encompasses various stages within our project timeline:

- Research and Planning: Extensive research is conducted to gather insights relevant to the project's scope and requirements. A comprehensive plan is formulated, delineating key objectives, methodologies, and deliverables.
- Design and Prototyping: Translating research findings into tangible solutions, we create prototypes and iteratively refine the conceptual framework based on feedback.
- Development: The actual implementation of the project occurs during this stage, encompassing coding, testing, and integration activities.
- Testing and Quality Assurance: Rigorous testing protocols are employed to validate functionality, reliability, and performance. Quality assurance measures are implemented to address any identified issues or discrepancies.

Manage (Documentation, Presentation, Review):

The "Manage" phase involves overseeing the project's execution and ensuring its successful completion:

- Documentation and Reporting: Thorough documentation of the entire development process is undertaken, covering key aspects such as methodologies and outcomes.
- Presentation and Review: A presentation of the completed project is conducted for stakeholders, including sponsors, team members, and relevant authorities. A comprehensive review assesses the project's adherence to timelines, objectives, and overall success.

By adhering to this structured framework of Define, Plan, and Manage, we aim to ensure the successful and timely completion of each phase of the engineering project, ultimately delivering a well-executed and impactful solution.

7.2.1 EEE400P

Table 7.1: Gantt Chart for EEE400P

Serial No	Task	Start	End	Duration
1	Finding Complex Engineering Problems	28/01/2023	02/02/2023	6
2	Research Papers and Journals	28/01/2023	07/02/2023	11
3	Selecting Final Topic	07/02/2023	11/02/2023	5
4	Tentative Problem Statement and Objective	13/02/2023	15/02/2023	2
5	Multiple Design Approach	14/02/2023	19/02/2023	5
6	Specifications, Requirements, Constraints	14/02/2023	20/02/2023	6
7	Applicable standards and Codes	18/02/2023	26/02/2023	8
8	Final Concept Note	28/02/2023	01/03/2023	2
9	Preparation for Progress Presentation	28/02/2023	01/03/2023	2

10	Progress Presentation	02/03/2023	02/03/2023	1
11	Background Research and Project Planning	04/03/2023	12/03/2023	8
12	Methodology, Budget and Impact	06/03/2023	10/03/2023	4
13	Expected Outcome, Sustainability and Safety	12/03/2023	16/03/2023	4
14	Risk Management and Ethical Consideration	28/03/2023	30/03/2023	3
15	Final Project Proposal Note	31/03/2023	03/04/2023	4
16	Preparation for Final Mock Presentation	03/04/2023	05/04/2023	2
17	Mock Presentation	06/04/2023	06/04/2023	1
18	Final Presentation	13/04/2023	13/04/2023	1

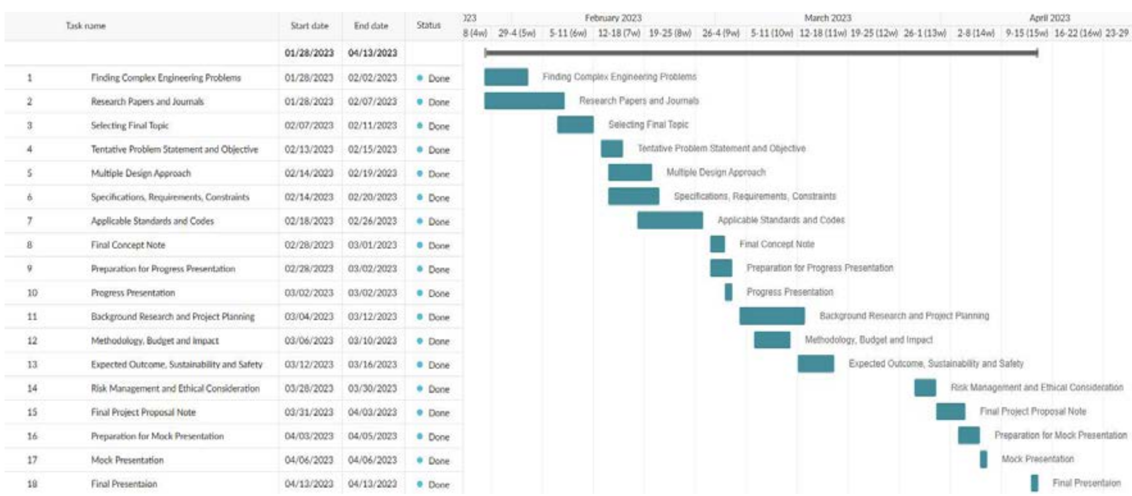

Fig 7.1 : Gantt chart for EEE400P

7.2.2 EEE400D

Table 7.2 : Gantt Chart for EEE400D

Serial No	Task	Start	End	Duration
1	Components Acquisition	28/05/23	03/06/23	7
2	Simulation for Design Approach 1	04/06/23	11/06/23	8
3	Simulation for Design Approach 2	15/06/23	22/06/23	8
4	Prepare Slides for progress presentation	23/6/23	24/6/23	2
5	Progress Report	25/6/23	05/07/23	12
6	Progress Presentation	06/07/23	06/07/23	1
7	Debug Software Simulation	15/07/23	24/07/23	10
8	Analyzing Multiple Solutions	25/07/23	01/08/23	8
9	Analyzing Optimal Solutions	02/08/23	05/08/23	4
10	Draft Report	06/08/23	13/08/23	8
11	Slides for final presentation	14/08/23	17/08/23	4
12	Mock Presentation to ATC	21/08/23	21/08/23	1
13	Final Presentation	24/08/23	24/08/23	1

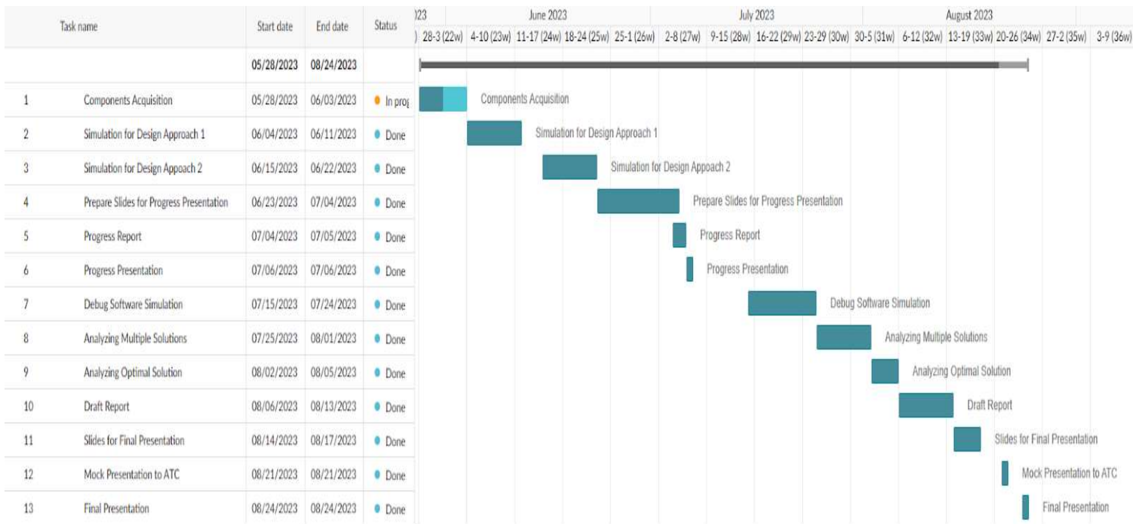

Fig 7.2: Gantt chart for EEE400D

7.2.3 EEE400C

Table 7.3 : Gantt Chart for EEE400C

Serial No	Task	Start	End	Duration
1	Component acquisition of optimal design solution	26/09/2023	02/10/2023	6
2.	Research for the hardware testing of component	03/10/2023	07/10/2023	4
3	Perform tests of the selected components	08/10/2023	14/10/2023	6
4	Developing Prototype, design criteria: Sensors and Buzzer	15/10/2023	21/10/2023	6
5	Developing Prototype, design criteria: GPS, GSM system	22/10/2023	28/10/2023	6
6	Progress Report Preparing	29/10/2023	01/11/2023	3
7	Progress Presentation Slide	29/10/2023	31/10/2023	2
8	Progress Presentation	02/11/2023	02/11/2023	1

9	Developing Prototype, design criteria: Voice feedback system	10/11/2023	18/11/2023	8
10	Developing Prototype of blind stick with all system integration	19/11/2023	25/11/2023	6
11	Perform testing of prototype	25/11/2023	30/11/2023	5
12	Constructing the final prototype	01/12/2023	07/12/2023	6
13	Preparing Draft Progress Report	07/12/2023	16/12/2023	9
14	Preparation for final demonstration of the prototype	16/12/2023	20/12/2023	4
15	Final Demonstration	21/12/2023	21/12/2023	1
16	Preparing Final Report	22/12/2023	27/12/2023	5

Fig 7.4: Gantt chart for EEE400C

7.3 Evaluate Project Progress

If all the negative circumstances are taken into account, every project has a significant number of dangers when it is implemented. The suggested method is an electronic project with built-in electronic parts. A project is more likely to run into risks whenever there are integrated electrical components. There are also additional health risks since the proposed system is linked to direct and ongoing use by a person who is visually impaired. The sensors giving inaccurate data can cause system malfunction in the form of incorrect navigation data which are key for the user's safety. Proper maintenance and troubleshooting can mitigate this issue to some degree. Keeping replacement parts in stock and making it cheaper can also help with this problem. Using proper coding and System management algorithms can decrease system level errors and random malfunctions. Use of better quality and higher capacity batteries can lend in more usage time for the device.

7.4 Conclusion

Project management includes the contingency plans for any malfunction or errors from manufacturing down to the systemic level. A detailed plan for project conduction can smooth out the progress and give desired results. To complete a project successfully and run properly, identification of risky events and setting up contingency plans for them is essential. To conclude, proper planning and management of all possible risk and contingency is regarded as one of the key pillars of all projects.

Chapter 8: Economical Analysis. [CO12]

8.1 Introduction

To evaluate the costs and advantages of a project, an economic analysis is required. Understanding a project's feasibility is made easier with the use of economic analysis. However, the main objective of this type of research is to ascertain the kind of response a product is getting in terms of making money. Furthermore, economic analysis is a highly useful instrument for improving comprehension of any business outcome.

8.2 Economic Analysis

Economic analysis may help us allocate resources more effectively so that we can make more money from any given product. Economic analysis may help us understand the profit margins that a product or business can attain, which allows us to evaluate the product or firm's efficacy. Currently, there are various companies which make assistive blind sticks that help with some level of obstacle detection which is not manual in nature. However, most of them do not come with the wide range of functionality that we are proposing with our design and also do not meet various requirements of the stakeholders. Our system comes with the uniformity of various automated methods of obstacle detection which might cause the user inconvenience. Moreover, the way in which we designed the system and integrated all the components, ensures that it is cost effective and easily manufacturable. The intuitive method of repairability will also help the end user to increase the lifespan of the product.

8.3 Cost Benefit Analysis

A cost-benefit analysis is used to determine if a project is viable. One aspect of economic analysis that, when done well and with precise assumptions, offers the benefit of offering a reliable, quantifiable roadmap for decisions on the product's future is cost-benefit analysis. The project need not be completed at the lowest possible price in order to be deemed cost-effective. The most important variables are the project's sensors and componentry's effectiveness, durability, and performance. To finish the prototype design, a wide variety of parts and sensors were available, but it was challenging to select the ideal one based on both functionality and cost. To achieve the best results, we must select the most affordable and effective component. Even so, each component included in the prototype design has pros and cons of its own. For the final product to guarantee consumer satisfaction, this governance process is essential. The CPU of the system in Design approach-1 uses an Arduino Uno microcontroller to process data from the sensors whereas Raspberry Pi is used as the CPU for Design approach-2. This disparity is because of the difference in method of obstacle detection between these two systems. As the second design utilizes Image Processing for object detection using cameras, a powerful microcontroller was necessary so that we would be able to train the system with some datasets for image recognition. We know, image processing is a complex process to handle for any microcontroller and it is also very power hungry, thus resulting in computational complexity for the 2nd design. There is also the matter of environmental conditions for the 2nd design to efficiently work. Which is why we chose to go with the first design approach.

