E-Bike Tracking and Alert System

Final Presentation

Course : Advanced Real Time Systems

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Overview

- With the growing popularity of e-bikes, there is an increasing need for solutions that provide security and real-time alerts. It has become necessary to have cost effective solution that helps to prevent theft and alert e-bikes location in real time.

- The goal of this project is to develop a system that tracks the location of e-bikes in real time using GPS. The system will track the e-bike's location and if the e-bike crosses a specific area or there is any unauthorized activity, there will be a security alert within a few seconds. With the integration of GPS and GSM technology, real-time tracking through GPS, and reliable communication through GSM, it has become an effective safety tool.

➔ **Why Real Time:**

Our system is responsive in real time. When the e-bikes cross the area, immediate sms will be sent to the owner with real time location of the e-bike.

Features

- **Geofence Security Alert:**

  An integrated geofencing capability monitors predefined areas. Crossing the unimaginable boundary by an unauthorized user results in the system sending an SMS with the geolocation of the device to the owner, providing real-time updates and improving safety.

- **Emergency Location Sharing:**

  The owner can set off an alert in emergencies. The system immediately sends an SMS message with their current coordinates to a pre-registered emergency contact for assistance. SMS will be sent after every 10 seconds once the bike crossed the geofence area.

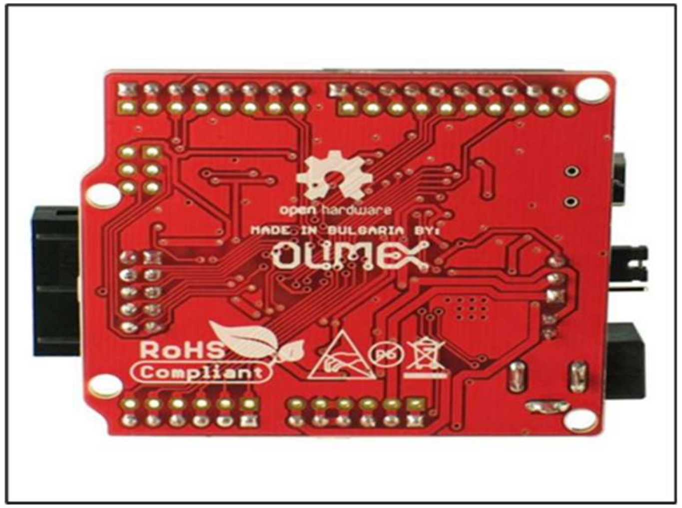
- **Emergency Call Assistance:**

  During critical situations, the system makes a direct call to a predefined number, thus conveniently providing the direct voice communication connection for urgent help. Call duration will be 30 seconds after the bike crossed the geofence area.

Hardware Components

1.Microcontroller (Olimexino-32U4)

- Compatible with Arduino IDE which makes easier for programming.
- Low power consumption, compact and efficient micro-controller.
- Integrating devices like GPS, GSM are easier.
- Low cost device



2. GPS Module (GPS Neo-6m)

- Provide a powerful satellite search capability.
- The module's status can be tracked using the power and signal indicators.
- Works in low power.

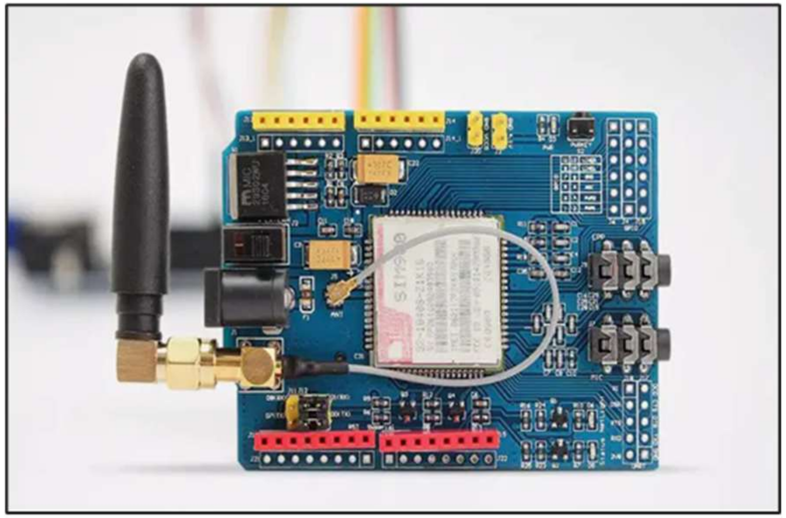
➔ Needs open space, sometimes creates connectivity problem.

