PROJECT REPORT ON

SMART WALKING STICK

SUBMITTED BY:

- HARSHITHA
- Y.ANUSHITHA
- BHAVATEJA RAJU
- SAI CHARAN
- SRI CHARAN
- JAYANTH PUGLIYA
- RAJESH
- PANDU
- GOKUL SAI
- NAGA SAI
- ACHYUTH KUMAR
- SURYA TEJA
- VAIBHAV

Mr. Popuri Hemanth Kumar

Mentor

Robotics Club - SNIST

Ms. Dhakshinya

Mentor

Robotics Club - SNIST

THE ROBOTICS CLUB

Integrating Knowledge...

Certification

This is to certify that the group project titled **”SMART WALKING STICK”** has been successfully completed and submitted by the following team members **HARSHITHA, PANDU, Y.ANUSHITHA, GOKUL SAI, BHAVATEJA RAJU, NAGA SAI, SAI CHARAN, ACHYUTH KUMAR, SRI CHARAN, SURYA TEJA, JAYANTH PUGLIYA, VAIBHAV**. The project was carried out as a part of our engineering, under the supervision of **Mr. Hemanth Kumar** and **Ms. Dhakshinya.** The team has shown dedication and teamwork in conducting research, analysis, and development of the project.

Mr. Popuri Hemanth Kumar
Mentor
Robotics Club - SNIST

Ms. Dhakshinya
Mentor
Robotics Club - SNIST

Acknowledgement

We, the members of the project group, would like to express our profound gratitude and appreciation to all those who have contributed to the successful completion of this project titled **”SMART WALKING STICK”.**

First and foremost, we extend our deepest thanks to our project supervisor, **Mr. Hemanth Kumar** and **Ms. Dhakshinya**, for their continuous guidance, support, and constructive feedback throughout the course of this project. Their expertise and insights have been valuable in helping us understand the complexities of the subject and guiding us through various stages of the project.

We would like to acknowledge the contributions of **Mr. Popuri Hemanth Kumar** who provided critical advice, data, or technical support during the project. We would also like to thank our peers for their constructive criticism and valuable suggestions.

Team Members:

- HARSHITHA
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Declaration

We, the undersigned, hereby declare that the project report entitled **”SMART WALKING STICK”** submitted, is a result of our original work conducted under the supervision of **Mr. Hemanth Kumar** and **Ms. Dhakshinya** We further declare that,This report has not been submitted to any other institution or organization for any other degree, diploma or certification. All work presented here is our own, except where specific references have been made to the work of others. We have fully acknowledged all the sources, literature, and data used in the completion of this project. This project was completed in accordance with the ethical and academic standards prescribed by our supervisior and the coordinator. We understand that any violation of this declaration may result in disciplinary action as per the guidelines of the our supervisor and coordinator.

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ABSTRACT

THE PROBLEM

As people age or recover from injuries, their mobility often becomes unstable, increasing the risk of falls especially when alone.In such events, they may be unable to move or call for help due to unconsciousness or injury, leading to dangerous delays in medical response. Traditional walking sticks provide physical support but lack intelligent features to handle emergencies. Without timely alerts, falls can result in severe health complications or fatalities. The lack of real-time communication poses a serious challange for caregivers in ensuring the safety and quick assistance for vulnerable indiviuals.

TEAMS APPROACH TO SOLVE THE PROBLEM

To address this serious concern, we propose the development of a Smart Walking Stick integrated with multiple sensors and communication modules to enhance the safety and independence of elderly or physically challenged individuals.Accelerometer and gyroscope used to detect sudden movements or falls. In the event of a fall, the system will automatically trigger an SOS alert, sending a text message via a SIM800L GSM module to predefined contacts such as caregivers or family members. Additionally, a GPS module will transmit the user's real-time location.The stick will also feature a heart rate sensor to monitor the user's vital signs, a buzzer for immediate audio alerts, an ultrasonic sensor for obstacle detection, and an LED light to aid visibility in low-light conditions. A manual push button will be included for users to trigger alerts voluntarily. Powered by a rechargeable battery and charging circuit, all components will be securely mounted onto a lightweight and ergonomic stick frame. Furthermore, an LDR (Light Dependent Resistor) sensor will be incorporated to detect ambient light levels and automatically activate the LED in dim environments.

Chapter 1

INTRODUCTION

1.1 INTRODUCTION

As populations around the world continue to age, ensuring the safety, well-being, and independence of elderly individuals and those with mobility impairments has become a significant and urgent challenge. Among the most pressing concerns is the high risk of falls, which are one of the leading causes of injury, hospitalization, and even death among older adults. A fall can result in serious complications such as fractures, head injuries, or prolonged immobility, especially when the individual is alone and unable to call for help. Traditional walking sticks, though useful for providing physical support and balance, are limited in functionality and do not address the broader safety and health monitoring needs of users. To address this gap, the Smart Walking Stick has been developed as an innovative, technology-enhanced assistive device that goes far beyond the basic role of support. This modern walking aid is equipped with a range of smart features designed to actively safeguard the user's health and well-being. Integrated sensors enable real-time fall detection. Upon detecting a fall, the stick can automatically send an emergency alert to caregivers or emergency services. Additionally, the stick includes a heart rate sensor that continuously monitors the user's pulse, detecting irregularities or warning signs of a medical issue before it becomes critical. The GPS tracking module ensures that the user's location can always be identified, which is particularly vital for elderly individuals who may suffer from memory loss or disorientation.

1.2 PURPOSE OF THE PROJECT

The primary purpose of the Smart Walking Stick project is to enhance the safety, health, and independence of elderly individuals and those with mobility challenges through the integration of modern technology into a traditional mobility aid. As the global elderly population increases, the risk of accidents such as falls, disorientation, and sudden health issues has become a growing concern. Traditional walking sticks only offer physical support, which is not sufficient to handle emergency situations that require immediate attention and intervention. Therefore, the Smart Walking Stick aims to fill this critical gap by incorporating intelligent features such as fall detection, GPS tracking, heart rate monitoring, obstacle detection, and emergency alert systems. In essence, the Smart Walking Stick provides elderly users with greater confidence and freedom to move independently while reassuring caregivers of their safety. The project also aims to reduce hospital admissions caused by preventable incidents and support the overall well-being of aging individuals by merging mobility support with proactive health and emergency management. The Smart Walking Stick is a semi-autonomous assistive device, combining user-controlled operation with intelligent, automated features. While it does not move or navigate on its own, it is equipped with smart sensors that allow it to respond automatically to certain conditions. This project is designed to act not only as a walking aid but also as a real-time health and safety monitoring tool. The stick detects and responds to dangerous situations, such as sudden falls or abnormal heart rates, and sends alerts to caregivers or emergency services, ensuring that help can be provided without delay. At its core, this project is designed to act as a proactive health and safety companion, rather than just a passive mobility aid. Another important purpose is to support caregivers and families, providing them with peace of mind. With real-time communication capabilities, the device ensures that they are immediately notified if their loved one encounters a problem, even if they are not nearby. By leveraging affordable and accessible technology, the Smart Walking Stick bridges the gap between traditional mobility aids and modern healthcare solutions. It empowers users to lead more independent lives while reducing the burden on caregivers. Ultimately, this project represents a meaningful step toward safer and more connected aging. It stands as a testament to how technology can be thoughtfully designed to support dignity, autonomy, and quality of life in later years.