A table containing the core components of Design approach 1 is given below:

Table 8.1: Core Components of Design Approach-1

Components	Price	Strength	Weakness
Arduino Uno	1100 taka	1. Low cost 2. Easy to change 3. Requires less power to function	1. Can not handle complex processing commands
Ultrasonic Sensors (distance measurement and obstacle detection)	850 + 190 = 1040 taka	1. Low cost option 2. Not affected by dust, dirt or high moisture environments 3. Can be used in the dark	1. Sensor accuracy can be affected by soft materials 2. Has a limited detection range
GPS/GSM Module	3450 taka	1. Instantaneous location sharing 2. SOS signal generation using emergency messages	1. Requires reliable signal

For Design approach -2, the core components are given below:

Table 8.2: Core Components of Design Approach-2

Components	Price	Strength	Weakness
Raspberry Pi	13995 taka	1. Capable of complex computational processing	1. Power hungry 2. Expensive
Camera Module	4090 taka	1. Capable of image processing and object identification	1. Less functionality in the dark 2. Hard to weather proof 3. Requirement of higher megapixel module for more details

By analyzing both tables, we can see that the first design implementation is much better than the second one, making it more cost beneficial for the stakeholders.

8.4 Evaluate Economic and Financial Aspects

This project will be very much beneficial for the mass market both economically and financially. It is a highly integrated design with complete features for the end users for assistive guidance and that too at an affordable price. Its primary target is to ensure ease of usability and accurate guidance. As we use off the shelf components and test them before deployment, there are very little chance of malfunction. The simple functionality of this design ensures that there will be very few errors, as the data collection and analysis is coming from analog sensors. As the product may fulfill many requirements of the visually impaired, the demand of mass production will become very high and generate huge funding from interested fields. This will steadily put a positive impact on the economy of our country. The following budget is allocated for this project:

Table 8.3: Budget for the Design Approach 1

Sl.	Component	Quantity	Price (BDT)	References
1.	Arduino Uno	1	1,100	https://store.roboticsbd.com/arduino-bangladesh/94-8-arduino-uno-r3-robotics-bangladesh.html
2.	GPS GSM GPRS SIM808 Module	1	3,950	https://store.roboticsbd.com/arduino-shield-module/1037-sim808-gprs-gsm-gps-shield-robotics-bangladesh.html
3.	Ultrasonic Sensor (measuring distance)	2	800	https://store.roboticsbd.com/sensors/396-ultrasonic-transducer-waterproof-distance-measuring-sensor-module-robotics-bangladesh.html
4.	Ultrasonic Sensor (obstacle detection)	1	190	https://store.roboticsbd.com/sensors/22-ultrasonic-sonar-sensor-hc-sr04-robotics-bangladesh.html
5.	Servo Motor	1	140	https://store.roboticsbd.com/motor/20-mini-servo-sg90-robotics-bangladesh.html
6	Arduino Nano	1	320	https://www.techbazar.com.bd/product/arduino-nano-v3-0-china/
7	Dfplayer Mini	1	360	https://www.daraz.com.bd/products/dfplayer-mini-mp3-player-module-for-arduino-black-i155056381.html

8	Auditory output device (speaker)	2	300	https://www.daraz.com.bd/products/15-inch-round-speaker-2-3w-i323821430-s1547448490.html
9	Li-ion Battery 18650	4	600	https://www.electronics.com.bd/SONY-LR18650-6800mAh-3.7V-18650-lithium-Battery-Grade-A-SONY-LR18650-6800mAh-3.7V-18650-lithium-Battery-Grade-A-Price-in-online-BD-Bangladesh
10	Push button , Jumper wire, switch	1,1,1	240	N/A
11	Npoly PVC Pipe	5 Feet	500	https://www.banglastall.com/product-details/National-Polymer-PVC-Pipe-Price-BD-%7C-National-Polymer-PVC-Pipe
12.	Miscellaneous cost	N/A	500	N/A
	Total		**9,000 Taka**	

Table 8.4: Budget for the Design Approach 2

Sl.	Component	Quantity	Price (BDT)	Reference
1.	Raspberry pi	1	13,995	https://store.roboticsbd.com/raspberry-pi/1076-raspberry-pi-4-robotics-bangladesh.html
2.	Camera module	1	4690	https://store.roboticsbd.com/raspberry-pi/568-raspberry-pi-camera-v21raspberry-pi-camera-in-robotics-bangladesh.html
3.	Push Button (SOS Button)	1	5	https://store.roboticsbd.com/components/1788-push-button-switch-4-pin12mm12mm-robotics-bangladesh-.html
4.	GPS GSM GPRS SIM808 Module	1	3,450	https://store.roboticsbd.com/arduino-shield-module/579-gps-gsm-gprs-sim808-module-arduino-compatible-robotics-bangladesh.html
5.	Vibration Sensor	1	190	https://store.roboticsbd.com/sensors/2229-piezoelectric-vibration-sensor-module-with-analog-digital-output-roboti

				cs-bangladesh.html
6.	Auditory output device (Ear bud)	1	1,850	https://www.startech.com.bd/uiisii-gm40-pro-tws-earbuds
7.	Li-ion Battery	2	400	https://store.roboticsbd.com/battery/1776-37v-18650-sanford-rechargeable-battery-robotics-bangladesh.html
8.	Li-ion Battery Shield	1	750	https://store.roboticsbd.com/arduino-shield-module/2208-2x-18650-lithium-battery-shield-v8-mobile-power-expansion-board-module-robotics-bangladesh.html
9.	Miscellaneous cost	N/A	500	N/A
	Total		**25,800 Taka**	

8.5 Conclusion

Proper Understanding of how a project will perform in the end is very much dependent on the economic and financial aspects of the project. Economic analysis helps to keep the project well maintained and ensure its sustainability. Moreover, the resources that are fundamental for the project can be assessed by the financial analysis. Relying only on the performance of the project is insufficient to determine if the project will be sustainable in the long run.

Chapter 9: Ethics and Professional Responsibilities [CO13, CO2]

9.1 Introduction

The Ethics and Professional Responsibilities chapter of this project report highlights the imperative nature of ethical considerations in the current environment. With the ease of accessing and using others' content for personal and academic purposes, there is a heightened risk of creating a misleading interpretation of individuals' hard work. Emphasizing the collaborative essence of projects, the chapter acknowledges that not every aspect is undertaken independently, encouraging the integration of ideas and content from others. It underscores the absence of restrictions on collaboration among engineers, stressing the need for ethical practices through proper citation, dedication, and acknowledgment. Additionally, the chapter delves into the vital aspect of stakeholder and user concerns, asserting their crucial role in ensuring the ethical and professional implementation of projects.

9.2 Identify Ethical Issues and Professional Responsibility

The design and implementation of a blind stick integrated with sensors and audio assistance involves several ethical considerations and professional responsibilities. These ethical factors play an important role in the product's viability and consumer prospects. Here are some key points to consider:

Privacy Concerns: The project involves the use of GPS and GSM technologies, raising potential privacy concerns as the user's location data is transmitted. Ensuring the privacy and security of this sensitive information is crucial. Secure data transmission of user location is critical for their privacy and safety.

Data Security: Handling user data, especially location information, requires robust security measures. Protecting this data from unauthorized access or misuse is an ethical responsibility. Location data can be used in various malicious ways, making it a key priority for security improvement.

Reliability and Safety: As the blind stick is designed to assist visually impaired individuals, the reliability of the device is paramount. Ensuring the accuracy of GPS information and the proper functioning of sensors is a professional responsibility. Miscalculation of navigational data and obstacle detection can cause accidents for the user, for which proper testing and use case improvement must be done.

Informed Consent: Users should be fully informed about the capabilities, limitations, and potential risks of the blind stick. Obtaining informed consent from users is an ethical obligation.

Open Communication: Maintaining transparent and open communication about the project's capabilities and limitations with stakeholders, including end-users, developers, and caregivers, is a professional responsibility.

Sensitivity to User Needs: Understanding the unique needs and preferences of visually impaired users is essential. The design and implementation should prioritize user-centric features and functionalities. Making these possible is an ethical responsibility.
Long-Term Support: Providing ongoing support, updates, and maintenance for the blind stick is a professional responsibility to ensure its continued effectiveness and safety.Addressing these ethical issues and professional responsibilities is essential for the successful and responsible development and deployment of the GPS GSM-enabled blind stick.

9.3 Apply Ethical Issues and Professional Responsibility

Considering all the unfavorable conditions, each project carries a notable array of risks during its execution. The recommended approach involves an electronic project featuring incorporated electronic elements. Projects are more prone to encountering risks when they involve integrated electrical components. Moreover, there are supplementary health hazards associated with the proposed system, as it is connected to the continuous use by a visually impaired individual. The subsequent table outlines these risks and outlines the appropriate measures for their management:

Table 9.1: Risk management

Sl.	Risky Events	Management Procedures
1.	Electrical threats	Ensuring that every connection of components are properly installed and insulated.
2.	Component availability	Making sure that alternative components are available.
3.	Collection of incorrect sensor data	Purchasing all the components after carefully inspecting them from trustworthy sources
4.	Battery health and drainage	Regularly keeping an eye on the battery health so that it doesn't stop working in hazardous situations. Alerting about the device battery percentage makes it more safe against sudden unexpected situations.

5.	GPS/GSM Malfunction	The activity of GPS/GSM module should regularly be checked to ensure the safety of the user
6.	Cybersecurity Concerns	The device's GPS connection makes it at risk of hacking, which could put the user at danger if it is compromised. so, it should be taken care of.
7.	Dependency on Technology	Over-reliance on the blind stick might compromise the user's focus span and ability to navigate their surroundings. The user and his/her caregiver should be made understood about the risk.

9.4 Conclusion

In summary, it is imperative to ensure the ethical and professional perspectives of all parties involved in the management of the GPS, GSM, and sensor-equipped audio assistance-based blind stick for visually impaired individuals. This involves the responsible handling of the system from both the user and production ends. Additionally, for any project, it is crucial to uphold ethical standards by maintaining proper credentials and citations for all personnel and documents associated with the development and implementation of the blind stick. This approach not only safeguards the integrity of the project but also reinforces the commitment to ethical considerations and professional responsibilities in the context of creating assistive technologies for the visually impaired.

Chapter 10: Conclusion and Future Work.

10.1 Project Summary/Conclusion

The blind stick with Integrated Sensor and Emergency Assistance System represents a state-of-the-art assistive device aimed at augmenting the autonomy and safety of visually impaired individuals. The device seamlessly integrates ultrasonic sensors for real-time object detection and avoidance, delivering haptic and short audio feedback to the user through speakers or earphones. Furthermore, it incorporates an ultrasonic sensor for slope detection and water moisture sensor to identify potential tripping hazards and wet surfaces. The emergency assistance system is a pivotal aspect, allowing the user to summon help in critical situations. Featuring a built-in GPS module, the device not only facilitates navigation but also transmits the user's real-time location to predefined contacts or emergency services upon activation of the emergency button, ensuring a prompt response in distress scenarios. Designed for user-friendliness, it boasts a straightforward and intuitive interface, complemented by a rechargeable battery for extended usage. This project signifies a noteworthy advancement in assistive technology, effectively addressing the distinctive challenges encountered by individuals with visual impairments and promoting increased independence in their daily lives.

