DEPARTMENT OF MECHANICAL ENGINEERING

21ARE382 DESIGN THINKING A

Fifth Semester

B Tech. Automation and Robotics Engineering

DESIGN THINKING REPORT

TRACKCARE

GOVIND H - AM.EN.U4ARE22023

HAMNA HAKKIM - AM.EN.U4ARE22024

ADITHYA POTHULA - AM.EN.U4ARE22026

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AMRITA SCHOOL OF ENGINEERING

AMRITA VISHWA VIDYAPEETHAM

AMRITAPURI CAMPUS, CLAPPANA P.O.

KERALA, INDIA 690 525

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1. INTRODUCTION

The GPS Tracking System for People with Medical Conditions like Amnesia is an innovative solution designed to enhance the safety of individuals who experience memory loss or confusion. By integrating GPS and wearable technology, this system provides real-time tracking and emergency alerts, enabling caregivers and loved ones to monitor the location of individuals with conditions like amnesia. This system helps prevent accidents and ensures that those affected by memory-related conditions are easily located and assisted when necessary. Its primary goal is to provide peace of mind to both the individuals who may wander and their caregivers.

2. DESIGN BRIEF

2.1 Scope:

The GPS Tracking System for Individuals with Medical Conditions like Amnesia integrates wearable technology and GPS tracking to provide a reliable safety solution. This system assists caregivers in monitoring movements, locating individuals in real time, and receiving emergency alerts when necessary. Designed for comfort, simplicity, and precision, the device ensures individuals with conditions like amnesia are effectively monitored and kept safe.

2.2 Aim:

To develop a wearable GPS tracking system that enhances the safety of individuals with memory-related conditions through real-time tracking, emergency alerts, and user-friendly features for wearers and caregivers alike.

2.3 Objectives:

- **Portability:** Design a lightweight, discreet wearable suitable for daily use, such as a wristband or pendant.
- **Real-Time Tracking:** Incorporate GPS technology to provide accurate, real-time location tracking.
- **Emergency Alerts:** Enable automatic notifications to caregivers when the wearer is in danger or exits a predefined safe zone.
- **Ease of Use:** Ensure straightforward setup and operation for both users and caregivers.
- **Durability:** Use water-resistant, shockproof materials to withstand regular wear.
- **Comfort and Aesthetics:** Create a comfortable, stylish, and functional design for extended use.

2.4 Design Brief:

A compact, durable GPS tracking system that prioritizes safety, offering real-time tracking and emergency alerts. The device will combine ease of use, comfort, and aesthetic appeal to support individuals with amnesia while ensuring peace of mind for their caregivers.

3. MARKET STUDY

There is a growing demand for personal safety and tracking solutions, particularly for individuals with medical conditions such as amnesia, dementia, or Alzheimer's. While there are several GPS tracking systems available, few are specifically designed to cater to the needs of individuals with memory-related conditions. Below are some examples of products in the market that offer GPS tracking and personal safety features, and how they compare to the proposed GPS Tracking System for People with Medical Conditions like Amnesia.

3.1. Wearable GPS Tracking Devices for Elderly

- **Description**: These devices are designed primarily for elderly individuals who may have cognitive impairments or memory issues. They typically include GPS tracking, emergency alerts, and fall detection.
- **Features**:
    - Real-time GPS tracking to monitor the user's location.
    - Emergency SOS button for immediate assistance.
    - Fall detection feature that alerts caregivers if a fall occurs.
    - Waterproof and durable for everyday wear.
- **Use Case**: These devices are ideal for caregivers and loved ones of elderly individuals with memory conditions, providing them with peace of mind knowing the person's location at all times.

