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AcciAlert: Accident Detection and Alert System

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Abstract:
Road traffic accidents remain one of the leading causes of death, mainly because emergency assistance often does not reach the victims in time. In several cases, accidents go unreported for a long duration due to the absence of witnesses or the unconscious state of the injured person. This work presents "AcciAlert", an automatic accident detection and alert system implemented using a Raspberry Pi platform. The system identifies accident conditions by monitoring abrupt changes in acceleration, vehicle orientation, and speed with the help of an MPU6050 accelerometer–gyroscope and a speed sensor. Once an accident is confirmed, the current geographical coordinates are obtained through a GPS module, and alert messages are transmitted to predefined emergency contacts using a GSM module. By removing the need for manual reporting, the proposed system ensures faster response time and improved safety, particularly for two-wheelers and economically affordable vehicles

Keywords— Accident Detection System, Raspberry Pi, MPU6050, Speed Sensor, GPS, GSM, Emergency Alert

INTRODUCTION
The rapid increase in the number of vehicles has resulted in a corresponding rise in road accidents. A large percentage of accident-related deaths occur not only due to the severity of impact but also because medical help does not arrive promptly. Conventional accident reporting depends on the ability of the victim or a bystander to inform emergency services, which is not always possible when the victim is unconscious, critically injured, or when the accident happens in isolated locations.
AcciAlert aims to overcome these limitations by continuously monitoring vehicle motion parameters such as acceleration, angular orientation, and speed. When abnormal variations indicating a crash are detected, the system automatically determines the accident location and sends an alert to emergency contacts. This automated process minimizes human dependency, reduces response time, and increases the probability of saving lives.

PROBLEM STATEMENT
To design and implement an automated accident detection and alert system capable of accurately identifying road accidents and instantly communicating the precise location to emergency responders without requiring any manual intervention.

OBJECTIVE OF PROJECT

- To detect accidents automatically using data from the accelerometer, gyroscope, and speed sensor
- To observe sudden speed drops or irregular speed behaviour during collision events
- To obtain real-time accident location using GPS technology
- To transmit emergency notifications through GSM communication
- To minimize reliance on traditional manual accident reporting system.

SYSTEM DESCRIPTION
The AcciAlert system is built around the Raspberry Pi, which serves as the main processing and control unit. It manages data acquisition from sensors, performs accident detection logic, and controls communication modules. The major functional modules are:

Accident Detection Module: The MPU6050 sensor continuously measures linear acceleration and angular velocity. Sudden and abnormal variations beyond predefined threshold values are considered potential indicators of a crash.

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Speed Monitoring Module: A speed sensor continuously tracks the velocity of the vehicle. A sharp decrease in speed within a short time interval strengthens the confirmation of an accident event.

Location Acquisition Module: The GPS unit provides real-time latitude and longitude coordinates of the accident site, enabling precise location tracking.

Communication Module: The GSM module is responsible for sending alert SMS messages containing accident details and a Google Maps location link to stored emergency contact numbers.

Power Management Module: This module ensures a stable and uninterrupted power supply to all system components for reliable operation.

EXISTING SYSTEM

Manual Accident Reporting: Most accidents are currently reported by eyewitnesses or victims using mobile phones. This approach is unreliable because the injured person may be unconscious or in severe pain. In remote areas, accidents may remain unnoticed for a long time, delaying emergency medical response.

Mobile SOS and Emergency Applications: Many smartphone applications provide panic-button or SOS features to share GPS location. However, these require manual activation, which is not possible if the user is incapacitated.

Modern Vehicle Safety Technologies: High-end vehicles are equipped with airbag sensors and automatic emergency calling systems. Although effective, these solutions are costly and generally unavailable in low-budget vehicles and two-wheelers.

Traffic Surveillance Systems: CCTV and smart traffic monitoring systems can detect accidents visually but are limited to specific urban areas and depend on centralized infrastructure. They also lack direct linkage with emergency services, which can delay rescue operations.

PROPOSED SYSTEM

The proposed AcciAlert system integrates motion sensors, GPS, and GSM communication to create a fully automated accident detection and alert mechanism. Abnormal motion patterns are analyzed to confirm a crash, after which alert messages are automatically transmitted. This eliminates the need for human involvement and significantly reduces the time required to initiate emergency assistance.