1.3 EXISTING SYSTEMS

A. The Smart Cane created by MIT helps visually impaired people get around more easily and safely by combining advanced sensing technology with intuitive feedback methods. It uses a compact 3D camera worn around the neck to “see” the environment in real-time and detect obstacles at different heights and distances, including overhanging objects and drop-offs that traditional canes might miss. This information is processed and translated into gentle vibrations on a haptic feedback belt worn around the user’s waist, guiding them on how to move safely. The cane also features a dynamic Braille display that shows tactile symbols to inform users about nearby obstacles, doorways, or changes in terrain. Unlike audio-based systems that can interfere with environmental sounds, this cane uses silent feedback—vibrations and tactile cues—allowing users to stay alert to ambient sounds like traffic or voices. The system is lightweight and comfortable for extended wear, and it can connect to a mobile app for route planning and customization. With real-time environmental awareness and intuitive design, the cane empowers users with greater autonomy and confidence.

B. The RCSP Smart Stick for the elderly is a thoughtfully designed mobility aid that combines traditional support with modern technology to enhance safety, comfort, and usability. It includes a built-in LED flashlight that automatically activates in low-light conditions, reducing the risk of falls. An integrated FM radio helps users stay entertained and mentally engaged. For emergencies, an SOS alarm button emits a loud siren to alert nearby people and caregivers. The stick’s height-adjustable, foldable design ensures it suits various users and is easy to store. Powered by a long-lasting rechargeable lithium battery, it avoids the hassle of frequent replacements. Its ergonomic handle offers a secure grip, and the anti-slip rubber tip provides stability across different terrains. Optional features like a GPS tracker and memory for recent alerts improve safety and caregiving. The RCSP Smart Stick delivers practical support and peace of mind, making it a reliable and dignified daily companion.It can be easily recharged using a standard USB port, making it convenient for elderly users and caregivers alike. Some models even include temperature and humidity sensors to help users monitor environmental comfort. Its lightweight yet durable construction ensures long-term use without adding strain. The device promotes a sense of independence while reducing reliance on constant supervision. Overall, it serves as a smart, multifunctional solution that empowers elderly individuals to lead more confident and secure lives.

1.4 LIMITATIONS OF EXISTING SYSTEMS

A.While the Smart Cane by MIT offers innovative features, it also has some limitations. Since it is still a prototype, it may not be fully reliable or practical for everyday use in all environments. Users need to be familiar with Braille and may require training to understand the vibration signals and Braille symbols effectively. The system involves several hardware components—like the camera, processing unit, vibrating belt, and Braille display—which can make it bulky, less portable, and potentially difficult to maintain. Additionally, the complexity of the device might make it expensive and less accessible for many users. B.While the RCSP Smart Stick offers useful features for elderly users, it does have some limitations. The built-in technologies like the LED light, FM radio, and SOS alarm rely on battery power, which may require frequent recharging depending on usage, potentially causing inconvenience. Its functionality is primarily limited to basic support and emergency signaling, lacking advanced sensors such as fall detection or health monitoring found in more sophisticated smart canes. The SOS alarm depends on nearby people hearing the siren, which may not be effective in isolated areas. Additionally, the stick's reliance on physical buttons and lack of connectivity features means it cannot send automatic alerts or share location data with caregivers, limiting its usefulness in critical emergencies. Lastly, the foldable and adjustable design, while convenient, may reduce the overall sturdiness and durability compared to traditional solid walking sticks.

This Smart Walking Stick overcomes many limitations found in simpler sticks like the RCSP Smart Stick by integrating multiple advanced sensors and communication features that provide proactive safety and health monitoring. Unlike basic sticks that only offer a flashlight, alarm, or manual SOS, this smart stick automatically detects falls through accelerometer and gyroscope sensors, eliminating reliance on the user to send alerts in emergencies. The heart rate sensor continuously monitors the user's health, allowing early detection of potential medical issues. The ultrasonic sensor warns the user of obstacles ahead, reducing the risk of trips or collisions, which simple sticks don't address.

The system intelligently coordinates all functions, providing a more comprehensive, reliable, and user-friendly safety solution than sticks with only basic features.

1.5 PROJECT ARCHITECTURE

The Smart Walking Stick is built using a combination of sensors, a microcontroller, communication modules, and power supply components. Here's a simplified overview of how the system works: The Smart Walking Stick integrates multiple components and technologies to provide real-time safety and assistance for elderly users and individuals with mobility challenges. At the core of the system are several sensors that constantly monitor the user's surroundings and physical condition. An accelerometer and gyroscope detect sudden movements or unusual patterns, helping identify if the user has fallen. A heart rate sensor keeps track of the user's heartbeat, alerting caregivers if irregularities are found. An ultrasonic sensor scans the path ahead to detect nearby obstacles, helping the user avoid collisions, while an LDR (Light Dependent Resistor) monitors ambient light levels and automatically switches on an LED light when it becomes dark, aiding visibility. A push button is also included, allowing users to manually trigger an SOS alert in case of distress. At the center of this system is the microcontroller—typically an Arduino board—which acts as the "brain" of the stick. It gathers data from all connected sensors, processes the inputs, and makes decisions, such as turning on the light or sending emergency alerts. For communication, the stick uses two key modules: the GSM module (SIM800L), which sends SMS alerts to family members or caregivers, and the GPS module, which determines the user's precise location to include in those messages. Output devices like a buzzer emit a loud sound to alert nearby people during emergencies, and the LED light assists with night navigation. The entire system is powered by a rechargeable battery, supported by a charging circuit to ensure easy recharging. In operation, the sensors continuously monitor conditions, and if a fall is detected or the SOS button is pressed, the system activates the buzzer, obtains the user's location via GPS, and sends a detailed alert through the GSM module. The LED automatically turns on in the dark, enhancing safety, while the rechargeable battery ensures the stick functions reliably throughout daily use. To improve usability, the system may include a low-battery alert to notify users when charging is needed. A compact LCD or OLED display can also be added to show real-time data like heart rate or GPS coordinates. The modular design allows for easy component replacement and system upgrades. Data logging functionality can store incident records, useful for medical assessments or future analysis. With thoughtful integration of smart features, the Smart Walking Stick represents a practical, life-enhancing tool for vulnerable populations.

