ACCIDENT DETECTION AND ALERT SYSTEM WITH GEOFENSING TECHNOLOGY

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Introduction:

Road accidents are one of the major causes of death and severe injuries worldwide. In many situations, the delay in informing emergency services after an accident significantly increases the risk to the victims. Quick response and timely medical assistance can greatly improve survival chances. Therefore, there is a strong need for an automated system that can detect accidents instantly and notify emergency contacts without relying on manual intervention. With this motivation, the project titled “Accident Detection and Alert System with Geofencing Technology” focuses on developing a smart, reliable, and automated safety device capable of detecting accidents in real time and sending immediate alerts.

The proposed system is designed using an ESP32 microcontroller as the central processing unit, which integrates multiple sensors and communication modules. An MPU6050 accelerometer and gyroscope sensor continuously monitors the motion and orientation of the vehicle. When the sensor detects sudden impacts, abnormal acceleration, or unusual movement patterns that may indicate a crash, the system identifies it as a potential accident. At this stage, a buzzer is activated for approximately ten seconds to alert nearby individuals and provide the user with an opportunity to cancel the alert if it was triggered accidentally.

If the alert is not cancelled within the given time, the system automatically sends an SMS containing the GPS location coordinates and initiates a call to pre-saved emergency contacts through the SIM800L GSM module. The system also incorporates additional safety features such as geofencing, a panic button for emergency alerts, and live location tracking using the NEO-6M GPS module and a mobile application. By integrating sensors, communication modules, and IoT technology, this project provides a low-cost and practical solution that can reduce emergency response time and potentially save lives during critical situations.