Hardware Components

3. GSM Module (SIM900)

- The GSM SIM900 module supports GSM/GPRS connectivity in embedded solutions..
- Connects devices to the internet, makes voice calls, and sends SMS messages over a mobile network.

➔ In isolated locations, performance could drop.



4. Lithium-ion battery

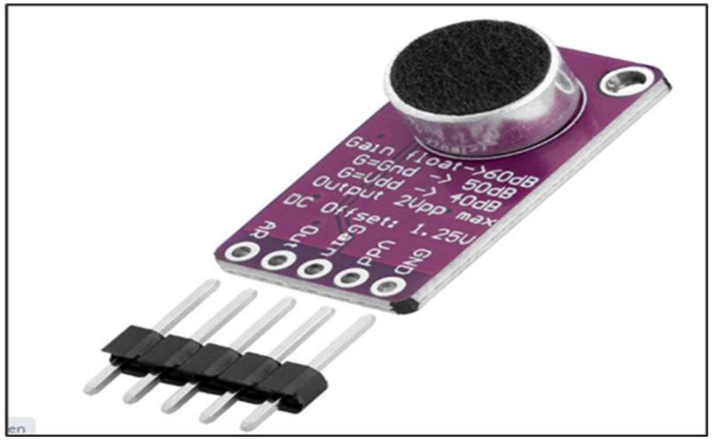
- Lithium-ion is the most common and widely used rechargeable battery.
- Suitable for portable devices.

➔ Overheating problem can happened due to temperature sensitivity.

Hardware Components

5. Battery Charger
6. Push Button
7. Breadboard/Zero PCB
8. Connecting Wire

9. Resistor(10k)



10.. Microphone(MAX9814)

Software

Software tools we used for our project:

Arduino IDE:

- Compatible with the Olimexino-32U4.
- Open source and easier to integrate extended libraries.

TinyGPSPlus:

- To fetch location data from GPS Neo-6M module.

SoftwareSerial:

- For GPS and GSM setup. It creates virtual port on microcontroller which enables communication with GPS and GSM.