1.6 PROPOSED SYSTEM

To further enhance the safety features of the Smart Walking Stick, we propose an upgrade to the ultrasonic sensor system. Instead of relying on a single sensor, we will integrate multiple ultrasonic sensors strategically placed in the front, left, and right directions of the stick. This multi-directional setup will provide a more comprehensive and proactive obstacle detection system, creating a 180-degree sensing field around the user. The front-facing sensor will detect obstacles directly in the user's path, ensuring they do not collide with walls, furniture, or people. Meanwhile, the left and right sensors will offer increased spatial awareness of nearby hazards in the user's periphery, which are often missed with conventional single-sensor designs. This expanded coverage will give users more time to react to approaching obstacles, significantly reducing the risk of collisions and falls, especially in crowded, narrow, or unfamiliar environments such as busy streets, public transport, or new homes. The data from these sensors will be processed in real-time by the microcontroller to trigger alerts through a buzzer. These alerts can vary in intensity and pattern depending on the direction and distance of the obstacle, allowing users to intuitively understand where a hazard is located. By combining this sensory upgrade with intelligent alert systems, the Smart Walking Stick will not only improve safety but also boost the user's confidence and independence during navigation. In addition, these sensors can be calibrated to adjust sensitivity based on the environment—higher sensitivity in cluttered areas and lower sensitivity in open spaces to avoid false alarms. A vibration motor can also be included alongside the buzzer to provide silent directional feedback, especially helpful in noisy environments. The system could log obstacle encounters to analyze mobility patterns and suggest safer routes over time. For further personalization, users or caregivers can customize alert tones and patterns through a mobile app. These features aim to accommodate different levels of mobility and sensory ability. The modular sensor layout also allows future expansion—for example, rear sensors to support backward movement or curved path detection. Integrating AI-based obstacle classification in future iterations could help distinguish between stationary and moving obstacles. Energy-efficient sensor scheduling can be implemented to conserve battery life without compromising safety. This upgrade moves the Smart Walking Stick closer to becoming a fully assistive smart mobility companion, blending real-time intelligence with adaptability for diverse user needs.

1.7 ADVANTAGES OF PROPOSED SYSTEM

The proposed upgrade to incorporate multiple ultrasonic sensors on the Smart Walking Stick significantly enhances its obstacle detection capabilities by covering the front, left, and right directions. This multi-directional sensing provides users with a more comprehensive awareness of their surroundings, allowing for earlier detection of potential hazards not just directly ahead but also on the sides. As a result, users gain valuable additional time to react and avoid collisions, greatly reducing the risk of trips and falls, especially in crowded or unfamiliar environments. The system's ability to deliver real-time audio alerts, combined with potential haptic feedback, offers intuitive guidance tailored to different user needs, further improving safety. This expanded coverage increases the reliability of obstacle detection through sensor redundancy and helps users navigate confidently and independently. Ultimately, this enhancement boosts user safety, autonomy, and peace of mind by making the walking stick a smarter and more proactive mobility aid. In addition, the improved sensor configuration helps in distinguishing between static and dynamic obstacles, allowing more intelligent decision-making based on the movement of surrounding objects. The use of multiple sensors also minimizes blind spots and enhances accuracy in cluttered areas, providing more precise navigation. This is particularly beneficial in urban settings where users must navigate through complex environments such as sidewalks, markets, or public transport hubs. To further elevate the user experience, the system could integrate AI-based object recognition to classify detected obstacles, enabling context-aware feedback. The addition of a gyroscopic stabilization system can help maintain consistent sensor orientation, especially if the user's hand position changes. These enhancements would be supported by a more powerful microcontroller capable of handling increased sensor input and data processing. Voice command integration could offer hands-free control of stick functions, such as activating specific modes or adjusting feedback intensity. Wireless connectivity via Bluetooth or Wi-Fi could allow syncing with a smartphone app for route planning, obstacle logging, or caregiver monitoring. Customizable user profiles can adapt feedback styles based on preferences or disabilities. Energy efficiency can be improved by incorporating smart power management systems, such as auto-sleep modes and solar-assisted charging. With these advanced features, the Smart Walking Stick becomes not just a support device but an intelligent mobility assistant designed to meet the evolving needs of users in real-world conditions.

1.8 HARDWARE REQUIREMENTS

1.8.1 Ultrasonic Sensor

An ultrasonic sensor works by emitting high-frequency sound waves (typically above 20 kHz) and measuring the time it takes for the echo to return after hitting an object. This time delay is used to calculate the distance between the sensor and the object. Ultrasonic sensors are energy-efficient, silent, and compact, making them ideal for wearable assistive technology.

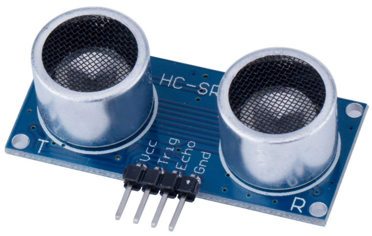

Figure 1.1: Ultrasonic Sensor(HC-SR04)

1.8.2 Accelerometer and Gyroscope

An accelerometer is a sensor that measures acceleration forces acting on a device in one or more directions (usually X, Y, and Z axes). It helps detect motion, orientation, and vibration. A gyroscope, on the other hand, measures angular velocity or the rate of rotation around an axis. When combined, these sensors provide precise motion tracking.

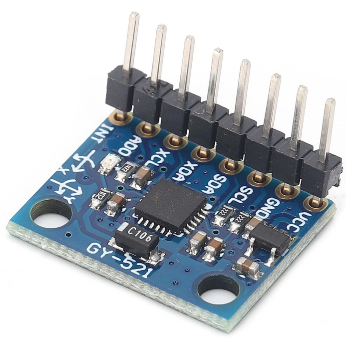

Figure 1.2: Accelerometer and Gyroscope(MPU6050)

1.8.3 GPS Module

A GPS (Global Positioning System) module is an electronic device that receives signals from satellites to determine precise geographic location (latitude, longitude, and altitude) anywhere on Earth. It uses a network of at least 3 satellites that continuously transmit signals, allowing the module to triangulate its position.

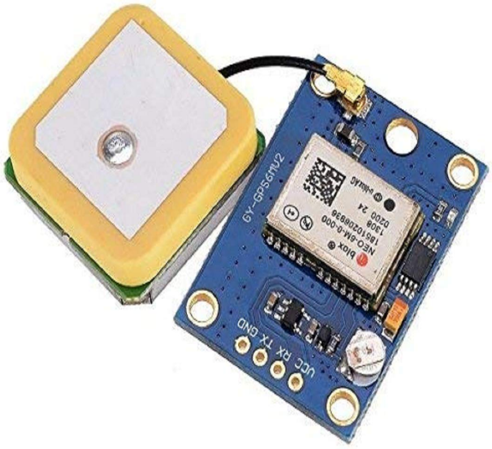

Figure 1.3: GPS Module (NEO 6M)

1.8.4 GSM Module

A GSM (Global System for Mobile Communications) module is a hardware device that enables electronic systems to communicate over a mobile network. It allows devices like microcontrollers, Arduino boards, or embedded systems to send and receive SMS, make calls, or access the internet using a SIM card, just like a mobile phone.