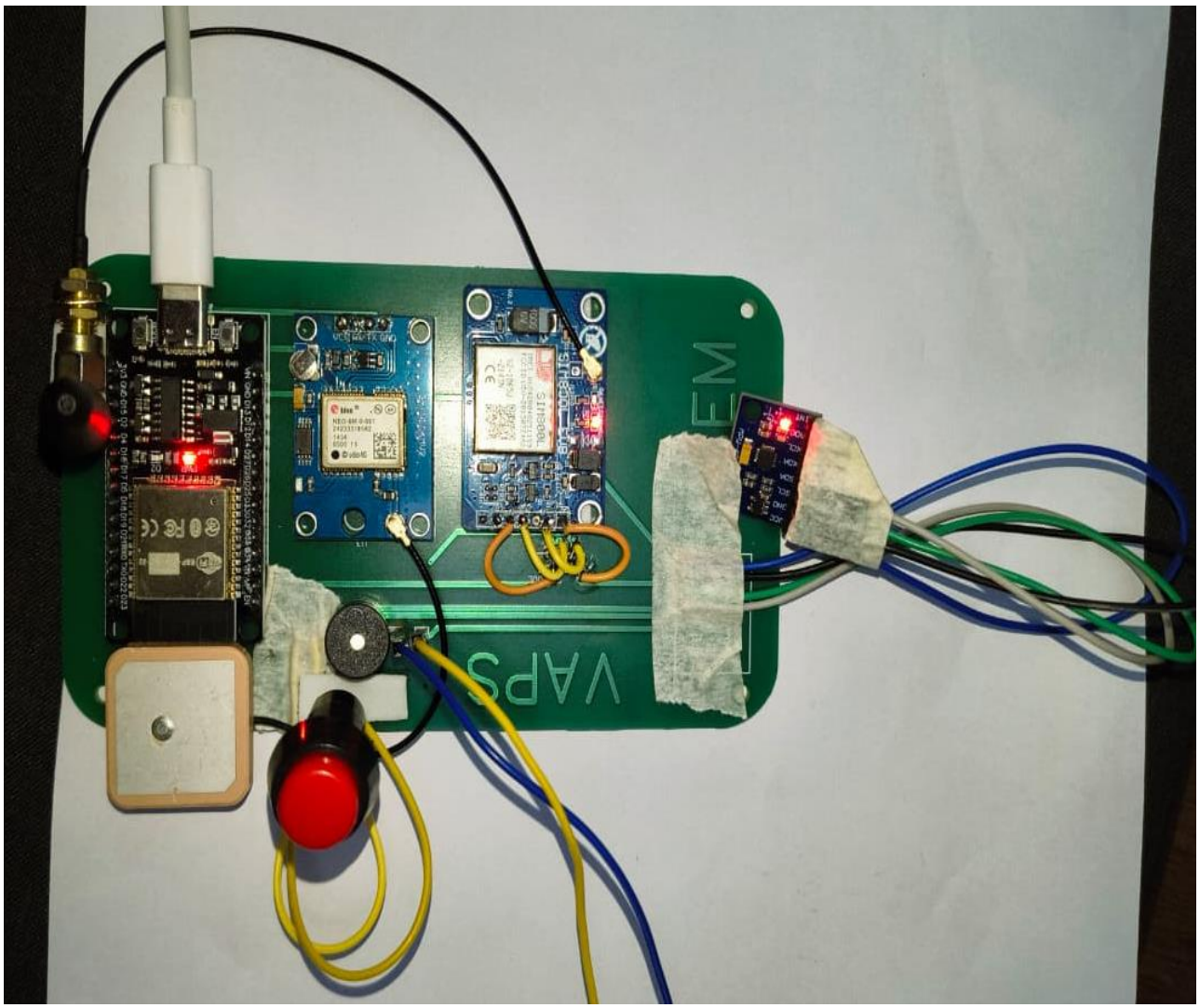


Figure 1: Testing of model

Objectives:

1. To Detects sudden vehicle impact using MPU6050 sensor and triggers buzzer alert for ten seconds.
2. To Automatically sends emergency SMS and calls to contacts including real-time GPS location data instantly.
3. To Monitors vehicle position and triggers alert when it moves outside predefined safety boundary areas effectively.
4. Panic button immediately alerts contacts with GPS. live tracking continuously monitors vehicle remotely.

Methodology:

The methodology of the Accident Detection and Alert System with Geofencing Technology focuses on developing a reliable system that can monitor vehicle movement, detect accidents automatically, and notify emergency contacts without requiring manual intervention. The system combines sensors, a microcontroller, and communication modules to ensure that accident alerts are generated quickly and accurately.

At the core of the system is the ESP32 microcontroller, which acts as the main control unit. It receives input data from different sensors, processes the information, and controls the

modules responsible for communication and alerts. The vehicle's motion and orientation are continuously monitored using the MPU6050 sensor, which contains both an accelerometer and a gyroscope. The accelerometer measures sudden changes in acceleration, while the gyroscope tracks angular movement and orientation. By analyzing this data in real time, the system can detect unusual motion patterns that may indicate a collision or accident.

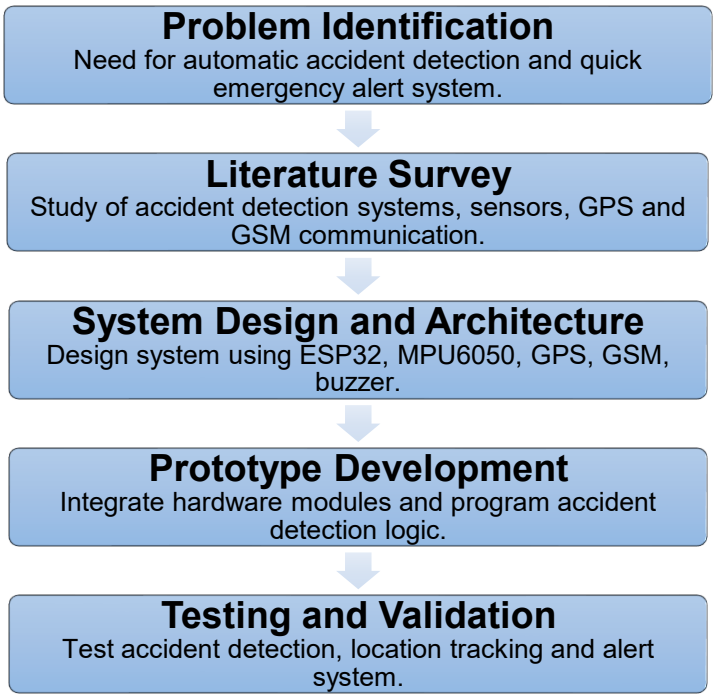


Figure 2: Methodology

When the sensor detects a sudden impact or acceleration beyond a predefined threshold value, the system assumes that an accident may have occurred. At this stage, a buzzer is activated for about ten seconds. This delay acts as a confirmation period, allowing the user to cancel the alert if it was triggered by a non-critical event such as a pothole, sudden braking, or rough road conditions. If the alert is not canceled within the given time, the system automatically proceeds with the emergency notification process.