Block Diagram

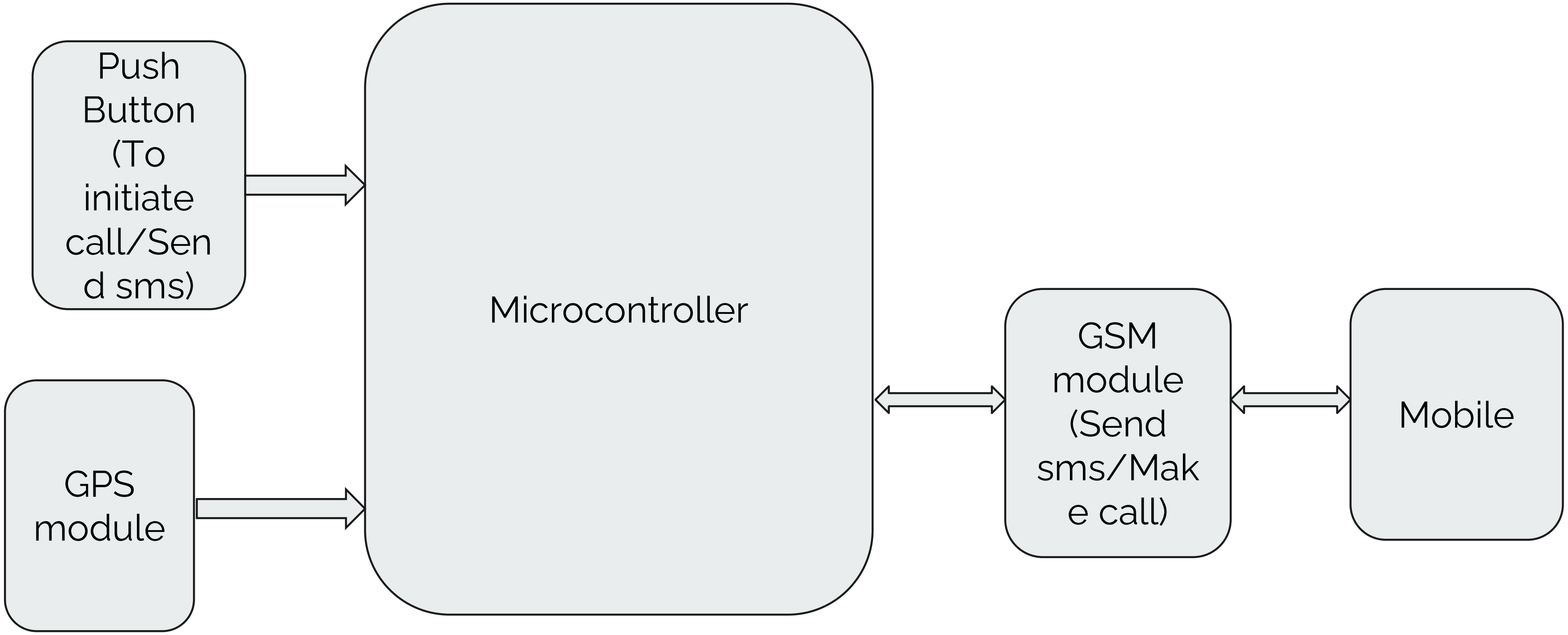


Fig: Block diagram

Circuit Diagram:

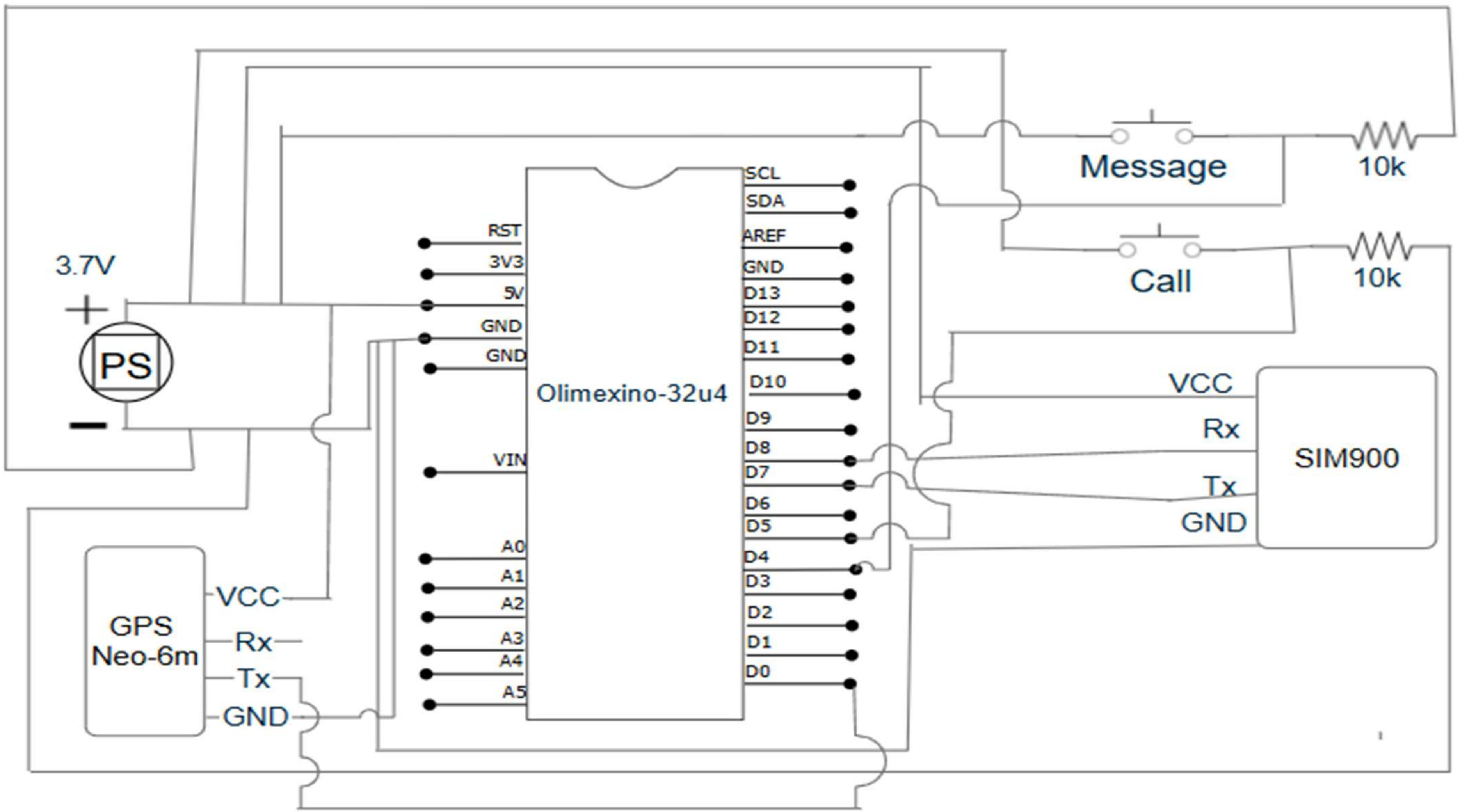


Fig: Circuit diagram

Implementation

- Setup all hardwares with proper connectivity.
- Setup GPS and GSM module.
- For programming, we parse latitude and longitude data collected through GPS.
- Develop a push button for emergency calling when the user fears any danger.