Figure 1.4: GSM Module(SIM800L)

1.8.5 Active Buzzer module

An Active Buzzer Module is an easy-to-use electronic component that produces sound when powered. It's commonly used in Arduino, Raspberry Pi, and embedded systems projects for alerts, alarms, or notifications.

Figure 1.5: Buzzer

1.8.6 Heart Rate Sensor

A heart rate sensor is a biomedical device used to measure a person's heartbeats per minute (BPM). It works by detecting the changes in blood flow through the body, typically using optical technology known as photoplethysmography (PPG). In this method, the sensor emits light—usually green or infrared—into the skin and measures the amount of light either absorbed or reflected back, which changes with each heartbeat.

Figure 1.6: Heart Rate Sensor

1.8.7 Arduino Nano

The Arduino Nano is a compact, versatile microcontroller board based on the ATmega328P chip, commonly used in electronics projects due to its small size and powerful capabilities. It operates at 5V and runs at 16 MHz, with 32 KB of flash memory, 8 analog input pins, and 14 digital I/O pins (including 6 PWM outputs). The Nano is ideal for projects with limited space, such as wearable devices, smart gadgets, or embedded systems.

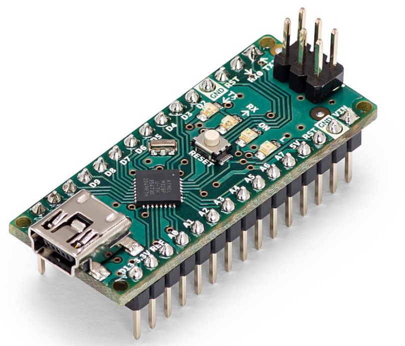

Figure 1.7: Arduino Nano

1.8.8 Push Button Switch

A push button switch is a simple electrical component used to control a circuit by manually pressing it. When pressed, it completes the circuit, allowing current to flow, and when released, the circuit breaks, stopping the current. Push button switches are commonly used in a wide variety of applications, from turning on lights and activating machines to resetting devices or controlling inputs in embedded systems like Arduino.

Figure 1.8: Push Button Switch

1.8.9 Li-ion 3.7V Battery

A 3.7V lithium-ion (Li-ion) battery is a compact, rechargeable power source commonly used in portable electronic devices such as smartphones, wearable gadgets, and assistive tools like smart walking sticks.

Figure 1.9: Battery 18650

1.8.10 Universal Dual Li-ion 3.7V Battery Charger

A Universal Dual Li-ion 3.7V Battery Charger is a charger that can simultaneously charge two 3.7V Li-ion batteries, such as 18650 cells or flat-pack batteries commonly used in electronics, flashlights, and DIY projects.

Figure 1.10: Universal dual battery charger

1.8.11 Jumper wires

Jumper wires are insulated wires with connectors at each end, used to create quick and temporary connections in electronic circuits without soldering. They are commonly employed in prototyping and testing circuits on breadboards or connecting components like sensors, modules, and microcontrollers. Available in three types—male-to-male, male-tofemale, and female-to-female—they allow versatile connections between male and female headers. They are indispensable in electronics for their reusability, ease of use, and ability to streamline circuit building and troubleshooting.

Figure 1.11: Jumper wires

1.8.12 Bread board

A breadboard, solderless breadboard, or protoboard is a construction base used to build semipermanent prototypes of electronic circuits. Unlike a perfboard or stripboard, breadboards do not require soldering or destruction of tracks and are hence reusable. For this reason, breadboards are also popular with students and in technological education.A breadboard is a board used to connect electronic components, such as wires, resistors, capacitors, and coils, to conduct various experiments and projects.

Figure 1.12: Bread board

1.8.13 3W White LED Chip

A 3W White LED Chip is a high-power light-emitting diode used for bright lighting applications. Unlike small indicator LEDs, this chip is capable of producing intense white light and is often used in flashlights, DIY lamps, and portable lighting systems.

Figure 1.13: LED

1.8.14 Stick

A wooden stick is simply a slender piece of wood, commonly used for a variety of practical, craft, or recreational purposes. It's one of the oldest and most versatile simple tools! From walking aids and tool handles to firewood and artistic creations, its uses are nearly endless.

Figure 1.14: Stick

1.8.15 U clamps

U-clamps, also known as U-bolts or pipe clamps, are U-shaped fasteners used to secure or support pipes, tubes, or round objects to surfaces such as walls or ceilings. Made typically from steel, stainless steel, or galvanized metal, they consist of a curved body and two threaded ends that allow for easy tightening with nuts and washers.

Figure 1.15: U Clamps

1.8.16 Plastic Box

A transparent plastic box is a clear, lightweight container commonly used for storage and organization. Its see-through design allows easy visibility of contents without opening the lid.

Figure 1.16: Plastic Box

1.8.17 Battery Holder

A battery holder is a device used to securely hold and connect batteries in electronic circuits. It provides a convenient and safe way to insert and remove batteries while ensuring proper electrical contact. Battery holders come in various sizes to accommodate different types of batteries (e.g., AA, AAA, CR2032). Advantages include easy battery replacement, improved safety, and organized power supply, making them ideal for portable electronics and DIY projects.

Figure 1.17: Battery Holder

1.9 SOFTWARE REQUIREMENTS

1.9.1 Arduino IDE

The Arduino IDE (Integrated Development Environment) is a user-friendly software platform used for writing, compiling, and uploading code to Arduino microcontrollers. It supports primarily C and C++ programming languages and provides a simple interface to interact with Arduino boards through USB connections. The IDE features a code editor with syntax highlighting and error checking, a vast library collection for easy component integration, and a Serial Monitor for real-time debugging and data communication. Available on Windows, macOS, and Linux, the Arduino IDE is ideal for both beginners and advanced users, making it a popular tool for prototyping and learning electronics.

Figure 1.18: ARDUINO IDE

1.9.2 Fusion 360

Fusion 360 is a versatile 3D CAD, CAM, and CAE software by Autodesk, designed for product design, engineering, and manufacturing. It combines powerful 3D modeling tools, including parametric and freeform design, with simulation capabilities for stress and motion analysis. The software also integrates CAM features like 2D and 3D milling and supports cloud-based collaboration for real-time teamwork. Fusion 360 is widely used in industries like robotics, automotive, and consumer product design due to its flexibility, ease of use, and ability to handle the entire design-to-manufacturing workflow

Figure 1.19: FUSION 360

1.9.3 Cirkit designer

Cirkit Designer is an intuitive software tool designed for creating, simulating, and visualizing electronic circuits. It combines schematic design, PCB layout, and simulation features into a single interface, making it ideal for hobbyists, students, and professionals. With real-time circuit simulation, users can test designs before physical implementation, saving time and resources. Its user-friendly interface supports drag-and-drop functionality, allowing quick and efficient circuit prototyping. Cirkit Designer often integrates with 3D visualization tools to preview layouts and optimize space. It is compatible with various component libraries, providing flexibility for diverse projects, from simple circuits to complex electronic systems.