The NEO-6M GPS module is used to obtain the real-time geographic location of the vehicle. Once the coordinates are captured, the SIM800L GSM module sends an SMS containing the accident alert message and the GPS location to the registered emergency contacts. In addition to sending a message, the system can also place an automatic call to ensure that the alert receives immediate attention.

To further improve safety, the system includes geofencing and a panic button feature. Geofencing allows users to define a safe area for the vehicle, and alerts can be generated if the vehicle moves outside the boundary. The panic button enables the user to manually trigger an emergency alert whenever assistance is required.

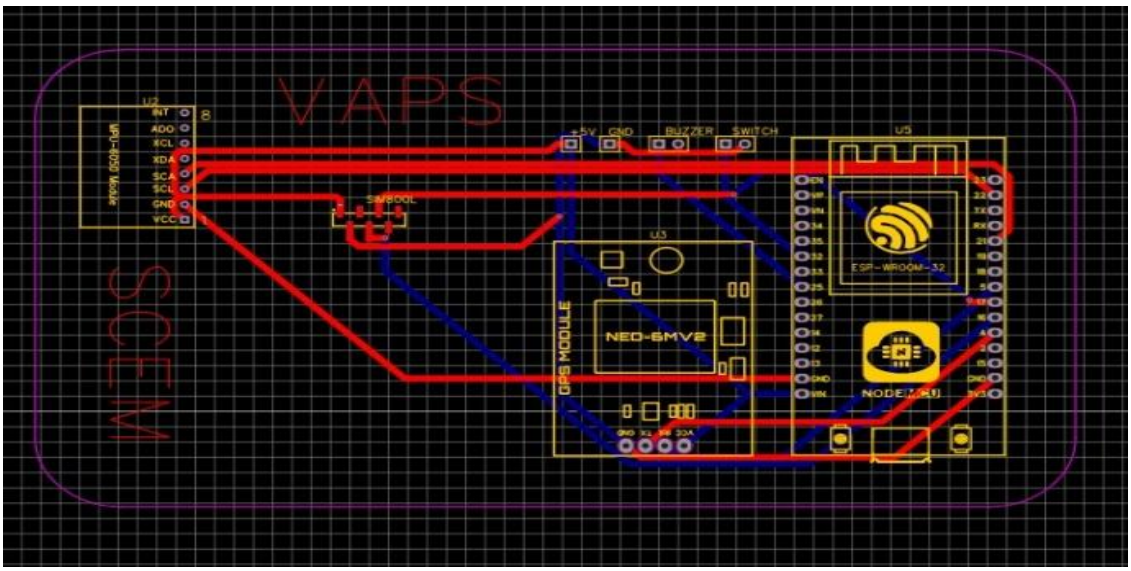
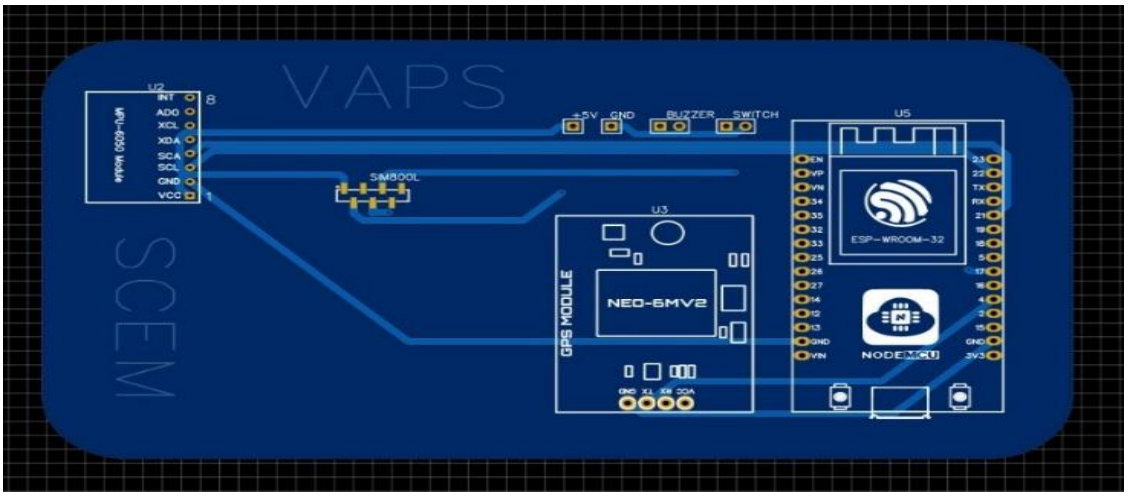