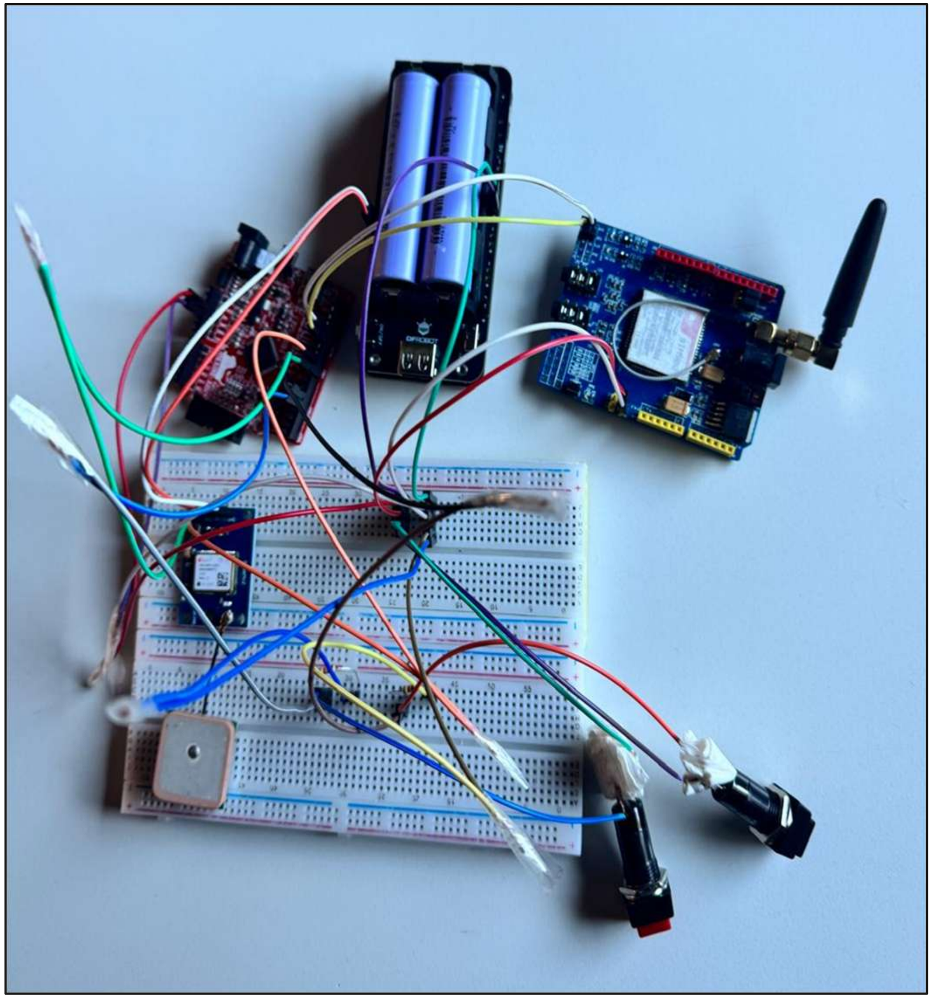


Image: Implemented hardware setup

Implementation

For counting the position of the cycle.

- As the location is calculated using Trilateration, a minimum of three satellites are necessary to provide a position fix.
- This is not the same as triangulation, which only counts distance rather than angles.