Figure 1.20: Cirkit Designer

1.10 BLOCK DIAGRAM

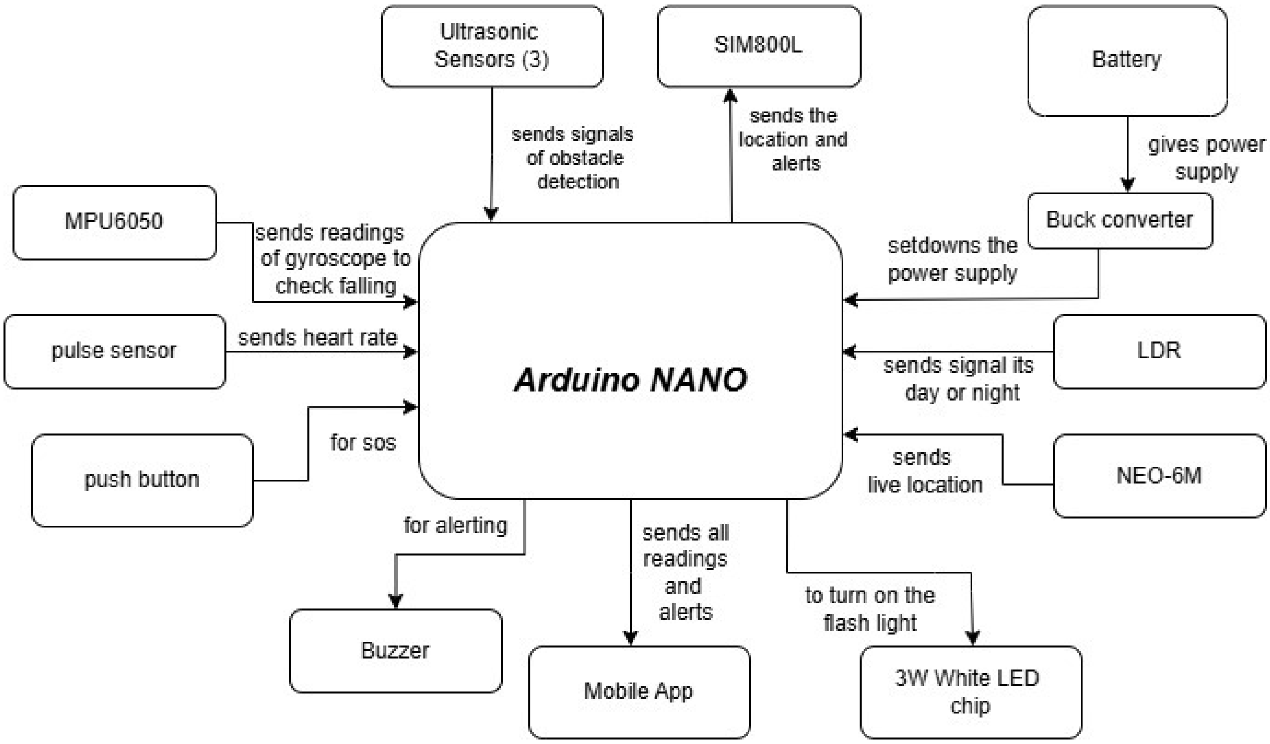

Figure 1.21: Block Diagram

The Smart Walking Stick system is an intelligent assistive device designed to enhance mobility, safety, and health monitoring for elderly individuals and people with physical disabilities. At the heart of the system is the Arduino Nano, which acts as the main controller, collecting data from various sensors and modules, processing the inputs, and managing outputs to ensure real-time safety and emergency response.

The system uses three ultrasonic sensors placed on the front, left, and right sides of the stick to detect obstacles in multiple directions. These sensors continuously send distance measurements to the Arduino Nano, helping it determine whether there is an object nearby. If an obstacle is detected, the system can alert the user and guide them to avoid a collision. This multi-directional detection improves navigation, especially in crowded or unfamiliar environments.

For fall detection, the system integrates an MPU6050 sensor, which includes an accelerometer and gyroscope. It sends movement and orientation data to the Arduino. If a sudden tilt or a sharp change in motion indicates a possible fall, the system responds by triggering an emergency alert. Alongside this, a pulse sensor monitors the user's heart rate in real time. The Arduino constantly checks this data and, if it detects irregularities (such as too high or too low BPM), it immediately sends an alert to caregivers via the communication module.

An SOS push button is provided as a manual emergency trigger. If the user feels distressed or needs help, they can press the button, prompting the Arduino to activate both a buzzer and a GSM message alert. The buzzer emits a loud sound to notify people nearby and confirm to the user that help is on the way. The LDR (Light Dependent Resistor) monitors ambient light levels and informs the Arduino whether it is day or night. In darker environments, the Arduino activates a 3W white LED chip that serves as a flashlight, improving visibility and safety during night-time movement.

To track the user's location, the system uses a NEO-6M GPS module, which continuously provides real-time coordinates to the Arduino. When an emergency occurs (fall detection or SOS trigger), the location is sent through the SIM800L GSM module to the mobile phone of a caregiver or family member. The GSM module is also responsible for sending other alerts like heart rate abnormalities or obstacle warnings, making the system responsive and connected at all times.

The entire system is powered by a rechargeable battery, making it portable and suitable for daily use. However, since some components (like the GSM module) require specific operating voltages, a buck converter is used to regulate the power supply and protect sensitive components. This ensures the entire setup operates efficiently and reliably without overheating or voltage issues.

In addition, the system can connect to a mobile app via the GSM module, allowing caregivers to monitor the user remotely. The app can receive alerts, display live GPS location, and show sensor readings like heart rate. This not only improves the user's safety but also provides peace of mind to their loved ones.

Overall, the Smart Walking Stick system combines multiple input sensors and output devices in a well-integrated, Arduino-based platform. Its ability to detect obstacles, monitor health conditions, send emergency alerts, and guide users through challenging environments makes it a proactive and intelligent mobility aid. The design is user-centered, aiming to boost confidence, independence, and safety for vulnerable individuals in a simple yet effective way.