Figure 3: Architecture of the model



Result and Conclusion:

The Accident Detection and Alert System was tested on both a toy car prototype and a Hyundai Eon vehicle. The system consistently showed dependable accident detection, accurate GPS tracking, prompt SMS and call alerts, effective geofencing, and quick response from the panic button. Overall testing indicated that the system performs well and is practical for real-world use.

1. **Accident Detection:** The MPU6050 sensor reliably identified sudden drops in vehicle speed. After adjusting the threshold, the system could clearly tell the difference between routine braking, small bumps, and real collisions. The buzzer offered an immediate local alert, giving a quick chance to confirm the event before emergency messages were sent, which helped prevent unnecessary alarms.
2. **Alert Transmission:** The SIM800L module sent SMS messages and placed calls to the preset emergency contacts within about 8-10 seconds after an incident was detected. Tests carried out in different locations showed steady network performance, even in places with only moderate signal strength, ensuring that emergency communication reached recipients on time.

3. **GPS Accuracy:** The NEO-6M GPS module delivered accurate location tracking, maintaining an average precision of around 2-3 meters. This accuracy allowed geofencing alerts to work properly whenever the vehicle moved beyond the set boundaries and also enabled emergency contacts to view the vehicle's live position in real time.
4. **Panic Button Functionality:** The manually operated panic button provided an additional safety layer. Pressing the button immediately triggered alerts with GPS data, demonstrating that the system can respond to emergency situations proactively, independent of accident detection.
5. **System Reliability and Integration:** Both toy car and real vehicle tests confirmed consistent performance, minimal false triggers, and stable integration of all modules.

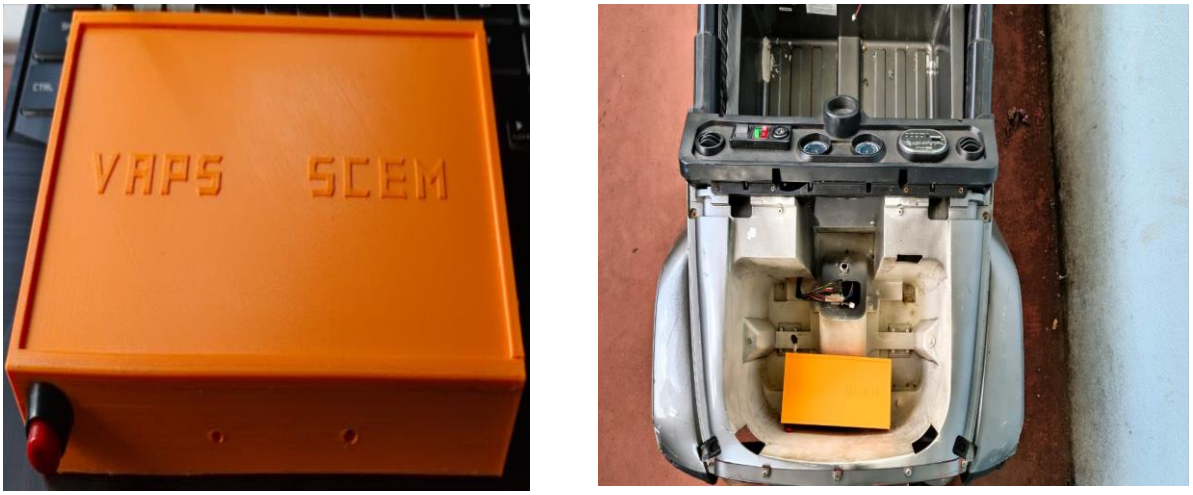


Figure 4: The Final Prototype

Project Implications and Industry Relevance:

- Improves road safety through automatic accident detection
- Enables faster emergency response using instant alert system
- Integrates IoT technologies for smart vehicle monitoring
- Supports safety applications in modern transportation industry

Road accidents remain a major global concern, often leading to severe injuries and fatalities. In many cases, the delay in notifying emergency services increases the risk to victims. The Accident Detection and Alert System with Geofencing Technology aims to address this problem by providing an automated system capable of detecting accidents and sending immediate alerts to emergency contacts. By reducing the time taken to communicate accident information, the system can help ensure faster medical assistance and improve the chances of saving lives.