10.2 Future work

Modern technology could lead to breakthroughs in blind sticks in the future. AI and machine learning algorithms are among these advancements, enabling a greater awareness of the user's surroundings and progressive adaptability. With the use of advanced sensors and computer vision algorithms, enhanced object identification capabilities can offer comprehensive details about particular items or barriers. When navigating complicated surroundings, intelligent navigation and path planning algorithms—which take into consideration variables like traffic and busy areas—can greatly increase efficiency. Real-time feedback and alerts can be provided through integration with wearable technology, including smart watches or augmented reality glasses, improving accessibility overall. Improvements to haptic feedback systems are intended to provide users with more detailed information, such as the kind and distance of barriers that have been detected. A seamless user experience depends on the creation of simple user interfaces, which may include voice commands, gesture detection, or touch-sensitive controls. In addition, to increase the battery life of blind sticks, energy efficiency must be prioritized through the use of power-efficient technologies. Emergency assistance features handle critical situations by offering rapid access to support and location sharing with emergency services. On the other hand, connectivity features facilitate contact with other devices, data sharing, and real-time updates from cloud-based platforms. Enhanced localization skills and comprehensive interior mapping provide seamless navigation in expansive public areas. Personalization and adaptability are improved by machine learning for user patterns, multi-sensory integration, and customizable profiles.

Chapter 11: Identification of Complex Engineering Problems and Activities.

11.1: Identify the attribute of complex engineering problem (EP)

Table 11.1: Attributes of Complex Engineering Problems (EP)

	Attributes	Put tick (✓) as appropriate
P1	Depth of knowledge required	✓
P2	Range of conflicting requirements	
P3	Depth of analysis required	✓
P4	Familiarity of issues	
P5	Extent of applicable codes	
P6	Extent of stakeholder involvement and needs	✓
P7	Interdependence	✓

11.2: Provide reasoning how the project address selected attribute (EP)

P1. Depth of knowledge required: This project calls for expertise in a wide range of electrical engineering disciplines. For the hardware circuit setups to be implemented, expertise of digital logic design and hardware implementation is required for analyzing sensor data with microcontroller data processing. Also, algorithm designing and machine learning knowledge is needed if we want to make proper decisions based on input data. Thus, depth of knowledge is a must for this project.

P3. Depth of analysis required: Using the collected data, decisions will be made regarding different types of object detection and give solutions for any circumstances. For such purposes all sensor data must be analyzed thoroughly to compare with optimum situation data and give out results.

P6. Extent of stakeholder involvement and needs: In recent years the number of blind and visually impaired people have been increased. For their betterment of walk movement, we need to get their feedback as a user of blind sticks and implement those ideas if it is fruitful for them. So, stakeholder involvement and needs has been extended.

P7 Interdependence: In blind stick interdependent systems, the effectiveness of decision-making relies on the quality and diversity of data acquired, the accuracy of the training process, and the adaptability of the algorithms to user-specific inputs. Continuous feedback loops between data acquisition, training, and decision-making stages contribute to the refinement and optimization of the blind stick's performance, ultimately enhancing its ability to provide meaningful assistance to visually impaired individuals.

11.3 Identify the attribute of complex engineering activities (EA)

Table 11.2 Attributes of Complex Engineering Activities (EA)

	Attributes	Put tick (✓) as appropriate
A1	Range of resource	✓
A2	Level of interaction	✓
A3	Innovation	
A4	Consequences for society and the environment	✓
A5	Familiarity	

11.4 Provide reasoning how the project address selected attribute (EA)

A1. Range of resource: Expertise of electrical and electronics knowledge is required as we need to sense different types of object from the blind stick. We need deep knowledge for implementation of electronics components and data analysis for machine learning.

A2. Level of interaction: To complete this project we need to talk to the expert of industry to implement blind sticks for user friendly. We also gather feedback and suggestions from the stakeholders about the system level design and their requirements.

A4: Consequences for society and the environment:
Positive Consequences: blind sticks could significantly enhance the mobility and independence of visually impaired individuals. The stick's sensors and navigation capabilities could help users avoid obstacles, navigate unfamiliar environments, and travel more confidently.
Negative Consequences: While technology can be empowering, there's a risk that visually impaired individuals might become overly reliant on blind sticks, neglecting traditional mobility skills and navigational techniques. This could be problematic if the technology fails or malfunctions.

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Appendix

Software Simulation Code For Design Approach 1

```
#include <SoftwareSerial.h>
#include <TinyGPS++.h>
#include <Tone.h>
#include <Wire.h>
#include <LiquidCrystal_I2C.h>

LiquidCrystal_I2C lcd(0x27,16,2);

#define TRIGGER_PIN_OBJ 2
#define ECHO_PIN_OBJ 3
#define TRIGGER_PIN_SLOPE 4
#define ECHO_PIN_SLOPE 5
#define MOISTURE_PIN A0
#define IR_PIN A1
#define EMERGENCY_PIN 6
#define VIBRATION_PIN 7
#define SPEAKER_PIN 8
#define GSM_TX_PIN 9
#define GSM_RX_PIN 10
#define GPS_TX_PIN 11
#define GPS_RX_PIN 12
#define BAUD_RATE 9600

SoftwareSerial gpsSerial(GPS_TX_PIN, GPS_RX_PIN);
SoftwareSerial gsmSerial(GSM_TX_PIN, GSM_RX_PIN);
TinyGPSPlus gps;
Tone speaker;

int alertThreshold = 30;
int moistureThreshold = 285;
void setup() {
  pinMode(TRIGGER_PIN_OBJ, OUTPUT);
  pinMode(ECHO_PIN_OBJ, INPUT);
```

```
  pinMode(TRIGGER_PIN_SLOPE, OUTPUT);
  pinMode(ECHO_PIN_SLOPE, INPUT);
  pinMode(MOISTURE_PIN, INPUT);
  pinMode(IR_PIN, INPUT);
  pinMode(EMERGENCY_PIN, INPUT_PULLUP);
  pinMode(VIBRATION_PIN, OUTPUT);
  pinMode(SPEAKER_PIN, OUTPUT);

 lcd.init();                      // initialize the lcd
 lcd.init();
  // Print a message to the LCD.
 lcd.backlight();
 lcd.setCursor(3,0);
 lcd.print("blind stick!");


  gpsSerial.begin(BAUD_RATE);
  gsmSerial.begin(BAUD_RATE);
  speaker.begin(SPEAKER_PIN);
  Serial.begin(BAUD_RATE);
}

void loop() {
  detectObject();
  detectSlope();
  detectWetMud();
  detectPothole();
  checkEmergency();
  readGPS();
  lcd.setCursor(0,1);
  lcd.print("...                  ");

}

void detectObject() {
  long duration;
  int distance;
```

```
  digitalWrite(TRIGGER_PIN_OBJ, LOW);
  delayMicroseconds(2);
  digitalWrite(TRIGGER_PIN_OBJ, HIGH);
  delayMicroseconds(10);
  digitalWrite(TRIGGER_PIN_OBJ, LOW);
  duration = pulseIn(ECHO_PIN_OBJ, HIGH);
  distance = duration * 0.034 / 2;

  if (distance <= alertThreshold) {
    digitalWrite(VIBRATION_PIN, HIGH);
    Serial.println("Object Detected!");
    lcd.setCursor (0, 1);
    lcd.print("Object Detected!**");
    delay(10);
    playAudioFeedback("Object Detected!");
  } else {
    digitalWrite(VIBRATION_PIN, LOW);
  }
}

void detectSlope() {
  long duration;
  int distance;
  digitalWrite(TRIGGER_PIN_SLOPE, LOW);
  delayMicroseconds(2);
  digitalWrite(TRIGGER_PIN_SLOPE, HIGH);
  delayMicroseconds(10);
  digitalWrite(TRIGGER_PIN_SLOPE, LOW);
  duration = pulseIn(ECHO_PIN_SLOPE, HIGH);
  distance = duration * 0.034 / 2;

  if (distance <= alertThreshold) {
    digitalWrite(VIBRATION_PIN, HIGH);
    lcd.setCursor (0, 1);
    lcd.print("Slope Detected!");
    delay(10);
    Serial.println("Slope Detected!");
```

```
    playAudioFeedback("Slope Detected!");
  } else {
    digitalWrite(VIBRATION_PIN, LOW);
  }
}

void detectWetMud() {
  int moisture = analogRead(MOISTURE_PIN);

  if (moisture > moistureThreshold) {
    digitalWrite(VIBRATION_PIN, HIGH);
    lcd.setCursor (0, 1);
    lcd.print("Wet Mud Detected!");
    delay(10);
    Serial.println("Wet Mud Detected!");
    playAudioFeedback("Wet Mud Detected!");
  } else {
    digitalWrite(VIBRATION_PIN, LOW);
  }
}

void detectPothole() {
  if (digitalRead(IR_PIN) == HIGH) {
    digitalWrite(VIBRATION_PIN, HIGH);
    Serial.println("Pothole Detected!");
    lcd.setCursor (0, 1);
    lcd.print("Pothole Detected!");
    delay(10);
    playAudioFeedback("Pothole Detected!");
  } else {
    digitalWrite(VIBRATION_PIN, LOW);
  }
}

void checkEmergency() {
  if (digitalRead(EMERGENCY_PIN) == LOW) {
```

```
    sendEmergencySMS();
    Serial.println("Emergency!");

    lcd.setCursor (0, 1);
    lcd.print(" Emergency Messagee Sending...  ");
    delay(100);
  }
}

void sendEmergencySMS() {

  Serial.println("I need emergency assistance. My location is:");
  Serial.println("Latitude: 23.68500000, ");
  Serial.println(gps.location.lat(), 23.68500000);
  Serial.print("Longitude: 90.36055556");
  Serial.println(gps.location.lng(), 90.36055556);

  delay(100);
}

void readGPS() {
while (gpsSerial.available() > 0) {
if (gps.encode(gpsSerial.read())) {
if (gps.location.isValid()) {
        Serial.println("Latitude: ");
        Serial.println(gps.location.lat(), 23.68500000);
        Serial.println("Longitude: ");
        Serial.println(gps.location.lng(), 90.36055556);
      }
    }
  }
}

void playAudioFeedback(const char* message) {
  }
```