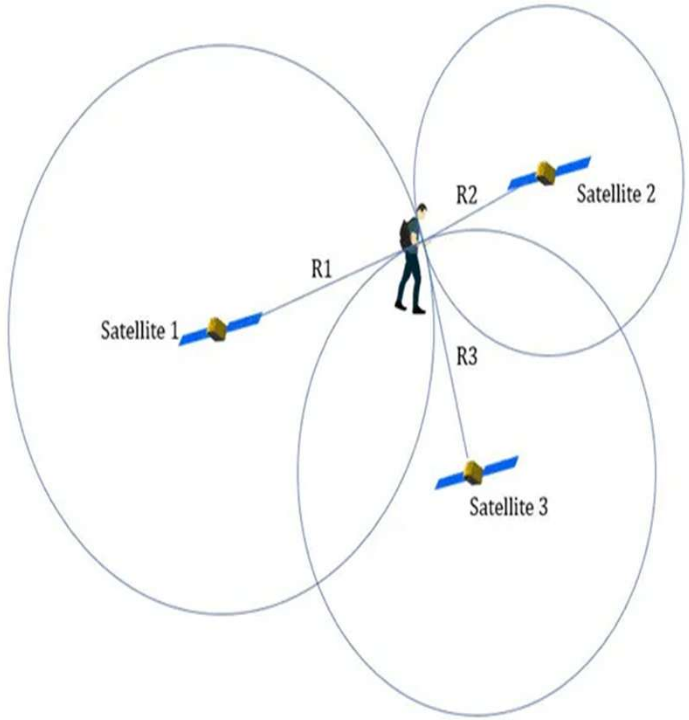


Figure 1 – https://www.pathpartnertech.com/triangulation-vs-trilateration-vs-multilateration-for-indoor-positioning-systems/

Implementation

For geofencing feature,
We used Haversine Formula to calculate the distance of two GPS coordinates.

We use the initial latitude and longitude data to establish the circle's center, and then we compare them with the latitude and longitude values of the GPS module.

$$\text{haversine}(\theta) = \sin^2(\theta/2)$$

Here, φ = latitude,
λ = longitude
R = earth's radius (6,371km)

$a = \sin^2(\varphi B - \varphi A/2) + \cos \varphi A * \cos \varphi B * \sin^2(\lambda B - \lambda A/2)$
$c = 2 * \text{atan2}(\sqrt{a}, \sqrt{(1-a)})$
$d = R \cdot c$

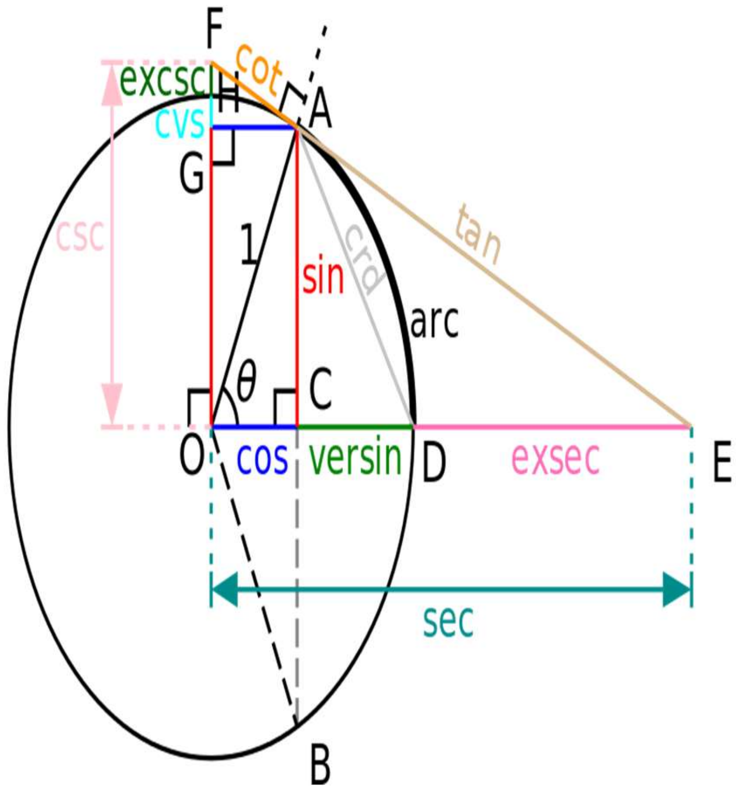


Figure: https://community.esri.com/t5/coordinate-reference-systems-blog/distance-on-a-sphere-the-haversine-formula

Implementation

Testing:

- Test our GPS to detect if our GPS module giving accurate data or not.
- Also test our GSP module by sending predetermined sms.
- Checked whether the emergency push button works properly or not.
- Tested our system in different locations to observe the performance.