3.2. Smartwatches for Medical Conditions

- **Description**: Smartwatches with integrated GPS tracking and health monitoring features, such as heart rate monitoring and step counting. These devices are equipped with tracking capabilities to help locate individuals with medical conditions like amnesia.
- **Features**:
    - Built-in GPS tracking and real-time location updates.
    - Heart rate monitoring, step tracking, and other health-related features.
    - Geofencing capabilities to set safe zones for the user.
    - Emergency alert feature that sends notifications to caregivers if the wearer is outside the safe zone or requires assistance.
- **Use Case**: These smartwatches provide more than just tracking. They offer a comprehensive health and safety solution, allowing caregivers to monitor both the user's physical health and whereabouts.

3.3. GPS-Enabled Personal Emergency Response Systems (PERS)

- **Description**: PERS devices are worn as pendants or wristbands and offer a simple solution for emergency alerting and location tracking. They are specially designed for people who might be prone to wandering due to cognitive conditions.
- **Features**:
    - GPS tracking for real-time location monitoring.
    - One-touch emergency button that contacts caregivers or emergency services.
    - Fall detection and other safety-related features.
    - Long battery life and simple, user-friendly interface.
- **Use Case**: Suitable for individuals with cognitive conditions who might wander or get disoriented, offering caregivers an easy way to ensure safety and act quickly in emergencies.

3.4. Wearable Devices for Children with Special Needs

- **Description**: Devices specifically designed to track children, particularly those with autism or other special needs. These devices often have features like geofencing and real-time tracking, with an emphasis on safety and easy access for caregivers.
- **Features**:
    - Real-time GPS location tracking.
    - Geofencing to set safe zones and receive alerts if the child moves outside.
    - SOS button for immediate communication.
    - Compact, child-friendly design.
- **Use Case**: While these devices are primarily targeted for children, they have crossover appeal for people with memory conditions, particularly those who may be prone to wandering.

3.5. Mobile Apps for Location Tracking

- **Description**: Several mobile apps offer GPS tracking for individuals, allowing family members or caregivers to track the location of a loved one. Some apps also include emergency alert features and geofencing.
- **Features**:
    - Real-time GPS location tracking through the user's smartphone.
    - Ability to set up safe zones and get notifications if the user leaves the area.

    - Communication features for caregivers to directly reach the individual in case of an emergency.
- **Use Case**: These apps are ideal for individuals who are already familiar with smartphones but may not want to wear a dedicated device. They allow caregivers to track the user's movements and receive alerts if necessary.

3.4 Market Opportunity:

- **Gap in the Market**: While there are several wearable GPS tracking devices for elderly individuals and those with cognitive impairments, there is a lack of dedicated solutions designed specifically for individuals with medical conditions like amnesia. A GPS tracking system tailored to meet their needs could provide enhanced safety and reassurance for both the wearer and caregivers. Furthermore, the integration of features such as emergency alerts, fall detection, and geofencing could offer a more comprehensive solution than existing products.
- **Target Audience**:
    - Caregivers and family members of individuals with memory-related conditions (e.g., amnesia, dementia, Alzheimer's).
    - Individuals with cognitive impairments who are at risk of wandering or becoming disoriented.
    - Healthcare providers looking for reliable tracking solutions for patients with memory loss.

3.5 Key Features & Design Considerations for the GPS Tracking System:

- **GPS Real-Time Tracking**: Continuous, real-time tracking to ensure that the location of the individual is easily accessible at all times.
- **Geofencing & Safe Zones**: The ability to set geofences around predefined areas, alerting caregivers if the individual leaves these safe zones.
- **Emergency SOS Button**: A simple button that allows the wearer to signal for help in case of an emergency.
- **Fall Detection**: Technology that automatically detects if the wearer falls and sends an alert to caregivers.
- **Comfortable and Durable Wearable Design**: The device should be lightweight, waterproof, and designed for long-term wear without discomfort.
- **Long Battery Life**: Ensuring the device remains functional for extended periods, minimizing the risk of the battery running out unexpectedly.

- **User-Friendly Interface**: Easy setup and usage for both the individual wearing the device and their caregivers.