The project demonstrates the practical use of sensor technology, GPS tracking, and GSM communication to create a reliable safety solution. The MPU6050 sensor continuously monitors vehicle movement and identifies sudden impacts or unusual acceleration patterns that may indicate a collision. Once such an event is detected, the system automatically sends an SMS containing the GPS coordinates of the accident location. This feature is

particularly useful in remote areas or during late-night travel when immediate assistance may not be easily available.

From an industry perspective, the project is highly relevant to the automotive, transportation, and Internet of Things (IoT) sectors. Modern vehicles increasingly rely on smart technologies to enhance safety and monitoring. Systems similar to this project can be integrated into vehicles by automobile manufacturers, fleet operators, and logistics companies to improve safety and track vehicle activity.

The inclusion of geofencing and a panic button feature further increases its practical value. Geofencing allows users or organizations to define safe operational zones for vehicles, which can be useful for monitoring company fleets or ensuring the safety of drivers. Overall, the project highlights how affordable electronic components and IoT technologies can be combined to create an effective and scalable road safety solution.

Project Outcomes and Learnings:

- Developed a functional accident detection and alert system
- Learned integration of sensors, GPS, and GSM modules
- Gained experience in ESP32 programming and IoT concepts
- Improved skills in hardware testing and troubleshooting

The Accident Detection and Alert System with Geofencing Technology helped in understanding how embedded systems and IoT technologies can be used to solve real-world safety problems. During the project, we successfully designed and implemented a system that detects sudden vehicle impacts and automatically sends emergency alerts with location details. The project provided practical knowledge of integrating different hardware components such as the ESP32 microcontroller, MPU6050 sensor, GPS module, and GSM communication module. It also improved our skills in programming, circuit design, and debugging. Overall, the project enhanced our technical understanding and demonstrated how technology can be applied to improve road safety and emergency response.