Software Simulation Code For Design Approach 2

```
import cv2
import numpy as np
img = cv2.imread("image/car.jpg")
cv2.rectangle(img, pt1=(100,100), pt2=(800,500),color=(255,0,0),thickness=3)
cv2.putText(img,org=(50,70),fontScale=4,color=(255,0,0),thickness=3,lineType=cv2.LINE_
AA,text="car",fontFace=cv2.FONT_ITALIC)
print(img.shape)

cv2.imshow("window",img)

cv2.waitKey(4000)


img = cv2.imread("image/dog.jpg")
cv2.rectangle(img, pt1=(100,100), pt2=(800,500),color=(255,255,0),thickness=3)
cv2.putText(img,org=(100,100),fontScale=4,color=(255,255,0),thickness=3,lineType=cv2.LI
NE_AA,text="DOG",fontFace=cv2.FONT_ITALIC)

print(img.shape)

cv2.imshow("window",img)
cv2.waitKey(2000)

img = cv2.imread("image/Bike.jpg")
cv2.rectangle(img, pt1=(300,400), pt2=(600,800),color=(255,255,0),thickness=3)
cv2.putText(img,org=(400,400),fontScale=4,color=(255,255,0),thickness=3,lineType=cv2.LI
NE_AA,text="Bike",fontFace=cv2.FONT_ITALIC)

print(img.shape)

cv2.imshow("window",img)
cv2.waitKey(2000)

img = cv2.imread("image/manhole.jpg")
cv2.rectangle(img, pt1=(400,80), pt2=(3200,1500),color=(255,0,0),thickness=5)
cv2.putText(img,org=(400,200),fontScale=6,color=(255,0,0),thickness=5,lineType=cv2.LINE
_AA,text="manhole",fontFace=cv2.FONT_ITALIC)


img_resize=cv2.resize(img,(800,800))
print(img_resize.shape)
```

```
cv2.imshow("window",img_resize)
cv2.waitKey(2000)

img = cv2.imread("image/electricpole.jpg")
cv2.rectangle(img, pt1=(80,80), pt2=(400,500),color=(0,0,255),thickness=3)
cv2.putText(img,org=(50,50),fontScale=3,color=(0,0,255),thickness=2,lineType=cv2.LINE_
AA,text="electricpole",fontFace=cv2.FONT_ITALIC)

print(img.shape)

cv2.imshow("window",img)
cv2.waitKey(2000)

img = cv2.imread("image/tree.jpg")
cv2.rectangle(img, pt1=(100,50), pt2=(400,200),color=(255,255,0),thickness=3)
cv2.putText(img,org=(50,50),fontScale=2,color=(255,255,0),thickness=2,lineType=cv2.LINE
_AA,text="tree",fontFace=cv2.FONT_ITALIC)

print(img.shape)

cv2.imshow("window",img)
cv2.waitKey(2000)


class_labels = []
with open('coco_labels.txt', 'r') as f:
class_labels = f.read().split('\n')

net = cv2.dnn.readNetFromDarknet('yolov3.cfg', 'yolov3.weights')

net.setPreferableBackend(cv2.dnn.DNN_BACKEND_OPENCV)
net.setPreferableTarget(cv2.dnn.DNN_TARGET_CPU)

image = cv2.imread('input_image.jpg')

blob = cv2.dnn.blobFromImage(image, 1 / 255.0, (416, 416), swapRB=True, crop=False)

net.setInput(blob)

output_layers = net.getUnconnectedOutLayersNames()
layer_outputs = net.forward(output_layers)

boxes = []
confidences = []
class_ids = []
```

```
for output in layer_outputs:
for detection in output:
scores = detection[5:]
class_id = np.argmax(scores)
confidence = scores[class_id]

if confidence > 0.5:
box = detection[0:4] * np.array([image.shape[1], image.shape[0], image.shape[1], image.shape[0]])
(center_x, center_y, width, height) = box.astype('int')

x = int(center_x - (width / 2))
y = int(center_y - (height / 2))

boxes.append([x, y, int(width), int(height)])
confidences.append(float(confidence))
class_ids.append(class_id)

indices = cv2.dnn.NMSBoxes(boxes, confidences, 0.5, 0.3)

for i in indices:
i = i[0]
box = boxes[i]
x, y, width, height = box
label = class_labels[class_ids[i]]
confidence = confidences[i]

cv2.rectangle(image, (x, y), (x + width, y + height), (0, 255, 0), 2)
cv2.putText(image, f'{label}: {confidence:.2f}', (x, y - 10), cv2.FONT_HERSHEY_SIMPLEX, 0.5, (0, 255, 0), 2)

cv2.imshow('Object Detection', image)
cv2.waitKey(0)
cv2.destroyAllWindows()


import cv2
import numpy as np

net = cv2.dnn.readNet('yolov3.weights', 'yolov3.cfg')
classes = []
with open('coco.names', 'r') as f:
   classes = f.read().splitlines()

cap = cv2.VideoCapture('test.mp4')
img = cv2.imread('img.png')

while True:
```

```
    _, img = cap.read()
    height, width, _ = img.shape

    blob = cv2.dnn.blobFromImage(img, 1/255, (416, 416), (0, 0, 0), swapRB=True,
crop=False)
    net.setInput(blob)
    output_layers_names = net.getUnconnectedOutLayersNames()
    layerOutputs = net.forward(output_layers_names)

    boxes = []
    confidences = []
    class_ids = []

    for output in layerOutputs:
        for detection in output:
            scores = detection[5:]
            class_id = np.argmax(scores)
            confidence = scores[class_id]
            if confidence > 0.7:
                center_x = int(detection[0] * width)
                center_y = int(detection[1] * height)
                w = int(detection[2] * width)
                h = int(detection[3] * height)

                x = int(center_x - w / 2)
                y = int(center_y - h / 2)

                boxes.append([x, y, w, h])
                confidences.append(float(confidence))
                class_ids.append(class_id)

    indexes = cv2.dnn.NMSBoxes(boxes, confidences, 0.5, 0.4)

    font = cv2.FONT_HERSHEY_COMPLEX
    colors = np.random.uniform(0, 255, size=(len(boxes), 3))

    for i in indexes.flatten():
        x, y, w, h = boxes[i]
        label = str(classes[class_ids[i]])
        confidence = str(round(confidences[i], 2))
        color = colors[i]
        cv2.rectangle(img, (x, y), (x + w, y + h), color, 2)
        cv2.putText(img, label + " " + confidence, (x, y + 20), font, 1, (255, 0, 0), 2)
```

```
    cv2.imshow('image', img)
    key = cv2.waitKey(1)
    if key == 27:
        break

cap.release()
cv2.destroyAllWindows()
```

Hardware Simulation Code For Optimal Design

```
#include <NewPing.h>
#include <SoftwareSerial.h>
#include <DFRobotDFPlayerMini.h>
#include <Servo.h>
#define water_PIN 13
int servoPin = 12;
int angle = 0;
int readings[5];
int sum = 0;
int i = 0;
// Use pins 2 and 3 to communicate with DFPlayer Mini
static const uint8_t PIN_MP3_TX = 2; // Connects to module's RX
static const uint8_t PIN_MP3_RX = 3; // Connects to module's TX
SoftwareSerial softwareSerial(PIN_MP3_RX, PIN_MP3_TX);
// Create the Player object
DFRobotDFPlayerMini player;
Servo servo;
NewPing s1(4,5,400);
NewPing s2(6,7,400);
NewPing s3(8,9,400);
int x,y,z;
void dis(){
  // distence//
  x=s1.ping_cm();
  y=s2.ping_cm();
```

```
  z=s3.ping_cm();

//water code start//
  int water = digitalRead(water_PIN);
  readings[i] = water;

 for (int i = 0; i < 5; ++i) {
    sum += readings[i];
    if(sum==6){sum=0;}
  }
  i++;
   if(i==6){i=0;}



  Serial.print("x=");
  Serial.print(x);

  Serial.print(" | y=");
  Serial.print(y);

  Serial.print(" | z=");
  Serial.print(z);

  Serial.print(" | Angle=");
  Serial.println(angle);

 Serial.print(sum);
```

```
 Serial.print("xyz");
 Serial.print(water);
 Serial.println();

if (x<=120 & x!=0){
  player.volume(30);
  player.play(4);
  delay(1000);
}
if(sum==5){
 /// player.volume(10);
  //player.play(3);
  delay(1000);
}
if (y>=70 &y<=100 & y!=0 ){
  player.volume(30);
  player.play(2);
  delay(1000);
}
if (y>=100 & z!=0 ){
  player.volume(30);
  player.play(1);
  delay(1000);
}
if (z<=80 & z!=0 & angle<90){
  player.volume(30);
  player.play(6);
```

```
  delay(1000);
}
if (z<=90 & z!=0 & angle>90){
  player.volume(30);
  player.play(7);
  delay(1000);}

  if (z<=90 & z!=0 & angle==90){
  player.volume(30);
  player.play(5);
  delay(1000);
}
}

void setup() {
  Serial.begin(9600);
  softwareSerial.begin(9600);
  servo.attach(servoPin);
  pinMode(water_PIN , INPUT);

 if (player.begin(softwareSerial)) {
   Serial.println("OK");
  }
 else {
    Serial.println("Connecting to DFPlayer Mini failed!");
  }
}
```

```
void loop(){
  //delay(20);

  // scan from 0 to 180 degrees
   for(angle = 0; angle < 180; angle+=30) {
     dis();
      servo.write(angle);
      delay(15);
   }

   // now scan back from 180 to 0 degrees
   for(angle = 180; angle > 0; angle-=30) {
     dis();
      servo.write(angle);
      delay(15);
   }

 delay(1000);
}
```

GPS GSM SYSTEM CODE:

```
#include <DFRobot_SIM808.h>
#include <SoftwareSerial.h>
#define MESSAGE_LENGTH 160
#define button_PIN 9
#define LED_PIN 10

char message[MESSAGE_LENGTH];
int messageIndex = 0;
char MESSAGE[300];
```

```
char lat[12];
char lon[12];
char wspeed[12];


char phone[16];
char datetime[24];


#define PIN_TX    2
#define PIN_RX    3
SoftwareSerial mySerial(PIN_TX,PIN_RX);
DFRobot_SIM808 sim808(&mySerial);//Connect RX,TX,PWR,


void setup()
{
  mySerial.begin(9600);
  Serial.begin(9600);
  pinMode(button_PIN, INPUT);
   pinMode(LED_PIN, OUTPUT);
  //******** Initialize sim808 module *************
  while(!sim808.init())
  {
      Serial.print("Sim808 init error\r\n");
      delay(1000);
  }
  delay(3000);


  if( sim808.attachGPS()){
      Serial.println("Open the GPS power success");}
  else
      {Serial.println("Open the GPS power failure");

  Serial.println("Init Success, please send SMS message to me!");
}
```

```
}


void loop()
{
  //*********** Detecting unread SMS ************************
if (sim808.getGPS()) {
  Serial.print(sim808.GPSdata.year);
   Serial.print("/");
   Serial.print(sim808.GPSdata.month);
   Serial.print("/");
   Serial.print(sim808.GPSdata.day);
  Serial.print(" ");
   Serial.print(sim808.GPSdata.hour);
   Serial.print(":");
  Serial.print(sim808.GPSdata.minute);
  Serial.print(":");
  Serial.print(sim808.GPSdata.second);
  Serial.print(":");
  Serial.println(sim808.GPSdata.centisecond);


   Serial.print("latitude :");
   Serial.println(sim808.GPSdata.lat,6);


  sim808.latitudeConverToDMS();
  Serial.print("latitude :");
  Serial.print(sim808.latDMS.degrees);
  Serial.print("\^");
  Serial.print(sim808.latDMS.minutes);
  Serial.print("\'");
  Serial.print(sim808.latDMS.seconeds,6);
  Serial.println("\"");
  Serial.print("longitude :");
  Serial.println(sim808.GPSdata.lon,6);
  sim808.LongitudeConverToDMS();
```

```
 Serial.print("longitude :");
 Serial.print(sim808.longDMS.degrees);
 Serial.print("\^");
 Serial.print(sim808.longDMS.minutes);
 Serial.print("\'");
 Serial.print(sim808.longDMS.seconeds,6);
Serial.println("\"");


 Serial.print("speed_kph :");
 Serial.println(sim808.GPSdata.speed_kph);
Serial.print("heading :");
 Serial.println(sim808.GPSdata.heading);
 digitalWrite(LED_PIN,HIGH);
   //*********** At least, there is one UNREAD SMS ***********
   if(digitalRead(button_PIN)==1){
    Serial.println(digitalRead(button_PIN));

    delay(100);
    Serial.println("did it");
     float la = sim808.GPSdata.lat;
      float lo = sim808.GPSdata.lon;
      float ws = sim808.GPSdata.speed_kph;
      int PHONE_NUMBER = "+8801959215076";
      dtostrf(la, 2, 6, lat); //put float value of la into char array of lat. 6 = number of digits
before decimal sign. 2 = number of digits after the decimal sign.
      dtostrf(lo, 6, 6, lon); //put float value of lo into char array of lon
      dtostrf(ws, 6, 6, wspeed);  //put float value of ws into char array of wspeed

      //sprintf(MESSAGE, "Latitude : %s\nLongitude : %s\nWind Speed : %s kph\nMy
Module Is Working. Try With This
Link.\nhttp://www.latlong.net/Show-Latitude-Longitude.html\nhttp://maps.google.com/maps
?q=%s,%s\n", lat, lon, wspeed, lat, lon);
      sprintf(MESSAGE, " I need EMergency help here: Latitude : %s\ ,Longitude : %s , Or tap
this link - \http://maps.google.com/maps?q=%s,%s\n", lat, lon, lat, lon);

       Serial.println("Sim808 init success");
```

```
      Serial.println("Start to send message ...");
      Serial.println(MESSAGE);
      Serial.println(phone);
      sim808.sendSMS(PHONE_NUMBER,MESSAGE);
      delay(15000);
 digitalWrite(LED_PIN,LOW);
}
delay(15000);
}
}
```