HARDWARE REQUIREMENTS

- Raspberry Pi 3 / 4
- MPU6050 Accelerometer and Gyroscope
- Speed Sensor
- GPS Module (Neo-6M)
- GSM Module (SIM800 / SIM900)
- Power Supply Unit
- Connecting Wires

SOFTWARE REQUIREMENTS

- Raspberry Pi Operating System
- Python Programming Language
- I2C and Serial Communication Libraries
- GPS Data Parsing Libraries

CIRCUIT DIAGRAM AND CONNECTIONS

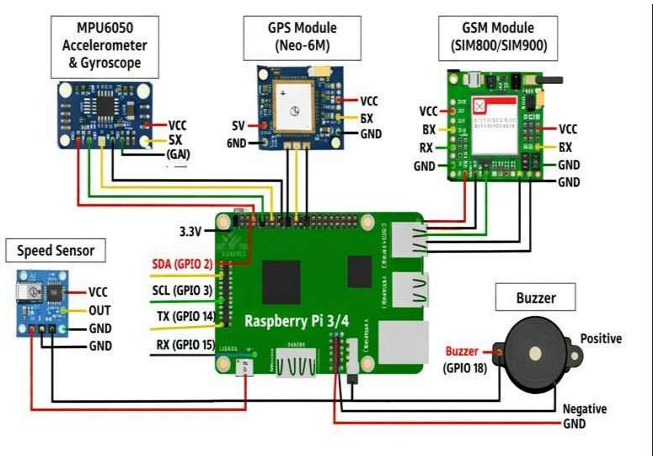

Figure 1

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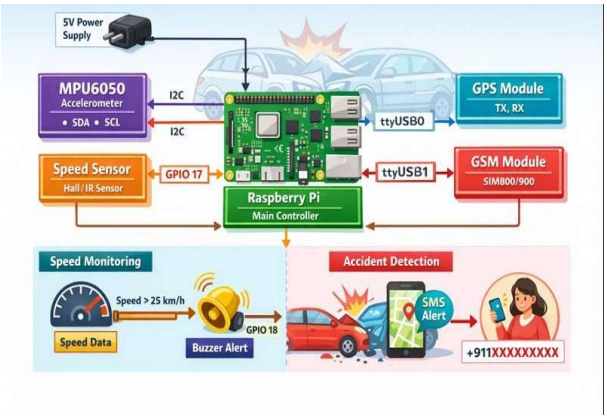

Figure 2

Figure 3

IMPLEMENTATION

The complete system is developed using Python on the Raspberry Pi platform. The MPU6050 and speed sensor data are continuously sampled and analyzed. When high-impact acceleration, abnormal tilt, and rapid speed reduction occur simultaneously, the system identifies the event as an accident. The GPS module then extracts the current coordinates, and the GSM module sends an emergency SMS containing accident information and a location link.

RESULTS AND DISCUSSION

The AcciAlert prototype was successfully implemented and tested under various real-time conditions. The MPU6050 accurately captured sudden changes in acceleration and orientation, while the speed sensor helped eliminate false triggers caused by road bumps or sudden braking.

Different scenarios such as sharp turns, abrupt deceleration, simulated collisions, and normal driving were tested. The system generated alerts only during accident-like situations and remained stable during regular operation. The GPS module achieved a positional accuracy of approximately 5–10 meters in open environments. Alert messages were delivered within 5–15 seconds depending on network strength. The overall system performance demonstrated reliable and consistent operation.

LIMITATIONS

1. **Dependence on Mobile Network:** GSM communication requires adequate cellular coverage. In low-signal or rural regions, message delivery may be delayed.
2. **GPS Signal Issues:** Location accuracy may degrade in tunnels, dense urban areas, or indoor environments.
3. **Fixed Threshold Values:** Static threshold-based detection may not perform equally well for all vehicle types and driving styles.
4. **Power Consumption:** Continuous operation of GPS and GSM modules increases energy usage.
5. **Lack of Adaptive Intelligence:** Absence of machine learning prevents the system from self-learning and improving detection accuracy over time.

FUTURE SCOPE

1. Integration of machine learning algorithms for intelligent accident detection
2. Development of a mobile application for live tracking and notifications
3. Cloud-based storage and analysis of accident data
4. Direct communication with hospitals, police, and ambulance services
5. Addition of a camera module for visual evidence
6. Vehicle-to-Vehicle (V2V) communication to warn nearby vehicles
7. Implementation of advanced power-saving techniques

CONCLUSION

AcciAlert successfully demonstrates an efficient and low-cost automatic accident detection and alert system using Raspberry Pi, MPU6050, speed sensor, GPS, and GSM modules. The system effectively detects accidents based on sudden variations in acceleration, orientation, and speed, and immediately sends location-based emergency alerts without human intervention.

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The results confirm that the proposed system significantly reduces the time gap between accident occurrence and emergency response. Its affordability and simplicity make it highly suitable for two-wheelers and budget vehicles. With further enhancements such as intelligent algorithms and cloud connectivity, AcciAlert can evolve into a comprehensive smart emergency response solutionOverall, AcciAlert offers a practical and scalable solution for improving road safety. With further enhancements such as adaptive algorithms, cloud integration, and direct connectivity to emergency services, the system has strong potential to evolve into a comprehensive intelligent accident response platform

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