TRACKING TYPE	USE CASE	PRICE	PROS	CONS
Bluetooth GPS	Keys. Wallets. Pets.	$5 to $100	Simple Setup. Cheap. Tiny in Size.	Short Battery Life. Short Tracking Range. Easily Detectable.
OBD GPS	Fleets.	$120 to $400	Simple Setup. Telematics.	No Backup Battery. Poor Theft Defence. Can Be Easily Disabled. Requires Constant Power.
Satellite GPS	Hiking. Containers. Rural Areas.	$600 to $1,000	Works With No Coverage.	Expensive Hardware Expensive Subscription Complex Setup
Wired GPS	Fleets.	$100 to $600	No Recharge. Telematics. Live Tracking.	Easy for Thieves to Find. Short/No Backup Battery. Complex Installation. No Satellite Tracking.
Wireless GPS	Theft. Tracking.	$150 to $300	Simple Setup. Tracks 24/7. Long Battery.	Requires Recharging. No Satellite Tracking

Brand	Price Range (INR)	Compatibility	Material	Features	Target Audience	Aesthetic Appeal	Portability	Market Position
Track Ease	₹2,500–₹4,000	Universal	Silicone	Real-time GPS tracking, SOS button, waterproof design	Amnesia patients, elderly, caregivers	High	High	Mid-range, user-friendly assistive technology
Care Track Pro	₹4,500–₹7,000	Universal	Hard plastic	Long battery life, geofencing alerts, fall detection	Elderly individuals, memory care facilities	Medium	High	Premium, advanced safety and monitoring tool
Safe Step Mini	₹2,000–₹3,500	Universal	Plastic	Compact, lightweight tracker with location sharing and app integration	Active seniors, caregivers	Medium	High	Affordable, portable safety device
Guardian Wear	₹5,000–₹8,000	Select smartwatches	Metal/Plastic	Discreet GPS tracking integrated with smartwatch features	Tech-savvy caregivers, professionals	High	Medium	Premium, stylish wearable tracker
Pathfinder One	₹1,800–₹2,800	Universal	Plastic	Basic GPS tracking, SOS button, budget-friendly	Budget-conscious families	Medium	High	Entry-level, accessible tracking device
Memory Safe	₹3,000–₹4,500	Universal	Silicone/Plastic	Enhanced accuracy, two-way communication, app-based loc.	Elderly, families with memory concerns	High	Medium	Mid-range, reliable family tracker

4. USER STUDY:

Category	Details
Target Audience	Patients with amnesia, caregivers, family members; typically aged 50–80 years.
Key Problems	Difficulty locating patients, risk of wandering or getting lost, and ensuring timely assistance.
Key Requirements	Compact, reliable, long battery life, waterproof, easy-to-wear design, and real-time tracking.
User Preferences	Comfortable wearable device, discreet design, clear notifications, and easy-to-use interface.
Market Insights	Increasing demand for assistive technology to enhance the safety and independence of patients.
Usability Tests	Test tracking accuracy, alert reliability, and comfort during extended wear.
Potential Challenges	Ensure affordability, maintain privacy, balance functionality and simplicity.

5.PERSONA AND SCENARIO:

5.1 Persona 1: The Elderly Retiree

- NAME: Suresh
- AGE: 68
- PROFESSION: Retired teacher

- LIFESTYLE: Lives independently but enjoys morning walks and visiting friends.
- GOALS: Maintain independence and stay connected with family in case of emergencies.

- **SCENARIO:** Concerns about getting lost during walks due to early signs of memory loss. Scenario: Suresh decides to go for his regular morning walk but gets disoriented on his way back. His GPS tracker sends an alert to his son, who quickly locates and helps him return home safely, ensuring Suresh's confidence in maintaining his daily routine.

5.2 Persona 2: The Working Caregiver

- NAME: Meera
- AGE: 35
- PROFESSION: IT professional

- LIFESTYLE: Juggling work, family, and caring for her mother who has amnesia.
- GOALS: Ensure her mother's safety while managing her busy schedule.