FYDP (P) Spring 2023 Summary of Group 03 Log Book/ Journal

Project Title:
DESIGN AND IMPLEMENTATION OF A BLIND STICK INTEGRATED WITH SENSORS AND AUDIO ASSISTANCE FOR VISUALLY IMPAIRED PEOPLE

Group-3

	Final Year Design Project (P) Spring 2023		
Student Details	**NAME & ID**	**EMAIL ADDRESS**	**PHONE**
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ATC Details:			
ATC 3			
Chair	Dr. AKM Abdul Malek Azad, Professor, Department of EEE, Brac University	a.azad@bracu.ac.bd	
Member 1	Dr. Touhidur Rahman, Professor, Department of EEE, Brac University	touhidur.rahman@bracu.ac.bd	
Member 2	Mohammed Thushar Imran, Lecturer, Department of EEE, Brac University	thushar.imran@bracu.ac.bd	

FYDP (P) Spring 2023 Summary of Group 03 Log Book/ Journal

Date/Time /Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
26.01.2023 (FYDP committee class-1)	**Students:** 1.Al Amin 2.Amlan 3.Imtiaz (Abid was absent due to sickness) **Faculty member:** 1. Mohaimenul Islam, Lecturer	Lecture-1: Introductory Class EEE400(P)		
28.01.2023 (Group meeting-1)	1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1. We discussed different types of electrical and electronic field areas to get some project ideas. 2. Individually desired to choose two different project topic ideas until the next meeting.	Task 1: Everyone Task 2: Everyone **Progress:** Task 1: Completed Task 2: Completed	
02.10.2023 (FYDP committee class-2)	**Students:** 1.Al Amin 2.Abid 3.Imtiaz (Amlan was absent due to sickness) **Faculty member:** 1. Prof. Dr. Arshad M. Chowdhury, Dean, School of Engineering.	Lecture-2: Complex Engineering Problem Identification		

FYDP (P) Spring 2023 Summary of Group 03 Log Book/ Journal

Date/Time /Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
04.02.2023 (Group meeting-2) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1. Shared and discussed our project ideas 2. Shortlisting 4 ideas among 8 project ideas 3. Evaluated whether the selected topic ideas are complex engineering problems or not.	Task 1: Everyone Task 2: Everyone Task 3: Al Amin **Progress:** Task 1: Completed Task 2: Completed Task 3: Completed	
09.02.2023 (FYDP committee class-3)	**Students:** 1.Al Amin 2.Abid 3.Imtiaz 4. Amlan **Faculty member:**1. Dr. Md. Mosaddekur Rahman, Chairperson, Dept. of EEE	Lecture-3: Introduction to engineering Design Process		
11.02.2023 (ATC meeting-1)	**ATC members:** 1. Prof. Dr. AKM Abdul Malek Azad 2. Prof. Dr. Touhidur Rahman 3. Mohammed Thushar Imran **Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1. ATC Introduction. 2. Directed to do further background research on selected two ideas from four ideas . 3. Send mail to ATC with our finalized ideas with supporting research papers.	Task 1: Everyone Task 2: Everyone Task 3: Al Amin **Progress:** Task 1: Completed Task 2: Completed Task 3: Completed	

FYDP (P) Spring 2023 Summary of Group 03 Log Book/ Journal

Date/Time /Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
13.02.2023 (Group meeting-3) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1. Background research on smart stick for visually impaired people by research papers.	Task 1: Everyone **Progress:** Task 1: Completed	
15.02.2023 (Group meeting-4)	**Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1. Discussed about how we can make smart stick with GPS system	Task 1: Everyone **Progress:** Task 1: Completed	
16.02.2023 (FYDP committee class-4)	**Students:** 1.Al Amin 2.Abid 3.Imtiaz 4. Amlan **Faculty member:** 1. Dr. Abu S.M. Mohsin, Associate Professor, Dept. of EEE	Lecture-4:Case Study: How to Identify a Complex Engineering Design Project and Fulfill CO Criteria		
17.02.2023 (Group meeting-5) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1. Project Title Selection 2. Writing problem statement as a draft for concept note	Task 1: Everyone Task 2: Al Amin & Imtiaz **Progress:** Task 1: Completed Task 2: Completed	
18.02.2023 (Group meeting-6) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1. Writing tentative objectives as a draft for concept note 2. In depth discussion and study research papers for multiple design approach as a draft for concept note 3. Design Methodology for smart blind stick	Task 1: Amlan & Imtiaz Task 2: Al Amin & amlan task 3: Al Amin & Abid **Progress:** Task 1: Completed Task 2: Completed Task 3: Completed	

FYDP (P) Spring 2023 Summary of Group 03 Log Book/ Journal

Date/Time /Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
19.02.2023 (Group meeting-7)	**Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1. Identify the functional, non-functional and system level requirements of our project. 2. Discussion about the specification of our project and finding the components based on the specification. 3. Adding references in the concept note. 4. Citing references in the problem statement. 5. Adding comparison criteria. 6. Adding attributes of Complex Engineering Problems in the concept note.	Task 1: Everyone Task 2: Everyone Task 3: Al Amin Task 4: Amlan & Imtiaz Task 5: Al Amin task 6: Al Amin **Progress:** Task 1: Completed Task 2: Completed Task 3: Completed Task 4: Completed Task 5: Completed Task 6: Completed	
22.02.2023 (Group meeting-8)	**Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1. Review the draft concept note and take necessary corrections. 2. Update the logbook 3. Mail Draft Concept Book to ATC panel	Task 1: Everyone Task 2: Al Amin Task 3: Al Amin **Progress:** Task 1: Completed Task 2: Completed Task 3: Completed	
23.02.2023 (FYDP committee class-5)	**Students:** 1.Al Amin 2.Abid 3.Imtiaz 4. Amlan **Faculty member:** 1. Abdullah Hil Kafi, Lecturer, Dept. of EEE	Lecture-05: Project Safety, Sustainability and Environmental impact in Engineering Design		

FYDP (P) Spring 2023 Summary of Group 03 Log Book/ Journal

Date/Time /Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
26.02.2023 (ATC meeting-2)	**ATC members:** 1. Prof. Dr. AKM Abdul Malek Azad 2. Prof. Dr. Touhidur Rahman 3. Mohammed Thushar Imran **Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1. Get feedback from the ATC panel and fully correct the draft concept note. 2. Instructed to prepare progress presentation slide and we send it within 1 March,2023 3. Practice and give mock presentations among ourselves.	Task 1: Everyone Task 2: Abid Task 3: Everyone **Progress:** Task 1: Completed Task 2: Completed Task 3: Completed	
02.03.2023 (FYDP Progress presentation with ATC panel and FYDP committee members)	**Students:** 1.Al Amin 2.Abid 3.Imtiaz 4. Amlan **ATC members:** 1. Prof. Dr. Touhidur Rahman **Faculty member:** 1. Mohaimenul Islam, Lecturer. 2. Taiyeb Hasan Sakib, Lecturer	1. Presenting our progress on Smart Stick for Visually Impaired People.		1. Get feedback to identify more for functional requirements. 2. Distinguish a little bit in design methodology.
04.03.2023 (Group meeting-9) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Imtiaz	1. Planning about writing the project proposal. 2. Planning the tentative budget. 3. Update logbook 4. Identify component for the project	Task 1: Everyone Task 2: Amlan Task 3: Abid & Imtiaz Task 4: Al Amin **Progress:** Task 1: Completed Task 2: Completed Task 3: Completed Task 4: Completed	

FYDP (P) Spring 2023 Summary of Group 03 Log Book/ Journal

Date/Time /Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
07.03.2023 (Group meeting-10)	**Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1. Started working on Budget and Project planning. 2. Started writing the Gantt chart and Tabulation. 3. Started making the flowchart for Methodology part 4. Started making the sustainability matrix.	Task 1: Amlan Task 2: Imtiaz Task 3: Al Amin & Abid Task 4: Everyone **Progress:** Task 1: Partially Completed Task 2: Partially Completed Task 3: Partially Completed Task 4: Partially Completed	
09.03.2023 (Group meeting-11)	**Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1. Complete the detailed flowchart and start writing the Methodology. 2. Start writing the Expected outcome and impact. 3. Complete the tentative budget for 2 design approaches.	Task 1: Al Amin & Abid Task 2: Al Amin Task 3:Amlan **Progress:** Task 1: Completed Task 2: Partially Completed Task 3: Completed	
10.03.2023 (Group meeting-12) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1.Complete the gantt chart and project plan for 400P, 400C and 400D. 2. Started writing the Ethical Consideration and Risk Management and analysis. 3. Start writing Safety Considerations.	Task 1: Imtiaz Task 2: Al Amin Task 3: Abid & Amlan **Progress:** Task 1: Completed Task 2: Partially Completed Task 3: Partially Completed	

FYDP (P) Spring 2023 Summary of Group 03 Log Book/ Journal

Date/Time /Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
11.03.2023 (Group meeting-13) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1. Complete writing of Ethical Consideration, Risk management 2. Complete writing of Safety Consideration. 3. Update logbook.	Task 1: Al Amin Task 2: Amlan & Abid Task 3: Imtiaz **Progress:** Task 1: Completed Task 2: Completed Task 3: Completed	
16.03.2023 (FYDP committee class-6)	**Students:** 1.Al Amin 2.Abid 3.Imtiaz 4. Amlan **Faculty member:** 1. Abdullah Hil Kafi, Lecturer, Dept. of EEE	Lecture-6: Review of Engineering Ethics and Professional Practices.		
17.03.2023 (Group meeting-14) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1. Complete methodology with detailed explanation 2. Start writing the explanation of the attributes of complex engineering problems (EP).	Task 1: Al Amin Task 2: Everybody **Progress:** Task 1: Completed Task 2: Partially Completed	
20.03.2023 (Group meeting-15)	**Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1. Provide explanation/justification for choosing the criteria of "Complex Engineering Problems (EP)" and "Complex Engineering Activities (EA)" 2. Update logbook.	Task 1: Everybody Task 2: Al Amin **Progress:** Task 1: Completed Task 2: Completed	
23.03.2023 (FYDP committee class-7)	**Students:** 1.Al Amin 2.Abid 3.Amlan (Imtiaz was absent due to mothers sickness) **Faculty member:** 1. Mohaimenul Islam, Lecturer.	Lecture-7: Review of Project Proposal Preparation and Project Management.		