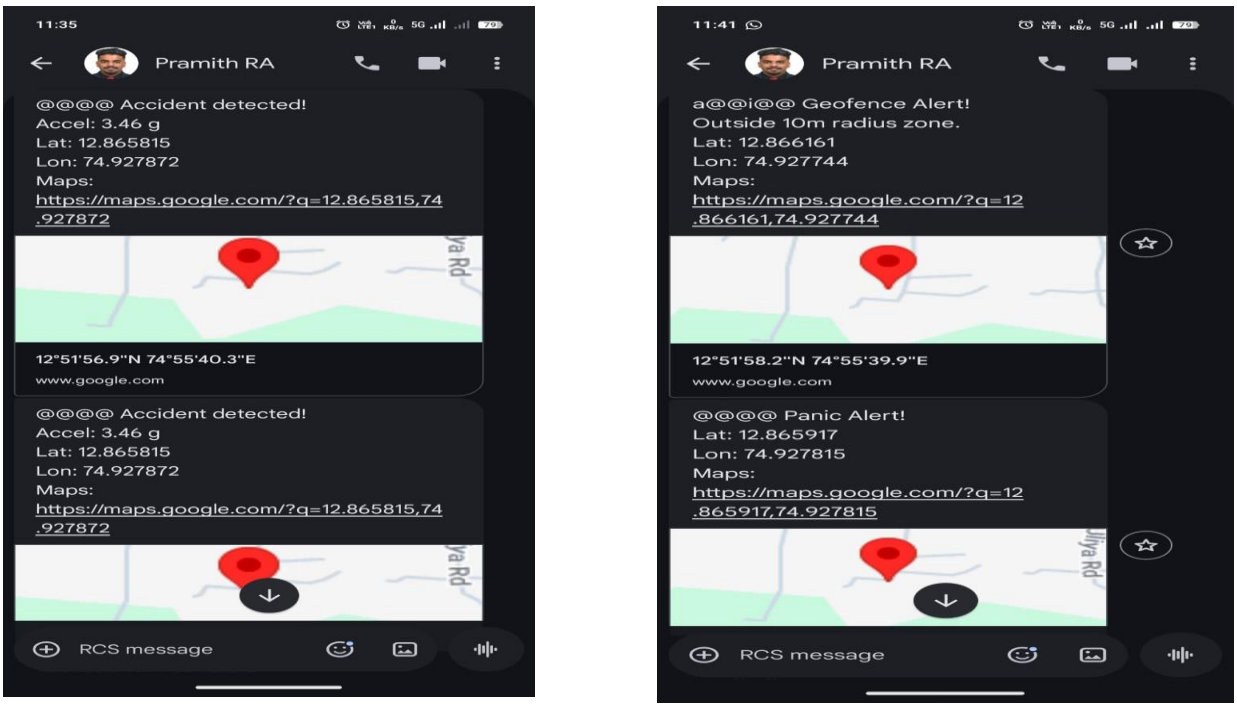


Figure 5: Final Output

Project Gantt Chart:

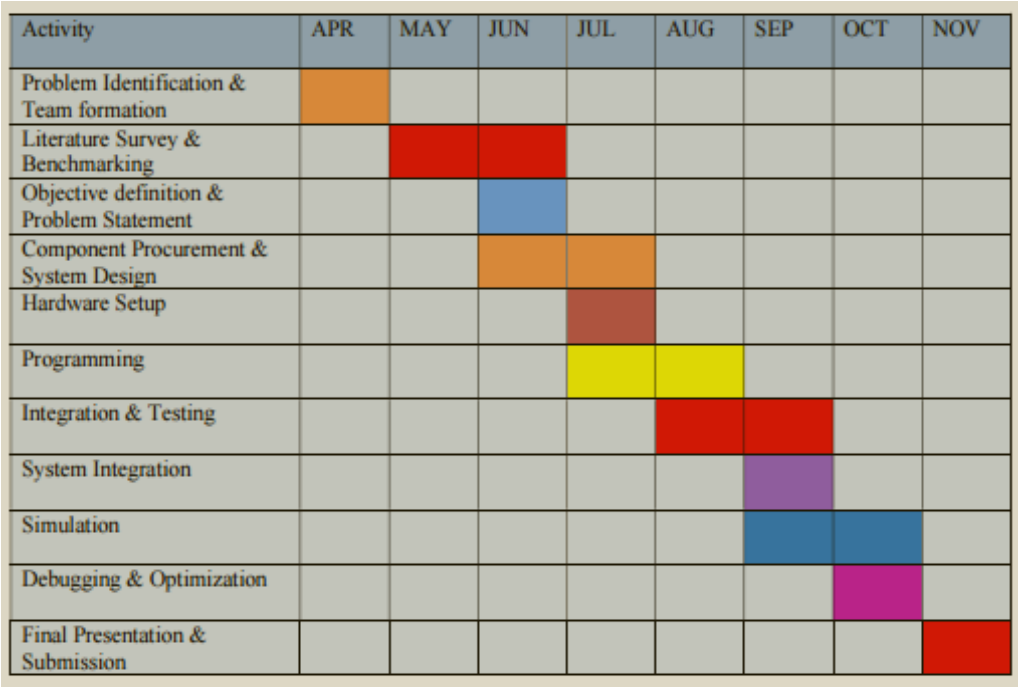


Figure 6: Gantt Chart

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Future Scope:

1. **Mobile application integration for real-time monitoring and alerts**
   In the future, a dedicated mobile application can be developed to connect with the system. This app could allow users to track the vehicle's live location, manage emergency contacts, and receive instant notifications whenever an accident or panic alert is triggered. It would also make the system easier to monitor and control.

2. **Use of machine learning for improved accident detection**
   Machine learning algorithms can be implemented to analyze vehicle motion patterns more accurately. This would help the system distinguish between normal disturbances such as potholes or sudden braking and actual accidents, thereby reducing false alerts and improving system reliability.

3. **Cloud connectivity for data storage and analysis**
   Integrating cloud technology can allow accident data, location history, and system activity to be stored securely. This information can later be analyzed to study accident patterns and improve road safety systems.

4. **Integration with emergency services and smart city systems**
   In the future, the system could be directly connected with hospitals, police stations, and traffic management centers so that emergency services receive accident alerts instantly and respond more quickly.