- **SCENARIO**: Anxiety about her mother's safety when she's not at home. Scenario: Meera is at work when she receives a notification that her mother has wandered outside the geofenced area. Using the tracker's app, she quickly contacts a neighbor to assist her mother, ensuring safety without interrupting her workday.

5.3 Persona 3: The Outdoor Enthusiast

- NAME: Raj
- AGE: 40
- PROFESSION: Freelance photographer

- LIFESTYLE: Frequently exploring new locations for photography, often in isolated areas.
- GOALS: Stay safe and reachable while pursuing his passion for photography.

- **SCENARIO:** Risk of losing his way in unfamiliar areas during photo excursions. Scenario: While exploring a remote forest for a photography project, Raj loses track of his location. His GPS tracker's SOS button helps him signal his assistant, who guides him back to a safe area using the live tracking feature, enabling Raj to continue his work without worry.

6. Conceptualization

6.1 Ideation Process

The concept for the design originated from the need for a versatile, cost-effective, and compact device that addresses multiple real-world use cases, including:

1. Assisting individuals with Alzheimer's or those requiring constant care by providing geofencing, fall detection, and alert mechanisms.
2. Serving as a crash detection system with automated emergency alerts for accidents.
3. Functioning as an anti-theft device for vehicles and other valuables, ensuring real-time tracking and alerts.

6.2 Features and Objectives

Key features that are decided that are essential to work this prototype :

- **Geofencing:** A virtual fence needs to be established around the house or a community. People with Alzheimer's will often tend to forget their current place.
- **Motion Detection:** people with difficulties even when they are home might fall down even when at home which might need immediate care. Also motion detection feature makes it more useful for detecting crashes which can be helped faster.
- **Communication:** the immediate caretakers or hospital services should be alerted immediately. Sending SMS alerts without any intervention is the most important feature. Playing a prerecorded message a sim module and a buzzer/speaker so that the person who is wearing it and the nearby people will also be alerted.
- **Compact Design:** Ensuring portability, allowing the device to be worn or attached easily.
- **Standalone Automation:** Unlike most devices that rely on a paired smartphone or subsystem, this device operates independently with direct network connectivity.

6.3 Addressing Market Gaps

The technical decisions were also guided by specific shortcomings in existing solutions:

- **Dependency on Smartphones**: Most current systems require a constant Bluetooth connection to a smartphone, limiting their effectiveness in standalone scenarios.
- **High Costs**: Many existing devices are prohibitively expensive due to proprietary technology or unnecessary features.
- **Limited Automation**: Few devices offer true automation, such as sending SMS alerts or activating audio notifications without manual intervention.
- **Inflexible Design**: Current systems are often designed for specific use cases (e.g., fitness tracking) and lack versatility.

6.4 Initial Development Approach

During this phase, the focus was on creating a functional prototype that could validate core features:

- Core Components: The prototype integrated the Neo 6M GPS module, 800L GSM module, MPU 6050 sensor, Arduino Nano, and a portable power source.
- Primary Features Tested:
    - Real-time GPS tracking for geofencing.
    - Automated SMS alerts for boundary violations or tilt detection.
    - Basic system reliability and integration of modules.

While the initial prototype successfully demonstrated functionality, future iterations will focus on:

- **Miniaturization**: Reducing size for enhanced portability.
- **Power Optimization**: Increasing battery efficiency to extend operational life.
- **User Feedback Integration**: Testing with target users to refine ease of use and performance.
- **Scalability**: Exploring the use of additional communication methods like LoRa or Wi-Fi for broader coverage.

7. Concept Detailing

7.1 System Architecture

The design integrates several key components that work together to provide the device's core functionality. The architecture focuses on creating a self-sufficient, compact system where each component serves a specific role:

- **Neo 6M GPS Module**: Provides real-time location tracking, essential for geofencing and monitoring the user's movements. It communicates via serial data to the Arduino Nano to send location updates.