FYDP (P) Spring 2023 Summary of Group 03 Log Book/ Journal

Date/Time /Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
30.03.2023 (FYDP committee class-8)	**Students:** 1.Al Amin 2.Imtiaz (Amlan and Abid was absent for sickness) **Faculty member:** 1. Taiyeb Hasan Sakib, Lecturer	Lecture-8: Report Writing and Presentation Technique.		
01.04.2023 (Group meeting-16) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1. Complete the project proposal draft. 2. Maintain the font size and page margin according to the given format.	Task 1: Everybody Task 2: Al Amin **Progress:** Task 1: Completed Task 2: Completed	
03.03.2023 (Group meeting-17)	**Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1. Start making presentation slide 2. Update Logbook	Task 1: Everybody Task 2: Al Amin **Progress:** Task 1: Partially Completed Task 2: Completed	
04.04.2023 (Group meeting-18) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1.Continuation of making presentation slide	Task 1: Everybody **Progress:** Task 1: Partially Completed	
05.04.2023 (Group meeting-19) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1.Continuation of making presentation slide	Task 1: Everybody **Progress:** Task 1: Partially Completed	
06.04.2023 (Group meeting-20)	**Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1.Complete presentation slide 2. Send mail with presentation slides, project proposal notes and updated logbook before 06.04. 2023	Task 1: Everybody Task 2: Al Amin **Progress:** Task 1: Completed Task 2: Completed	

FYDP (P) Spring 2023 Summary of Group 03 Log Book/ Journal

Date/Time /Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
08-04-2023 (ATC Meeting-3)	**ATC members:** 1. Prof. Dr. AKM Abdul Malek Azad 2. Prof. Dr. Touhidur Rahman 3. Mohammed Thushar Imran **Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1. Mock Presentation of FYDP-P Final Presentation 2. Update Logbook 3. Get feedback on presentation slides, project proposals and logbooks.	Task 1: Everybody Task 2: Al Amin **Progress:** Task 1: Completed Task 2: Completed	1.In slides use bullet points instead of sentences and add slide numbers. 2. Add system level specification in slides as well as project proposal. 3. Add ''Any Question" to the last slide. 4. In the project proposal add component level description.
10.04.2023 (Group meeting-21) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1.Customize the slide theme and add page number. 2. Find out system level specifications. 3. Make bullet points for slide.	Task 1: Al Amin Task 2: Al Amin & Abid Task 3: Everybody **Progress:** Task 1: Completed Task 2: Completed Task 3: Completed	
11.04.2023 (Group meeting-22) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1. Practice and give mock presentations among ourselves.	Task 1: Everybody **Progress:** Task 1: Completed	
13-04-2023 Final Presentation (FYDP committee class)	**Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1. Final Proposal Presentation to all ATC panel members and FYDP Committee.		

FYDP (P) Spring 2023 Summary of Group 03 Log Book/ Journal

Date/Time /Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
14.04.2023 (Group meeting-23) [Online]	**Students:** 1. Al Amin 2. Abid	1. Adding component level description 2.Revise methodology 3. Adding system level description 4. Update Logbook	Task 1: Al Amin Task 2: Al Amin & Abid Task 3: Abid Task 4: Al Amin **Progress:** Task 1: Completed Task 2: Completed Task 3: Completed Task 4: Completed	
16.04.2023 (Group meeting-24) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1. Revise Project Proposal 2. Revise Logbook 3. Send Project proposal and logbook to ATC panel before 16.04.2023	Task 1: Everybody Task 2: Everybody Task 3: Al Amin **Progress:** Task 1: Completed Task 2: Completed Task 3: Completed	

FYDP (D) Summer 2023 Summary of Group 03 Log Book/ Journal

Project Title:
DESIGN AND IMPLEMENTATION OF A BLIND STICK INTEGRATED WITH SENSORS AND AUDIO ASSISTANCE FOR VISUALLY IMPAIRED PEOPLE

Group-3

	Final Year Design Project (D) Summer 2023		
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Member 4	Kazi Saklain Imtiaz 19121006	kazi.saklain.imtiaz@g.bracu.ac.bd	01794727502
ATC Details:			
ATC 3			
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Member 1	Dr. Touhidur Rahman, Professor, Department of EEE, Brac University	touhidur.rahman@bracu.ac.bd	
Member 2	Mohammed Thushar Imran, Lecturer, Department of EEE, Brac University	thushar.imran@bracu.ac.bd	

FYDP (D) Summer 2023 Summary of Group 03 Log Book/ Journal

Date/Time/Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
08.06.23 (FYDP-D committee class)	**Students:** 1.Al Amin 2.Amlan 3.Imtiaz 4.Abid (Absent due to sickness) **Faculty member:** 1. Tasfin Mahmud, Lecturer	Introduction of FYDP- D (EEE400D)		
10.06.23 (ATC Meeting-1) [Online]	**ATC members:** 1. Prof. Dr. AKM Abdul Malek Azad 2. Prof. Dr. Touhidur Rahman **Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1. Discussed about the weekly meeting procedure and submission of weekly work before Friday. 2. Update Gantt Chart according to work update and follow the timeline properly.	Task 1: Everyone Task 2: Everyone	1.Have to start working on design approaches
12.06.23 (Group meeting-1) [Offline]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1. Work on the design approach 1 for circuit diagram and functional code. 2. Update problem statement in background research part 3. Project Design Report organization.	Task 1: Al Amin, Abid Task 2: Imtiaz Task 3: Amlan **Progress:** Task 1: Partially Completed Task 2: Completed Task 3: Completed	
15.06.23 (Group meeting-2) [Offline]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1.Continuation of working on circuit diagram and simulation code 2. Update Logbook 3. Write Modern Engineering IT Tools description in report 4. Attach Simulation work in report 5. Prepare Gantt chart for FYDP-D & C	Task 1: Al Amin, Abid Task 2: Al Amin Task 3: Al Amin, Amlan Task 4: Abid Task 5: Imtiaz **Progress:** Task 1: Partially Completed Task 2: Completed Task 3: Completed Task 4: Partially Completed Task 5: Not Completed	

FYDP (D) Summer 2023 Summary of Group 03 Log Book/ Journal

Date/Time/Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
17.06.23 (ATC Meeting-2) [Online]	**ATC members:** 1. Prof. Dr. AKM Abdul Malek Azad 2. Prof. Dr. Touhidur Rahman 3. Mohammed Thushar Imran **Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1. Discussed about the mistakes in the project report and logbook.	Task 1: Everyone	1.Need to prepare a Gantt chart for FYDP D & C by next meeting.
19.06.23 (Group meeting-3) [Offline]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4. Imtiaz	1.Add component weight in specification. 2.Continuation of working on circuit diagram and simulation code 3. Prepare Gantt chart for FYDP-D & C	Task 1: Amlan Task 2: Al Amin, Abid Task 3: Imtiaz **Progress:** Task 1: Completed Task 2: Partially Completed Task 3: Partially Completed	
21.06.23 (Group meeting-4) [Offline]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1. Add hyperlink in budget references 2. Continuation of working on circuit diagram and simulation code 3. Prepare Gantt chart for FYDP-D & C	Task 1: Amlan Task 2: Al Amin, Abid Task 3: Imtiaz **Progress:** Task 1: Completed Task 2: Partially Completed Task 3: Completed	
22.06.23 (Group meeting-5) [Offline]	**Students:** 1. Al Amin 2. Abid 3. Amlan	1.Continuation of working on simulation code of design approach 1 2.Continuation of working on circuit diagram 3. Update Logbook	Task 1: Al Amin Task 2: Al Amin, Abid Task 3: Al Amin **Progress:** Task 1: Completed Task 2: Partially Completed Task 3: Completed	
23.06.23 (Group meeting-6) [Offline]	**Students:** 1.Al Amin 2.Abid	1.Continuation of working on circuit diagram and run with different cases for design approach 1	Task 1: Everyone **Progress:** Task 1: Partially Completed	

FYDP (D) Summer 2023 Summary of Group 03 Log Book/ Journal

Date/Time/Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
24.06.23 (ATC Meeting-3) [Online]	**ATC members:** 1. Prof. Dr. AKM Abdul Malek Azad 2. Prof. Dr. Touhidur Rahman 3. Mohammed Thushar Imran **Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1.Show the simulation of design approach 1	Task 1: Everyone	1.Work on Design Approach 2 has to get started.
27.06.23 (Group meeting-7) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4. Imtiaz	1.Modification of the report based on the feedback given. 2.Update Logbook	Task 1: Abid, Amlan Task 2: Al Amin **Progress:** Task 1: Completed Task 2: Completed	
04.07.23 (Group meeting-8) [Offline]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4. Imtiaz	1.Preparing Progress Presentation Slides	Task 1: Everyone **Progress:** Task 1: Partially Completed	
05.07.23 (Group meeting-9) [Offline]	**Students:** 1. Al Amin 2. Amlan 3. Abid	1.Preparing Progress Presentation Slides	Task 1: Everyone **Progress:** Task 1: Partially Completed	
06.07.23 (Group meeting-10) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4. Imtiaz	1.Preparing Progress Presentation Slides 2.Work on the design approach 2 for functional code.	Task 1: Al Amin, Amlan Task 2: Al Amin, Abid **Progress:** Task 1: Completed Task 2:Partially Completed	
06.07.23 FYDP-D Progress Presentation	**Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1,Presenting our progress on Design And Implementation of Smart Stick for Visually Impaired People		1. Prepare dataset for the design approach 2 for better object visualizing.

FYDP (D) Summer 2023 Summary of Group 03 Log Book/ Journal

Date/Time/Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
08.07.23 (Group meeting-11) [Offline]	**Students:** 1. Al Amin 2. Amlan	1.Continuation of working on the design approach 2. 2.Update Logbook	Task 1: Al Amin, Amlan Task 2: Al Amin **Progress:** Task 1: Partially Completed Task 2: Completed:	
08.07.23 (ATC Meeting-4) [Online]	**ATC members:** 1. Prof. Dr. AKM Abdul Malek Azad 2. Mohammed Thushar Imran **Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1.Show the simulation of design approach 2 2.Modification needed for logbook	Task 1: Everyone Task 2: Everyone **Progress:** Task 1: Partially Completed Task 1: Completed	1.Need to send a report and logbook in time.
10.07.23 (Group meeting-12) [Offline]	**Students:** 1. Al Amin 2. Amlan 3. Abid	1.Continuation of working on the design approach 2 where we simulate different types of image objects for image processing. 2.Update Logbook	Task 1: Al Amin, Amlan, Abid Task 2: Al Amin **Progress:** Task 1: Partially Completed Task 2: Completed:	
11.07.23 (Group meeting-13) [Offline]	**Students:** 1. Al Amin 2. Amlan 3. Abid	1.Further research on Image Processing for object detection. 2.Update logbook	Task 1: Al Amin, Amlan Task 2: Al Amin **Progress:** Task 1: Partially Completed Task 2: Completed	
12.07.23 (Group meeting-14) [Offline]	**Students:** 1. Al Amin 2. Amlan 3. Abid	1.Create datasets for different types of object data for the help of simulation. 2.Write contingency plan in Project Report.	Task 1: Al Amin, Abid Task 2: Amlan **Progress:** Task 1: Partially Completed Task 2: Completed	
13.07.23 (Group meeting-15) [Offline]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4. Imtiaz	1.Continuation of working on image datasets where we run objects by datasets. 2.Update logbook. 3.Write Design Approach 1 Component level description. 4.Write Report summary.	Task 1: Al Amin,Abid Task 2: Al Amin Task 3: Imtiaz Task 4: Amlan **Progress:** Task 1: Partially Completed Task 2: Completed Task 3: Partially Completed Task 4: Completed	

FYDP (D) Summer 2023 Summary of Group 03 Log Book/ Journal

Date/Time/Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
15.07.23 (ATC Meeting-5) [Online]	**ATC members:** 1. Prof. Dr. AKM Abdul Malek Azad 2. Mohammed Thushar Imran **Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1. Feedback on correcting font size, project title, giving numbers to all the figures, rewriting some points of functional requirements, scopes and objectives	Task 1: Everyone	1. Reviewing report and need to correct all the errors
23.07.23 (Group meeting-16) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4. Imtiaz	1.Continuation of working on image datasets where we detect objects through real time checking 2.Update logbook. 3.Work on auditory output for design approach 1	Task 1: Al Amin,Abid Task 2: Amlan Task 3: Imtiaz, Abid **Progress:** Task 1: Partially Completed Task 2: Completed Task 3: Partially Completed	
24.07.23 (Group meeting-17) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1.Work on auditory output for design approach 1 2.Update logbook 3. Correct report errors according to the feedback given in previous meeting	Task 1: Al Amin,Abid Task 2: Amlan Task 3: Imtiaz, Amlan **Progress:** Task 1: Partially Completed Task 2: Completed Task 3: Partially Completed	
26.07.23 (Group meeting-18) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1.Work on auditory output for design approach 1 2.Update logbook 3. Work on real time location tracking by GPS for design approach 1	Task 1: Al Amin,Abid Task 2: Amlan Task 3: Al Amin,Imtiaz **Progress:** Task 1: Partially Completed Task 2: Completed Task 3: Partially Completed	
28.07.23 (Group meeting-19) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4. Imtiaz	1.Continuation of working on image datasets where we detect objects through real time checking 2.Update logbook 3.Work on real time location tracking by GPS for design approach 1	Task 1: Al Amin,Amlan Task 2: Amlan Task 3: Imtiaz,Abid **Progress:** Task 1: Partially Completed Task 2: Completed Task 3: Partially Completed	