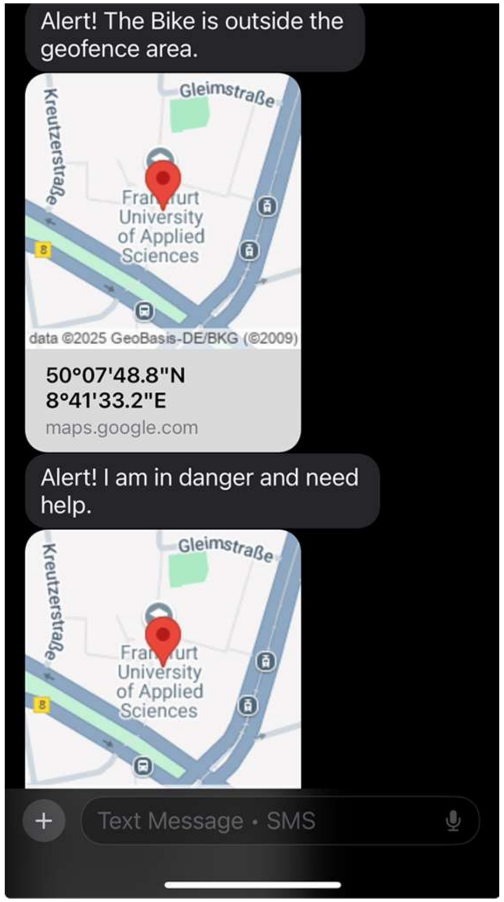


Image: Emergency alert

Time Plan

Phase	Tasks	Time	Status
Planning	Project scope, planning, research, timeline	Week (1 -2)	Completed
Design	Circuit design,Arduino code framework	Week 3	Completed
Setup	Hardware setup	Week 4	Completed
Coding	Programming, GSM and GPS Module Setup	Week (5-6)	Completed
Testing	Testing and debugging for alerts, geofencing	Week (7-8)	Completed
Final Integration	Final report and integration	Week (9-10)	In Progress

Table 1 : Time plan of the project

Time Plan

Fig: Gantt Chart

Members Contribution

Task	Responsibility
Planning, Research	Pronab/Anika/Prajakta
Circuit Design	Anika/Prajakta
Hardware setup	Pronab/Anika
Programming and Integration	Prajakta/Anika/Pranob
Testing and Final Deployment	Prajakta/Pronab
Scientific Report	Anika/Prajakta/Pronab

Table 2 : Individual contribution of the group members.

Challenges:

- **Power Supply and Management:** The setup uses two 3.7V Li-ion batteries with 3.3V and 5V outputs to power the GPS Neo-6M (3.3V), Olimexino microcontroller, and SIM900 GSM module (both 5V). Recharging these batteries takes time, potentially delaying operations.
- **GPS Signal Issue:** During testing we faced difficulties in receiving GPS Signal inside the building.
- **GPS Module Faulty:** While integration of hardware we found GPS module was not working. After replacing GPS module it's starts working as expected.

References

1, Dahiya, P. (2019) *Real Time Systems - GeeksforGeeks*, *GeeksforGeeks*. Available at: https://www.geeksforgeeks.org/real-time-systems/. [Accessed 25 Nov. 2024]

2. *Random Nerd Tutorials | Learn ESP32, ESP8266, Arduino, and Raspberry Pi* (no date) *Random Nerd Tutorials*. Available at: https://randomnerdtutorials.com/. [Accessed 28 Nov. 2024]

3. Arduino official page. Available at: https://www.arduino.cc/ [Accessed 28 Nov. 2024]

4. Arduino IDE. Available at: https://www.arduino.cc/en/Guide [Accessed 28 Nov. 2024]

5. Guide to NEO-6M GPS Module Arduino. Available at: https://randomnerdtutorials.com/guide-to-neo-6m-gps-module-with-arduino [Accessed 30 Nov. 2024]

6 How to Use Arduino GSM Shield SIM900. Available at: https://www.instructables.com/How-to-Use-Arduino-GSM-Shield-SIM900/ [Accessed 30 Nov. 2024]

7. Arduino based Vehicle Tracker using GPS and GSM. Available at: https://circuitdigest.com/microcontroller-projects/vehicle-tracking-system-using-arduino-gps-and-gsm [Accessed 1 Dec. 2024]

8.Haversine Formula . https://community.esri.com/t5/coordinate-reference-systems-blog/distance-on-a-sphere-the-haversine-formula/[Accessed 13 Jan}

9. For GPS : https://actisense.com/news/gps/ [Accessed 13 Jan}

10. https://www.electroniclinic.com/geofencing-in-cars-using-arduino-gps-and-gsm-geofence-gps-tracker/ [Accessed 13 Jan}

11. https://justdoelectronics.com/build-your-smart-gps-tracker-system-using-arduino [Accessed 13 Jan}

Thank You