- **800L GSM Module**: Used to send automated SMS messages. This module is integrated directly into the device, eliminating the need for a paired smartphone or additional communication systems. It is activated by sensors, such as the GPS and MPU 6050, to send alerts in case of boundary violations, falls, or accidents.

- **MPU 6050 Sensor**: Detects motion and orientation. It is responsible for sensing tilt or falls. The sensor continuously tracks the user's movements and triggers SMS alerts or audio notifications if an abnormal movement pattern is detected.

- **Arduino Nano**: Acts as the central processing unit, receiving inputs from the GPS module and MPU 6050 sensor. It processes these signals and determines when to trigger an alert. It also manages the device's overall functionality, ensuring seamless operation.

- **Buzzer/Speaker**: A key component for audible alerts. When a critical event, such as a fall or geofence violation, is detected, the speaker plays a pre-recorded message or sound to alert the user and nearby people.

- **Battery**: A 5-10V power source ensures the device runs efficiently for extended periods. Power management is critical to the system's overall design and will be optimized in future iterations.

7.2 Features Breakdown

- **Geofencing**: The GPS module tracks the user's location and compares it to set boundaries. If the user leaves the designated area, the GSM module sends an SMS alert to emergency contacts.
- **Fall Detection**: The MPU 6050 sensor detects tilt or sudden movements, triggering an SMS alert when a fall is detected.
- **Communication and Alerts**: The GSM module sends SMS alerts for boundary violations or falls. The buzzer or speaker plays a pre-recorded message to notify the wearer and others nearby.

7.3 Power Management and Efficiency

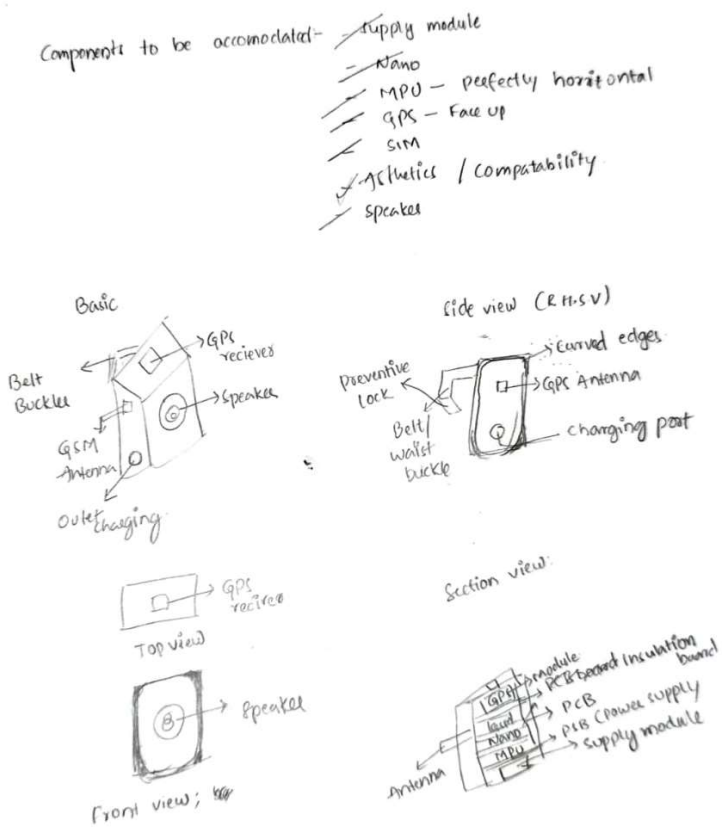
- **Low-Power Design**: The Arduino Nano and other components are selected for their low power consumption. GPS and MPU sensors are activated only when necessary to conserve battery life.
- **Battery**: A 5-10V battery powers the system, ensuring adequate operation time. Power management optimizations will be explored in future iterations to extend battery life.