FYDP (D) Summer 2023 Summary of Group 03 Log Book/ Journal

Date/Time/Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
01.08.23 (Group meeting-20) [Offline]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4. Imtiaz	1.Analyzing Image data that is needed for detecting objects on the road. 2.Work on real time location tracking by GPS for design approach 1 3. Work on auditory output for design approach 1	Task 1: Everyone Task 2: Al Amin, Abid Task 3: Al Amin, Amlan **Progress:** Task 1: Completed Task 2: Partially Completed Task 3: Partially Completed	
04.08.23 (Group meeting-21) [Online]	**Students:** 1. Al Amin 2. Amlan	1.Correct report errors according to the feedback given in previous meeting (Design Approach 2 Block) 2.Update Logbook	Task 1: Al Amin,Amlan Task 2: Al Amin **Progress:** Task 1: Completed Task 2: Completed	
05.08.23 (ATC Meeting-6) [Online]	**ATC members:** 1. Prof. Dr. AKM Abdul Malek Azad **Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1.Getting feedback regarding project report and logbook 2. Advice to present in group meetings to contribute to group work.	Task 1: Everyone	1. Need to complete design approaches within this week 2. In report start writing on design approach 2 3. Need to send video of two design approaches
07.08.23 (Group meeting-22) [Offline]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4. Imtiaz	1.Work on auditory output for design approach 1 2.Work on real time location tracking by GPS for design approach 1 3.Update Logbook	Task 1: Everyone Task 2: Everyone Task 3: Al Amin **Progress:** Task 1: Completed Task 2: Completed Task 3: Completed	
09.08.23 (Group meeting-23) [Offline]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4. Imtiaz	1.Completion of simulation of design approach 2	Task 1: Everyone **Progress:** Task 1: Completed	
11.08.23 (Group meeting-24) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1.Completion of simulation design approach 1 2.In report,writing explanation of design approach 2 3.In report, writing expected impact 4.In report writing GPS and SMS explanation part for design approach 1 5.In report, writing optimal solution	Task 1: Everyone Task 2: Al Amin Task 3: Amlan Task 4: Abid Task 5: Imtiaz **Progress:** Task 1: Completed Task 2: Completed Task 3: Incomplete Task 4: Completed Task 5: Incomplete	

FYDP (D) Summer 2023 Summary of Group 03 Log Book/ Journal

Date/Time/Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
12.08.23 (ATC Meeting-7) [Online]	**ATC members:** 1. Prof. Dr. AKM Abdul Malek Azad **Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1. Showing the simulation of two design approaches. 2. Show the working update on Project Logbook and report for this week.	Task 1: Everyone Task 2: Al Amin	1.Prepare Final Presentation Slide and will send it before the next meeting.
14.08.23 (Group meeting-25) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Abid	1.Recording video of the two design approaches and debugging it if any issue occured. 2.Preparing Final Presentation Slides.	Task 1: Everyone Task 2: Everyone **Progress:** Task 1: Completed Task 2: Partially Completed	
15.08.23 (Group meeting-26) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Imtiaz	1.In report, writing table of contents 2.In report, writing expected impact of the optimal solution 3.In report, writing optimal solution	Task 1: Al Amin Task 2: Al Amin, Imtiaz Task 3: Amlan **Progress:** Task 1: Completed Task 2: Completed Task 3: Completed	
16.08.23 (Group meeting-27) [Offline]	**Students:** 1. Al Amin 2. Amlan 3. Abid	1.Preparing Final Presentation Slides.	Task 1: Everyone **Progress:** Task 1:Partially Completed	
17.08.23 (Group meeting-28) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Abid (Absent due to sickness.)	1.Preparing Final Presentation Slides. 2. Update Logbook	Task 1: Everyone Task 2: Al Amin **Progress:** Task 1: Completed Task 2: Completed	
21.08.23 (ATC Meeting-8) [Online]	**ATC members:** 1. Prof. Dr. AKM Abdul Malek Azad 2. Prof. Dr. Touhidur Rahman 3. Mohammed Thushar Imran **Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1.Giving Mock presentation to the ATC panel.	Task 1: Everyone	1.Presentation should be finished in time. 2. Make a 3D model for a smart stick. 3.Send final report and slide before 30th August.
22.08.23 (Group meeting-29) [Offline]	**Students:** 1. Al Amin 2. Amlan 3. Abid	1.Slide modification according to the feedback from ATC Panel. 2.Battery percentage showing simulation for the betterment for project design.	Task 1: Everyone Task 2: Everyone **Progress:** Task 1: Completed Task 2: Partially Completed	

FYDP (D) Summer 2023 Summary of Group 03 Log Book/ Journal

Date/Time/Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
23.08.23 (Group meeting-30) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4. Imtiaz	1.Battery percentage showing simulation for the betterment for project design. 2.Report Modification in Optimal Design Part	Task 1: Everyone Task 2: Al Amin, Amlan **Progress:** Task 1: Completed Task 2: Completed	
24.08.23 FYDP-D Final Presentation	**Students:** 1. Al Amin 2. Amlan 3. Imtiaz 4. Abid	1,Give a final presentation on Design And Implementation of Smart Stick for Visually Impaired People to all ATC Panel.		1.Give some graphical data regarding machine learning approach
25.08.23 (Group meeting-31) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4. Imtiaz	1. For our design approach 2, which is a machine learning approach, where we add graphical data in slides in the optimal solution part. 2.Update Logbook	Task 1: Everyone Task 2: Al Amin **Progress:** Task 1: Completed Task 2: Completed	

FYDP (C) Fall 2023 Summary of Group 03 Log Book/ Journal

Project Title:
DESIGN AND IMPLEMENTATION OF A BLIND STICK INTEGRATED WITH SENSORS AND AUDIO ASSISTANCE FOR VISUALLY IMPAIRED PEOPLE

Group-3

	Final Year Design Project (C) Fall 2023		
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FYDP (C) Fall 2023 Summary of Group 03 Log Book/ Journal

Date/Time/Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
27.09.23 (Group meeting-1) [Offline]	**Students:** 1.Al Amin 2.Amlan 3.Imtiaz 4.Abid	1. Start component acquisition for the prototype of the optimal solution of our design.	Task 1: Everyone	
02.10.23 (Group meeting-2) [Offline]	**Students:** 1.Al Amin 2.Amlan 3.Imtiaz 4.Abid	1.Developing plan for the completion of prototype design and divided work for report writing segments 2. Correction of dates in FYDP-C gantt chart along with rewriting it completely.	Task 1: Everyone Task 2: Al Amin (Date Plan), Imtiaz (Gantt Chart) **Progress:** Task 1: Completed Task 2: Partially Completed	
06.10.23 (FYDP-C committee class)	**Students:** 1.Al Amin 2.Amlan 3.Imtiaz 4.Abid **Faculty member:** Abu S.M Mohsin, Associate Professor	Introduction of FYDP- C (EEE400C) Provide Guidelines regarding: ● Report writing ● Poster preparing ● Final Book		
07.10.23 (ATC Meeting-1) [Online]	**ATC members:** 1. Prof. Dr. AKM Abdul Malek Azad **Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1.Discussed the report writing procedure and gave instructions to us on how to deal with the overall plan. 2.Discussed about the timeline of the entire semester and instructed to prepare before the deadline and complete it early as soon as possible.	Task 1: Everyone Task 2: Everyone **Progress:** Task 1: Completed Task 2: Completed	1.Need to start working on prototype design and report writing. 2. Maintain the work schedule according to gantt chart and follow the FYDP Committee given timeline

FYDP (C) Fall 2023 Summary of Group 03 Log Book/ Journal

Date/Time/Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
09.10.23 (Group meeting-3) [Offline]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4. Imtiaz	1. Start working on the prototype design with component testing 2. Updating EEE400C gantt chart.	Task 1: Al Amin, Abid, Amlan Task 2: Imtiaz **Progress:** Task 1: Partially Completed Task 2: Completed	
09.10.23 (Group meeting-4) [Offline]	**Students:** 1.Al Amin 2.Amlan 3.Imtiaz 4.Abid	1. Continuation of working on the prototype design with component testing	Task 1: Everyone **Progress:** Task 1: Completed	
13.10.23 (Group meeting-5) [Online]	**Students:** 1.Al Amin 2.Amlan 3.Imtiaz 4.Abid	1. Divide the work of project report writing to all members: 2.Update Logbook	Task 1: Everyone a) Amlan: Chapter 1 b) Imtiaz: Chapter 2 c) Abid: Chapter 3 d) Al Amin: Chapter 4 Task 2: Al Amin **Progress:** Task 1: a) Partially Completed b) Partially Completed c) Not Completed d) Partially Completed Task 2: Completed	

FYDP (C) Fall 2023 Summary of Group 03 Log Book/ Journal

Date/Time/Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
14.10.23 (ATC Meeting-2) [Online]	**ATC members:** 1. Prof. Dr. AKM Abdul Malek Azad 2. Prof. Dr. Touhidur Rahman **Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1. Provide feedback regarding report writing. 2. Development of the prototype design.	Task 1: Everyone Task 2: Everyone **Progress:** Task 1: Completed Task 2: Completed	1.Prepare final gantt chart. 2.Prototype design related work needs to be recorded.
16.10.23 (Group meeting-6) [Offline]	**Students:** 1.Al Amin 2.Amlan 3.Imtiaz 4.Abid	1.Developing Prototype regarding ultrasonic sensors and buzzer: a)Determining the distance between the sensor and the object. b)Program the ultrasonic sensor to measure distances. c)Implement logic to trigger the buzzer when the distance between the sensor and an object is less than a certain threshold, indicating an obstacle. d) Connect the ultrasonic sensor to the microcontroller following the datasheet or pinout diagram.	Task 1: Everyone a)Al Amin, Abid b)Al amin, Abid c)Amlan, Imtiaz d) Al Amin, Abid **Progress:** Task 1: Partially Completed a) Completed b) Completed c) Completed d) Not Completed	
18.10.23 (Group meeting-7) [Offline]	**Students:** 1.Al Amin 2.Amlan 3.Abid	1.Continuation of developing prototype regarding ultrasonic sensors and buzzer: a)Connect the ultrasonic sensor to the microcontroller following the datasheet or pinout diagram. b)Connect the vibration motor or buzzer to the microcontroller. c)Optimize your code for better performance and efficiency.	Task 1: Everyone a)Al Amin, Abid b)Al amin, Abid c)Amlan, Al Amin **Progress:** Task 1: Completed a) Completed b) Completed c) Completed	