1.11 CIRCUIT DIAGRAM

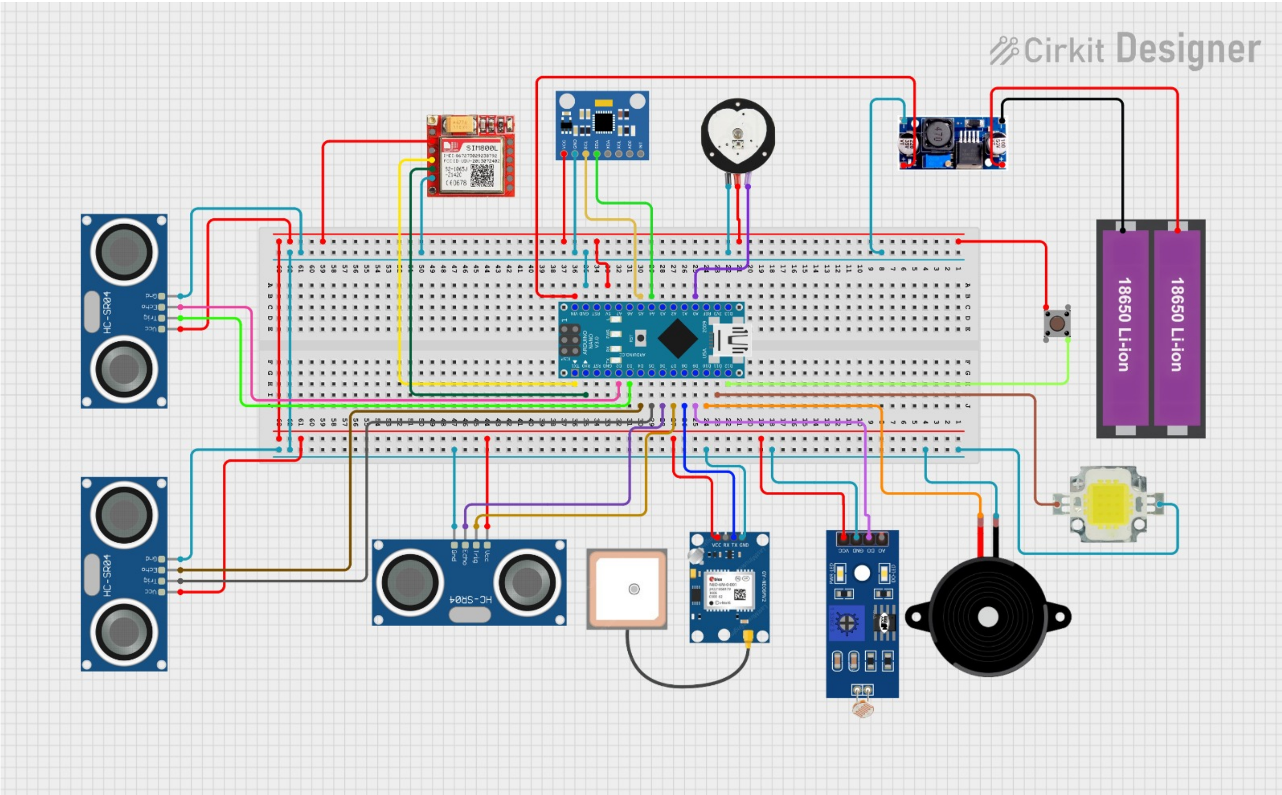

Figure 1.22: Circuit Diagram

The Smart Walking Stick circuit is designed using an Arduino Nano as the central microcontroller, which serves as the control hub for all sensor inputs and actuator outputs. The circuit integrates multiple modules and components to monitor the user's environment, health status, and provide alerts or assistive actions when required. Power is supplied through two 18650 Li-ion batteries connected to a buck converter, which steps down the voltage to appropriate levels needed by the components, especially the Arduino and the GSM module, ensuring stable operation across the system.The system incorporates four ultrasonic sensors (HC-SR04) placed strategically around the breadboard to detect obstacles on the front, left, right, and downward directions. Each sensor has its VCC and GND connected to the power rails on the breadboard, while the trigger and echo pins are routed to individual digital pins of the Arduino Nano. These sensors provide real-time distance measurements, enabling the stick to alert users about nearby obstacles to prevent collisions or trips.An MPU6050 accelerometer and gyroscope sensor is included in the setup to detect user motion and orientation. It is responsible for fall detection by sensing sudden changes in angle and acceleration. It communicates with the Arduino Nano through the I2C protocol, using the SCL and SDA lines connected to the respective analog pins. Just beside it, a heart rate sensor (pulse sensor) is also connected, which continuously sends BPM readings to the Arduino. This data is crucial in identifying any abnormal heart rates, which, if detected, can trigger emergency protocols.

The system also includes a push button, connected to a digital pin and ground, used as a manual SOS trigger by the user. When pressed, the Arduino reads the HIGH signal from the button and initiates alerts. One such alert is through the buzzer connected near the bottom right of the circuit, which produces an audible signal to alert people nearby. The buzzer's VCC and GND are connected to the power rails, and the signal pin is controlled via a digital output pin from the Arduino.

To handle low-light navigation, a light-dependent resistor (LDR) is incorporated to detect ambient light levels. When the surroundings get dark, the Arduino receives this signal and turns on a 3W white LED chip connected to the bottom-right side of the board. The LED is driven through a transistor or direct digital pin with a suitable resistor, ensuring visibility during night-time.A crucial component for location tracking is the NEO-6M GPS module located at the bottom of the circuit. It connects to the Arduino Nano via serial communication using TX and RX pins, and continuously streams latitude and longitude data. Alongside it, a SIM800L GSM module is connected, also via serial communication, enabling the system to send SMS alerts with GPS coordinates to registered phone numbers. This dual module setup ensures that caregivers can track the user in real-time and be informed in case of an emergency.

A mobile app can receive the data sent by the GSM module and display it in a user-friendly manner for caregivers. The real-time data includes fall detection alerts, heart rate irregularities, GPS location, and SOS activations. The components are neatly arranged and wired through a breadboard, which simplifies prototyping and allows for flexible modifications. Proper voltage regulation is maintained using the buck converter, which ensures that the SIM800L operates within a safe range, typically 3.7V–4.2V. In summary, the circuit integrates various sensors and output devices in a modular architecture controlled by an Arduino Nano. It provides comprehensive real-time monitoring of the user's physical state and surroundings and initiates alerts or assistive responses when necessary. By combining obstacle detection, fall sensing, heart rate monitoring, emergency communication, and lighting, the Smart Walking Stick system offers a powerful, multifunctional solution that significantly enhances mobility and safety for the elderly or disabled individuals.