8. Prototyping

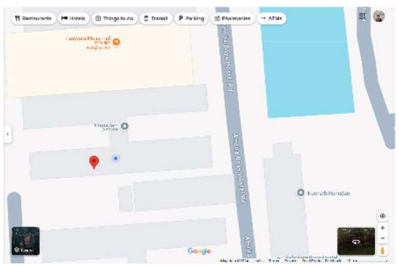
8.1 Prototype Development Process

The prototype development process involved several key steps to create a functional device capable of validating the core features. These steps are outlined below:

- **Step 1: Conceptualization and Shell Design**
  The first step was to sketch out rough models for the shell, considering factors like portability and ease of attachment. These rough models were used to envision how the components would fit together in a compact, wearable design.



- **Step 2: Component Testing**
  Before integrating the components, individual tests were conducted for each part:
  - The GPS module was tested for location accuracy and initialization times.



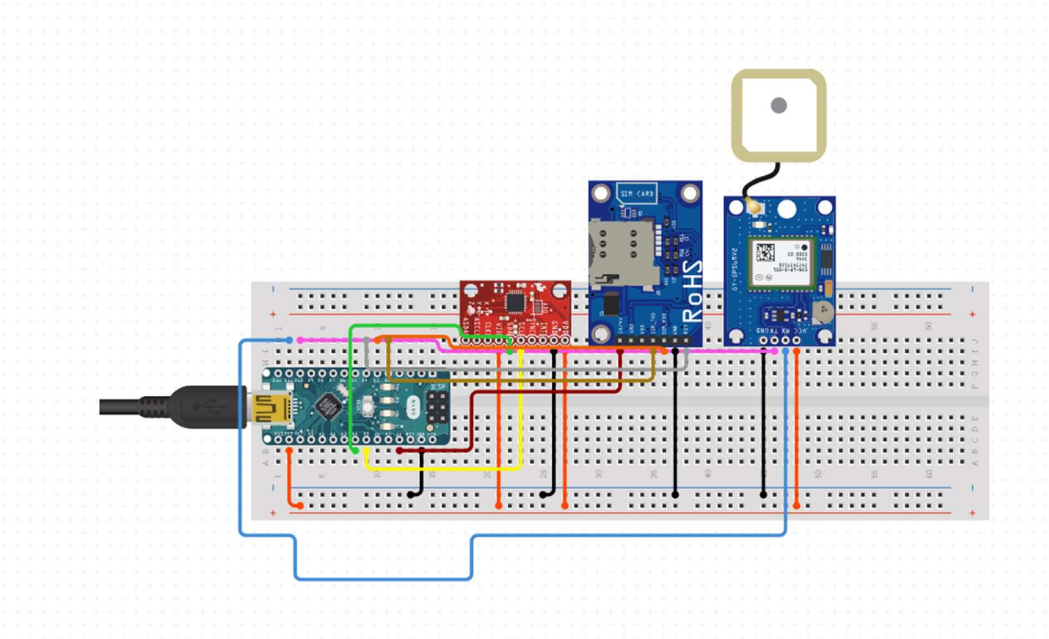
Current position vs

the detected position

(error range of ± 1.5m)

- The GSM module was tested for SMS functionality and power requirements.
- The MPU 6050 sensor was calibrated and tested for motion sensitivity.

- **Step 3: Circuit Diagram and Component Selection**
  A circuit diagram was created to plan out how all the components—GPS module, GSM module, MPU 6050 sensor, Arduino Nano, and buzzer/speaker—would be connected. The components were selected based on their compatibility with the overall system and their ability to work together efficiently.



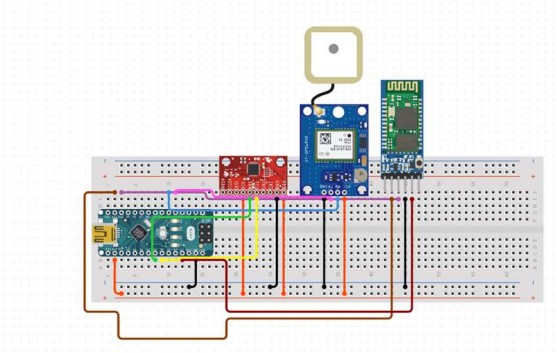
- **Step 4: Integration and Wiring**
  Once each component was tested, the wiring was set up to connect the components as planned in the circuit diagram. The Arduino Nano was programmed to read data from the GPS and MPU 6050 sensors, process it, and trigger the GSM module to send SMS alerts when necessary.