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20.10.23 (Group meeting-8) [Online]	**Students:** 1.Al Amin 2.Amlan 3.Imtiaz 4.Abid	1. Divide the work of project report writing to all members (Continuation from 13.10.23) 2.Update Logbook	Task 1: Everyone a) Amlan: Chapter 1 b) Imtiaz: Chapter 2 c) Abid: Chapter 3 d) Al Amin: Chapter 4 Task 2: Al Amin **Progress:** Task 1: a) Completed b) Completed c) Partially Completed d) Completed Task 2: Completed	
21.10.23 (ATC Meeting-3) [Online]	**ATC members:** 1. Prof. Dr. AKM Abdul Malek Azad **Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1.Provide feedback regarding logbook and report writing. a) In the report's literature gap section, a proper research paper citation should be added. 2.Observed the progress of hardware implementation	Task 1: Everyone Task 2: Everyone **Progress:** Task 1: Completed Task 2: Completed	1.Logbook writing needs to improve in terms of writing and work division among group members.
26.10.23 (Group meeting-9) [Offline]	**Students:** 1.Al Amin 2.Amlan 3.Imtiaz 4.Abid	1.Developing subsystem of the Prototype regarding GPS, GSM system: a) First,familiarize ourselves with the GSM module's commands and communication protocols. b) Then, learn how to send and receive SMS messages using the module. c)Then, Learn how to communicate with the GPS module and extract GPS data. (latitude, longitude, etc.) d)Connect the GSM module to the microcontroller according to the module's datasheet or pinout diagram. e)Connect the GPS module to the microcontroller, usually using UART communication. f)Attach antennas to both GSM and GPS modules for better signal reception. g. Write program code for a microcontroller with the Arduino IDE. .	Task 1: Everyone a)Al Amin, Abid, Amlan b) Abid c) Amlan d) Al Amin e) Al Amin, Abid f) Imtiaz g. Al Amin, Abid **Progress:** Task 1: Partially Completed a) Completed b) Completed c) Completed d) Completed e) Completed f) Completed g) Partially Completed	

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Date/Time/Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
27.10.23 (Group meeting-10) [Online]	**Students:** 1.Al Amin 2.Amlan 3.Imtiaz 4.Abid	1.Continuation of developing the subsystem of the Prototype regarding GPS, GSM system: a)Write program code for a microcontroller with the Arduino IDE. . b)Configure the GSM module to send and receive SMS messages. Implement error handling and response mechanisms. c)Optimize code for efficiency, especially if the system needs to run on a low-power microcontroller for extended periods. 2)Continuation Of Project Report writing: (Continuation from 20.10.23) a)Chapter 3 b)Chapter 6 c)chapter 7 d)chapter 11 3) Update logbook	Task 1: Everyone a) Al Amin, Abid b) Abid, Al Amin c) Al Amin d) Al Amin Task 2: a)Abid b) Amlan c) Imtiaz d)Al Amin Task 3: Al Amin **Progress:** Task 1: Completed a) Completed b) Completed c) Completed d) Completed Task 2: a) Partially Completed b) Partially Completed c) Partially Completed d) Completed Task 3: Completed	
28.10.23 (ATC Meeting-4) [Online]	**ATC members:** 1. Prof. Dr. AKM Abdul Malek Azad 2. Mohammed Thushar Imran **Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1.Mention different mistakes in logbook and report writing. a) Add table of contents in report b) Change the picture of image processing in multiple design approach 2.	Task 1: Everyone a) Al Amin, Abid b) Amlan , Imtiaz **Progress:** Task 1: Completed Task 2: Completed	1.Complete work according to the Gantt Chart. 2. Send progress presentation slides on 31.10.23
29.10.23 (Group meeting-11) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1.Adjust the slide for the presentation. 2.We rehearse and perform a mock presentation together.	Task 1: Everyone Task 2: Everyone **Progress:** Task 1: Completed Task 2: Completed	

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Date/Time/Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
02.11.23 FYDP-C Progress Presentation	**Students:** 1.Al Amin 2.Amlan 3.Imtiaz 4.Abid **Faculty member:** Abu S.M Mohsin, Associate Professor	1.Giving presentation in front of Faculty members: Amlan: Introduction, Problem statement, Objective, Functional and Nonfunctional requirements and Constraints Abid: Specifications, Modern Engineering Tools, Multiple design approaches, Optimal solutions Al Amin: Simulation of Multiple design approaches, Showcase of hardware implementation of optimal design solutions. Imtiaz: Budget, Project plan, Sustainability, impact, Ethical Considerations, References, Conclusions.	Task 1: Everyone	1.The project prototype building should be finished as early as possible..
06.11.23 (Group meeting-12) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1.Developing subsystem of the prototype regarding voice assistance feature: a) Learn how voice recognition modules work and how to train them for specific commands. b) Understand the basics of text-to-speech technology and the available modules. c) Write a program for the microcontroller. Implement logic for voice recognition and processing user commands. d) Define a set of voice commands that the blind stick can recognize e) Implement hardware navigation assistance features such as notifying about upcoming obstacles f) Test the voice assistance system in various environments to ensure accurate recognition of voice commands.	Task 1: a) Imtiaz b) Amlan c) Al Amin d) Abid e) Al Amin, Abid f) Amlan, Imtiaz **Progress:** Task 1:Partially Completed a) Completed b) Completed c) Completed d) Completed e) Partially Completed f) Partially Completed	

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Date/Time/Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
13.11.23 (Group meeting-13) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1.Continuation of Project Report writing: (Continuation from 27.10.23) a)Chapter 3 b)Chapter 6 c)chapter 7 2.Update Logbook	Task 1: a) Abid b) Amlan c) Imtiaz Task 2: Al Amin **Progress:** Task 1: Completed a) Completed b) Completed c) Completed Task 2: Completed	
15.11.23 (Group meeting-14) [Online]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1.Continuation of Project Report writing: (Continuation from 13.11.23) a) Chapter 8 b)Chapter 9 c)Chapter 10 d) Correct the previous mistakes in report writing.	Task 1: a) Imtiaz b) Amlan c) Abid d) Al Amin **Progress:** Task 1: a) Partially Completed b) Partially Completed c) Partially Completed d) Completed	
18.11.23 (ATC Meeting-5) [Online]	**ATC members:** 1. Prof. Dr. AKM Abdul Malek Azad 2. Mohammed Thushar Imran **Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1.Mentioned different mistakes in logbook and report writing. a) In gantt charts, provide figure numbers b) In the report, add introduction in multiple design approaches. c) In the report reference part, add more references . d) In the logbook, group meeting-12, states clearly why it is partially completed.	Task 1: Everyone a)Al Amin b)Amlan c) Abid d) Imtiaz **Progress:** Task 1: Completed	1.In attributes of complex engineering activities, the familiarity issue should be reassessed. 2.Could not demonstrate the prototype today.

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Date/Time/Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
21.11.23 (Group meeting-15) [Offline]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1.Continuation of developing a subsystem of the prototype regarding voice assistance feature: (Continuation from 06.11.23) a) Implement hardware navigation assistance features such as notifying about upcoming obstacles b) Test the voice assistance system in various environments to ensure accurate recognition of voice commands.	Task 1: a) Al Amin, Abid b) Amlan, Imtiaz **Progress:** Task 1: Completed a) Completed b) Completed	
23.11.23 (Group meeting-16) [Offline]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1.Continuation of Project Report writing: (Continuation from 15.11.23) a) Chapter 8 b)Chapter 9 c)Chapter 10	Task 1: a) Imtiaz b) Amlan c) Abid, Al Amin **Progress:** Task 1: a) Completed b) Completed c) Completed	
24.11.23 (Group meeting-17) [Offline]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1.Continuation of Project Report writing: (Continuation from 23.11.23) a) Table of Contents b) References c) Correct the previous mistakes in report writing of chapter [1-4]. d) Correct the previous mistakes in report writing of chapter [6-11]. 2. Update Logbook	Task 1: a) Al Amin, Abid b) Al Amin c) Amlan d) Abid, Imtiaz Task 2: Al Amin **Progress:** Task 1: a) Partially Completed b) Completed c) Completed d) Completed Task 2: Completed	
25.11.23 (ATC Meeting-6) [Online]	**ATC members:** 1. Prof. Dr. AKM Abdul Malek Azad 2. Mohammed Thushar Imran **Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1.Mentioned different mistakes in I report writing: a) In chapter 8, add budget of design approach 2 b) In chapter 11, think about the interdependence part according to the project requirements.	Task 1: Everyone a)Al Amin, Abid b)Amlan, Imtiaz **Progress:** Task 1: Completed	1. Start writing chapter 5

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Date/Time/Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
27.11.23 (Group meeting-18) [Offline]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1.Developing Prototype of smart stick with all system integration	Task 1: Everyone **Progress:** Task 1: Partially Completed	
29.11.23 (Group meeting-19) [Offline]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1.Continuation of Project Report writing: (Continuation from 24.11.23) a) Table of Contents b) Acknowledgement c) Chapter 5 2.Start preparing Poster for the FYDP-C final showcase.	Task 1: a) Al Amin, Abid b) Al Amin c)Amlan, Abid Task 2: Al Amin, Imtiaz **Progress:** Task 1: a) Partially Completed b) Completed c) Partially Completed Task 2: Partially Completed	
30.11.23 (Group meeting-20) [Offline]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1.Developing Prototype of smart stick with all system integration 2. Perform testing of the prototype. 3. Continuation of preparing Poster for the FYDP-C final showcase. 4. Update Logbook	Task 1: Al Amin, Amlan, Abid Task 2; Everyone Task 3; Imtiaz Task 4: Al Amin **Progress:** Task 1: Completed Task 2: Partially Completed Task 3: Partially Completed Task 4: Completed	
02.12.23 (ATC Meeting-7) [Online]	**ATC members:** 1. Prof. Dr. AKM Abdul Malek Azad **Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1.Mentioned different mistakes in report and poster: a) In report, add intro in chapter 6.2 b) In poster add small paragraph in Abstract and Introduction	Task 1: Everyone a) Amlan, abid b)Al Amin, Imtiaz **Progress:** Task 1: Completed	1.Need to complete writing of chapter 5.
05.12.23 (Group meeting-21) [Offline]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1.Perform testing of the prototype. 2.Construct the final prototype.	Task 1:Al Amin, Amlan, Abid Task 2: Everyone **Progress:** Task 1: Completed Task 2: Partially Completed	

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Date/Time/Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
07.12.23 (Group meeting-22) [Offline]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1.Construct the final prototype. 2.Continuation of preparing Poster for the FYDP-C final showcase. 3. Update Logbook	Task 1:Al Amin, Amlan, Abid Task 2: Imtiaz, Al Amin Task 3: Al Amin **Progress:** Task 1: Partially Completed Task 2: Completed Task 3: Completed	
08.12.23 (Group meeting-23) [Offline]	**Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz	1.Continuation of Project Report writing: (Continuation from 29.11.23) a) Table of Contents b) Ethics Statement c) Dedication d) Chapter 1: Problem Statement e) Chapter 5: i) Evaluate the solution to meet the desired need. ii) Conclusion 2. In Poster, writing abstract, introduction concisely.	Task 1: a) Abid b) Al Amin c) Al Amin d) Al Amin e) Amlan Task 2: Imtiaz **Progress:** Task 1: a) Completed b) Completed c) Completed d) Completed e) Partially Completed Task 2: Completed.	
09.12.23 (ATC Meeting-8) [Online]	**ATC members:** 1. Prof. Dr. AKM Abdul Malek Azad **Students:** 1. Al Amin 2. Amlan 3. Abid 4.Imtiaz (Absent)	1.Mentioned different mistakes in poster: a) Draw the 3D diagram appropriately. b) Rephrase the introduction part. c) Write Table number and Figure number properly. d) State the commercial price of the stick in economic analysis.	Task 1: Everyone a) Abid b)Al Amin c)Amlan d)Al Amin **Progress:** Task 1: Completed	1. In the poster, add one more picture in hardware implementation that needs to include an open box of GPS, GSM system.
12.12.23 (Group meeting-24) [Offline]	**Students:** 1. Al Amin 2. Amlan 3. Abid	1.Construct the final prototype. 2..Continuation of Project Report writing: Chapter 5 (Continuation from 08.12.23) 3. Update Logbook	Task 1:Al Amin, Amlan, Abid Task 2: Abid, Al Amin Task 3: Al Amin **Progress:** Task 1: Completed Task 2: Completed Task 3: Completed	