1.12 CAD MODEL

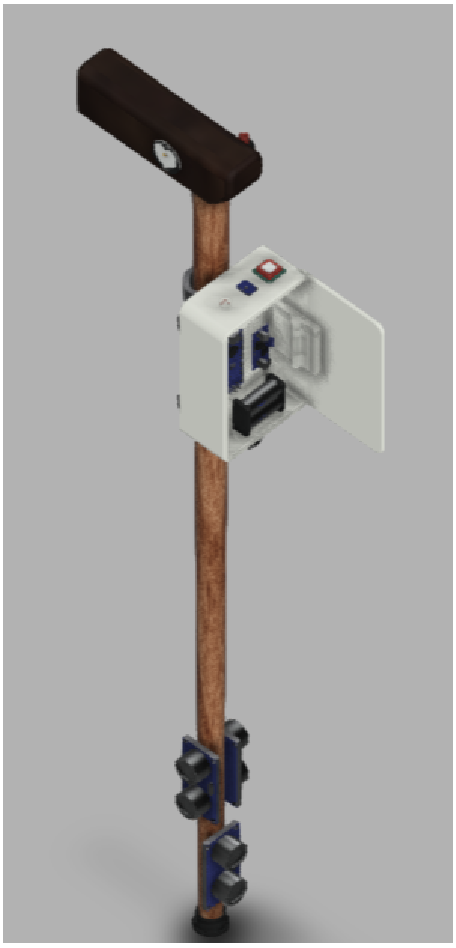

Figure 1.23: CAD Model

The CAD model illustrates the complete structural and component layout of the Smart Walking Stick. It features a sturdy wooden shaft that provides traditional physical support to the user. At the top, a black ergonomic handle offers a comfortable grip, with an SOS button for emergencies. The central section houses a transparent plastic enclosure that securely holds the electronic modules. Inside the box, key components such as the Arduino Nano, GSM module, GPS module, and battery are organized. The enclosure has a front-opening door to allow easy access for maintenance and battery charging. Ultrasonic sensors are mounted at the bottom in a three-directional configuration for obstacle detection. A white LED flashlight is also placed near the base for navigation in low-light conditions. All elements are neatly positioned to maintain balance, durability, and aesthetics. This CAD design ensures modularity, ease of assembly, and real-world applicability of the smart stick.

1.13 RESULT

The Smart Walking Stick with Fall Alert is an innovative assistive technology designed to enhance the safety, independence, and well-being of elderly or physically challenged individuals. Addressing the critical problem of falls and delayed medical response, this advanced walking aid integrates a range of intelligent features including fall detection via accelerometer and gyroscope, real-time GPS tracking, and automatic SOS alerts through the SIM800L GSM module. In the event of a fall or prolonged inactivity, the system instantly notifies caregivers with the user's exact location, even if the user is unconscious or unable to operate the device manually. This ensures that timely help can be dispatched, potentially preventing serious health consequences. Additional safety components include a heart rate sensor for monitoring vital signs, which can detect abnormalities such as bradycardia or tachycardia. When abnormal values are detected, the system can automatically trigger alerts. A buzzer is integrated for audio feedback, providing immediate situational awareness to the user and nearby people. The manual SOS push button serves as a backup alert mechanism, allowing the user to call for help in non-fall-related emergencies. For nighttime or low-visibility conditions, a high-intensity LED light is automatically activated through an LDR (Light Dependent Resistor) sensor, ensuring safe movement in dark environments without the need for manual operation. A standout feature of this design is its proactive multi-directional obstacle detection system. It uses three ultrasonic sensors strategically placed to monitor the front, left, and right sides of the user, providing 360-degree environmental awareness. The real-time data from all sensors is processed by an Arduino Nano microcontroller, which acts as the central control unit for the entire system.

All components are powered by a compact, rechargeable Li-ion battery pack with an integrated buck converter for regulated power supply. This ensures energy efficiency and consistent operation throughout the day. This smart assistive device functions effectively both indoors and outdoors, making it highly versatile for everyday use. It can be further enhanced with future upgrades such as Bluetooth connectivity for app-based monitoring, voice alerts for guided assistance, and a waterproof casing to support all-weather usability. With its intelligent design, modular structure, and user-centric features, the Smart Walking Stick is not just a mobility aid—it is a comprehensive health and safety companion aimed at empowering vulnerable individuals, reducing caregiver burden, and potentially saving lives in emergency situations.

Chapter 2

CONCLUSION AND FUTURE SCOPE

2.1 CONCLUSION

The Smart Walking Stick with Fall Alert is a powerful step forward in the field of assistive technology, aimed at addressing the critical challenges faced by elderly individuals and those with mobility impairments. Falls are among the most common and dangerous incidents affecting the elderly, often leading to severe health complications, long-term disability, or even fatality—especially when help is delayed. Traditional walking aids offer physical support but lack the intelligent features required to ensure timely medical response or proactive safety. This smart solution bridges that gap by offering a fully integrated system that combines health monitoring, environmental sensing, and emergency communication in one compact, ergonomic, and easy-to-use device.

Equipped with an accelerometer and gyroscope, the stick accurately detects sudden movements or the absence of motion, signaling a potential fall. When such an incident is identified, the system immediately triggers an SOS alert and transmits the user's real-time GPS location to caregivers or family members via the SIM800L GSM module. This ensures rapid intervention, even if the user is unconscious or unable to seek help themselves. Additional layers of safety are provided through a heart rate sensor for basic health monitoring, a buzzer for audio alerts, and an LED light that activates automatically in low-light conditions through the LDR sensor. A push-button is included for manual emergency activation. A particularly innovative feature is the implementation of multiple ultrasonic sensors placed in the front, left, and right directions, offering 360-degree obstacle detection. This multi-directional awareness system significantly improves navigation and reduces the risk of falls or collisions, especially in crowded or poorly lit environments. All components are efficiently powered by a rechargeable battery and secured on a lightweight and durable frame, ensuring the stick remains portable and practical for daily use. It is suitable for various environments including homes, hospitals, public places, and even during travel.

Looking ahead, the Smart Walking Stick is a highly scalable solution. Future upgrades such as Bluetooth connectivity for smartphone pairing, voice alert systems, waterproof housing, and integration with health tracking apps could further enhance its utility and user experience. By seamlessly blending technology with compassion, this device not only safeguards the lives of its users but also provides peace of mind to their families and caregivers. Ultimately, the Smart Walking Stick is more than just a mobility aid—it is a smart companion that empowers individuals to live more safely, independently, and confidently.

2.2 FUTURE SCOPE

The future scope of the Smart Walking Stick is vast and promising, with several technological advancements that can significantly enhance its functionality and user experience. Integration with mobile applications and cloud platforms will allow real-time health data, fall alerts, and GPS locations to be monitored remotely by caregivers or medical professionals, providing a more connected and responsive care system. Voice assistance features using AI-based modules could offer hands-free interaction, enabling users to issue commands or receive updates about their condition or surroundings. Advanced obstacle detection using LiDAR or infrared sensors, combined with GPS-guided navigation, can help users safely traverse complex environments, while machine learning algorithms can analyze walking patterns to predict and prevent potential falls. Additional health monitoring sensors like ECG, temperature, and hydration sensors can turn the stick into a comprehensive mobile health station. Power efficiency can be improved through smart sleep modes and solar charging capabilities, ensuring longer operation without frequent recharging. Moreover, waterproof and shockproof designs will make the stick durable for varied environmental conditions, and future models can be customized for specific user groups such as the visually impaired, post-surgical patients, or outdoor adventurers. With potential integration into emergency services and smart home systems, the Smart Walking Stick could evolve into a complete safety solution that supports not just mobility, but also proactive health management, emergency response, and independent living, making it a truly indispensable companion for those in need.