8.2 Challenges and Solutions

Several challenges arose during the prototyping process:

- **GPS Initialization**: The GPS module took around 20 minutes for the first initialization, which was much longer than expected. This delay was attributed to the GPS module's need to locate satellites, and future optimizations will focus on reducing initialization time.
- **GSM Module Burnout**: The GSM module burned out due to voltage fluctuations. To solve this, a supply board was introduced to provide a stable voltage, preventing damage to the components from voltage spikes.

- **Communication with HC-05**: For the prototype, the HC-05 Bluetooth module was used for communication testing, offering a simpler solution for testing the communication functionality without requiring the GSM module's full integration.

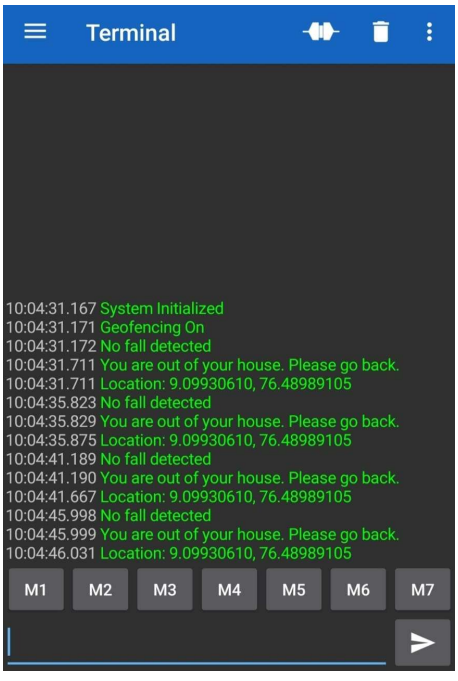


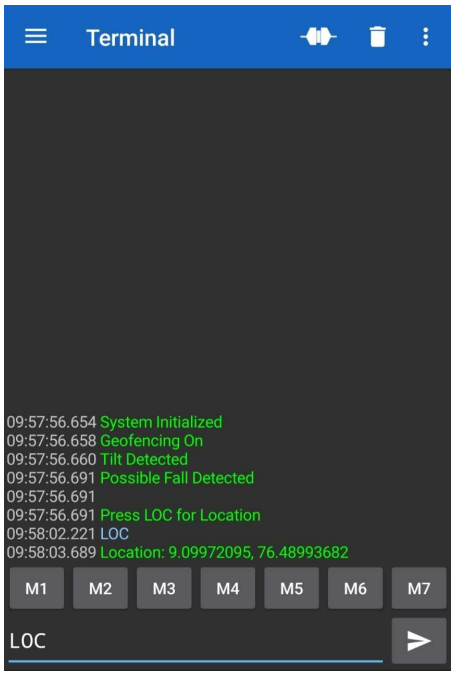
8.3 Results and Evaluation

Despite the challenges, the prototype successfully demonstrated core functionalities:

- Real-time GPS tracking and geofencing
- Fall detection with the MPU 6050
- Automated message alerts

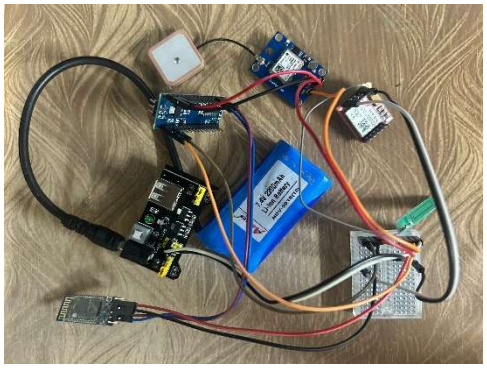
However, further refinement is needed, especially regarding GPS initialization time, power stabilization, and sensor calibration. Future iterations will focus on optimizing these aspects to improve the device's performance.





Terminal responses for two cases:
(I) when the device is out of the geofence
(II)fall detection and LOC command

Final Prototype



9. User Testing

9.1 Testing Approach

User testing was conducted in various indoor and outdoor settings to evaluate the device's performance. Different scenarios were tested, including fall detection and geofencing, to gauge the device's functionality in real-world applications.

- **Test Conditions**:
    - **Indoor vs. Outdoor**: To simulate diverse environmental conditions.
    - **Falling and Non-Falling**: To assess the accuracy of fall detection and responsiveness.

9.2 Feedback and Results

Key findings from the testing:

- **Pros**:
    - **Geofencing** worked accurately, with fast signal cycles and reliable alerts when boundaries were crossed.
    - **Fall detection** was effective for most fall scenarios, with a long battery life (up to 6 hours), making the device suitable for prolonged use.

- **Cons**:
    - **Voltage fluctuations** impacted system stability, particularly affecting the GSM module.
    - The **MPU sensor** was more sensitive than expected, leading to occasional false positives during fall detection.
    - **GPS initialization** was initially slow but improved over time.
    - **Indoor GPS perception** was non-existent, but this is not an issue as the device is designed for outdoor use only.

9.3 Areas for Improvement

Based on testing feedback, the following improvements will be prioritized:

- **Compact Microcontroller**: Using a microcontroller with parallel processing capabilities for improved performance and smaller form factor.

- **Custom PCB Design**: Designing a custom PCB will enhance power management and simplify the device's integration.

- **Fall Detection Algorithm**: Refining the algorithm to reduce false positives and improve detection accuracy.

- **Power Optimization**: Further optimization of power consumption to extend battery life, especially in GPS and motion detection modes.

10. Conclusion

Successful Prototype:
The project successfully developed a compact, cost-effective device designed for real-world applications, including assistance for individuals with Alzheimer's, crash detection, and anti-theft functionality.

Key Discoveries:

- **Geofencing**: The device reliably created a virtual fence, providing accurate boundary detection with fast signal cycles.
- **Fall Detection**: The MPU 6050 sensor effectively detected falls, though further tuning is needed to minimize false positives.
- **GPS Initialization**: Initial GPS signal acquisition was delayed, though this resolved over time, indicating a need for further optimization in the future.
- **Indoor GPS Limitations**: The Neo 6M GPS module lacked indoor signal perception, but this is not an issue as the device is primarily intended for outdoor applications.
- **Power Consumption**: The battery performed well, lasting up to 6 hours, but optimization of power efficiency is a key area for future improvements.

Areas for Future Enhancement:

- **Microcontroller Optimization**: Use a compact, parallel-processing microcontroller to improve performance and reduce size.
- **Custom PCB Design**: Design a custom PCB to better regulate power, integrate components efficiently, and reduce the device's footprint.
- **Fall Detection Algorithm**: Refine the fall detection algorithm to minimize false positives and improve accuracy for real-world scenarios.
- **Power Management**: Optimize power consumption, especially for GPS and motion detection, to extend battery life during prolonged use.
- **Scalability and Communication**: Incorporate additional communication methods, such as **LoRa**, **Wi-Fi**, or **Bluetooth Low Energy (BLE)**, to enhance range, data transmission efficiency, and device scalability.

Conclusion:
The prototype successfully demonstrated its core functionalities. While some limitations were discovered during testing, they provide valuable insights into areas for further improvement. The planned enhancements, including power optimization, custom PCB design, and integration of LoRa and other communication technologies, will contribute to a more efficient, reliable, and scalable device. This device holds great potential in applications ranging from health monitoring and accident detection to anti-theft systems, providing practical and versatile solutions for a variety of real-world needs.