Furthermore, integrating multilingual support can make the stick accessible to users across different regions, ensuring inclusivity and ease of use. Real-time voice-to-text conversion can assist hearing-impaired users by displaying spoken instructions on a connected mobile device. Incorporation of haptic feedback for alerts and directional cues can enhance navigation without the need for visual or audio prompts. Future iterations might also feature biometric authentication for secure health data access and personalization. Enhanced data analytics on user mobility trends can assist healthcare providers in tailoring treatment plans.

Smart power-saving features and solar charging can make the stick work longer without charging. Waterproof and strong design will help it last in all weather conditions. It can also be made for different people, like the blind, those recovering from surgery, or those who love hiking. In the future, it can be connected to emergency services and smart home systems to give full safety and support. The stick could become a must-have tool for helping people stay safe and independent.

It can also connect with smartwatches to work together and give health alerts. Doctors can use the data to spot health problems early. Vibration alerts can help people who can't hear or see well. Fingerprint or face unlock can keep health info safe. Working with hospitals and tech companies will help make the stick even better for those who need it.

Chapter 3

REFERENCES

1. IoT Based Walking Stick for Visually Impaired using Raspberry Pi – ultrasonic sensors plus GPS/GSM and voice commands via headphones.

2. IOT-Based Smart Sight Cane (IJCRT, 2024) – uses Arduino Uno and ultrasonic sensors (one facing front), detects obstacles up to 3.5m.

3. Smart IoT Navigation System for Visually Impaired Individuals (2025) – uses ESP32, ultrasonic sensors, smartphone app (MIT App Inventor), with 90° obstacle detection accuracy greter than 99 percentage.

ResearchGate: Smart IoT Navigation System – Jan 2025

4.Smart Cane—An SOS Enabled Blind Stick (IJSET) – Arduino UNO, ultrasonic sensors, GPS/GSM for SMS alerts.

5.SmartCane by IIT DelhiFeatures: Obstacle detection (knee to head), vibration feedback, USB charging.

6.Drordino Smart Stick Features: GPS tracking, fall detection, SOS button, flashlight, FM radio, voice reminder, and speaker.

7. Dr Trust Smart CaneFeatures: Flashlight, alarm, SOS button, ergonomic handle, foldable.

8. Walking Stick with GPS and SOS by Life assure Features: Real-time GPS tracking, fall alert, SOS button with 2-way communication.

Chapter 4

SOURCE CODE

```
#include <Wire.h>
#include <MPU6050.h>
MPU6050 mpu;
const int pulsePin = A0;
const int highThreshold = 700;
const int lowThreshold = 350;
int pulseValue = 0;
const long motionThreshold = 25000;
bool buzzerOn = false;
#define ECHO1 2
#define TRIG1 3
#define ECHO2 4
#define TRIG2 5
#define ECHO3 6
#define TRIG3 7
#define BUZZER 8
#define pushbutton 9
int ldrPin = 10;
int ledPin2 = 11;
int ledPin3 = 12;
```

```
#define OBSTACLE_THRESHOLD 25
#include <SoftwareSerial.h>
#include <TinyGPS++.h>
TinyGPSPlus gps;
SoftwareSerial ss(A2,A3);// RX, TX
float readDistance(int trigPin, int echoPin);
void setup() {
  Serial.begin(9600);
  Wire.begin();
  mpu.initialize();
  ss.begin(9600);
  Serial.println("Waiting for GPS signal...");
  pinMode(TRIG1, OUTPUT);
  pinMode(ECHO1, INPUT);
  pinMode(TRIG2, OUTPUT);
  pinMode(ECHO2, INPUT);
  pinMode(TRIG3, OUTPUT);
  pinMode(ECHO3, INPUT);
  pinMode(BUZZER, OUTPUT);
  pinMode(ldrPin, INPUT);
  pinMode(ledPin2, OUTPUT);
  pinMode(ledPin3, OUTPUT);
  pinMode(pulsePin, INPUT);
  pinMode(9, INPUT_PULLUP);
}
void loop() {
  float dist1 = readDistance(TRIG1, ECHO1);
  float dist2 = readDistance(TRIG2, ECHO2);
  float dist3 = readDistance(TRIG3, ECHO3);
   int lightState = digitalRead(ldrPin);
```

```
 while (ss.available() > 0) {
gps.encode(ss.read());
if (gps.location.isUpdated()) {
  double lat = gps.location.lat();
  double lng = gps.location.lng();
  int hour = gps.time.hour();
  int minute = gps.time.minute();
  int second = gps.time.second();
  hour += 5;
  minute += 30;
  if (minute >= 60) {
    minute -= 60;
    hour += 1;
  }
  if (hour >= 24) {
    hour -= 24;
  }
  Serial.println("Coordinates:");
  Serial.print(lat, 6);
  Serial.print(", ");
  Serial.println(lng, 6);
  Serial.print("Google Maps: https://www.google.com/maps?q=");
  Serial.print(lat, 6);
  Serial.print(",");
  Serial.println(lng, 6);
  Serial.print("Time (IST): ");
  if (hour < 10) Serial.print("0");
  Serial.print(hour);
  Serial.print(":");
  if (minute < 10) Serial.print("0");
```

```
    Serial.print(minute);
    Serial.print(":");
    if (second < 10) Serial.print("0");
    Serial.println(second);
    Serial.println("------------------------");
  }
}
if (lightState == LOW) {
  digitalWrite(ledPin2, LOW );
  digitalWrite(ledPin3, LOW );
} else {
  digitalWrite(ledPin2, HIGH);
  digitalWrite(ledPin3, HIGH);
}
pulseValue = analogRead(pulsePin);
Serial.println(pulseValue);
if (pulseValue > highThreshold || pulseValue < lowThreshold || (dist1 > 0 && dist1
    (dist2 > 0 && dist2 <= OBSTACLE_THRESHOLD) ||
    (dist3 > 0 && dist3 <= OBSTACLE_THRESHOLD)) {
  digitalWrite(BUZZER, HIGH);
  delay(200);
    }
    else{
  digitalWrite(BUZZER, LOW);
}
int16_t ax, ay, az;
mpu.getAcceleration(&ax, &ay, &az);
long totalAccel = abs(ax) + abs(ay) + abs(az);
Serial.println("Accel sum: " + String(totalAccel));
if(totalAccel > motionThreshold){
```

```
    digitalWrite(BUZZER, HIGH);
    delay(5000);
  }
   if(digitalRead(pushbutton) == LOW){
  digitalWrite(BUZZER, HIGH);
  delay(5000);
    digitalWrite(BUZZER, LOW);
 }
 }

float readDistance(int trigPin, int echoPin) {
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  long duration = pulseIn(echoPin, HIGH);
  float distance = duration * 0.034 / 2.0;
  return distance;
}
```