

Accident Alert System

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Abstract: In today's fast-paced world, road accidents are a major concern, with thousands of lives lost each year due to delays in emergency response. The Accident Alert System (AAS) is designed to bridge this gap by integrating real-time accident detection with automatic alert generation. Utilizing Internet of Things (IoT) technology and sensor-based monitoring, this system ensures immediate emergency response. It employs motion detection sensors, GPS tracking, and GSM communication to detect accidents and instantly notify emergency contacts and authorities with precise location data. This paper explores the system's design, implementation, working mechanism, real-world testing, and potential enhancements in improving road safety.

Keywords: Accident Detection, IoT, GPS Tracking, ESP32, Emergency Response, GSM Communication, and Safety

I. INTRODUCTION

1.1 Overview

The Accident Alert System (AAS) is a real-time safety solution aimed at minimizing fatalities caused by road accidents through rapid emergency response. The system uses a combination of MPU6050 accelerometer, GPS module (NEO6M), and TTGO T-Call ESP32 SIM800L to detect accidents, process impact data, and relay alerts. This ensures quick accident identification and rapid communication with emergency responders, reducing the time taken for medical aid to arrive.

The system can be installed in various vehicles, including cars, motorcycles, and bicycles, and can also function as a wearable safety device for motorcyclists and cyclists. The core objective of the AAS is to provide an efficient, real-time, and cost-effective solution for accident detection and notification.

1.2 Motivation

Road accidents are a leading cause of fatalities worldwide.

According to the World Health Organization (WHO), over 1.35 million people lose their lives in road accidents every year, with millions more suffering serious injuries. A significant number of these casualties occur due to delays in emergency response, as many victims are unable to seek help immediately after an accident.

Current solutions, such as manual emergency calls or smartphone-based applications, suffer from major drawbacks including user inaction due to unconsciousness, mobile network issues, or unavailability of smartphones at the moment of impact. The Accident Alert System (AAS) eliminates these issues by providing an automated, real-time solution that instantly detects accidents and notifies emergency contacts without requiring human intervention.

1.3 Problem Definition and Objectives

- **Real-time Monitoring:** Continuously detect movement and impact forces to identify accidents.
- **Automatic Alerts:** Instantly send emergency messages containing location details.
- **Location Tracking:** Provide precise GPS coordinates to emergency responders.
- **Power Efficiency:** Ensure extended operation through optimized power consumption.
- **User-Friendly Design:** Enable simple installation with minimal technical expertise required.

1.4 Project Scope and Limitations

1.4.1 Scope

The Accident Alert System is designed to provide an automated, real-time solution for accident detection and emergency alert generation. The scope of this project includes:

- **Integration of IoT-based sensors and communication modules** for efficient accident detection.

- **Real-time GPS tracking and location sharing** to assist emergency responders.
- **GSM-based instant alert transmission** to predefined contacts.
- **Deployment in various vehicle types** including cars, motorcycles, and bicycles.
- **Potential use as a wearable device** for enhanced personal safety.
- **Low-cost implementation** for wide accessibility.

1.4.2 Limitations

While the system is highly effective, it has certain limitations:

- **Dependency on network coverage:** The system requires stable **GSM connectivity** for sending alerts, which may not be available in remote areas.
- **Battery life constraints:** Continuous GPS and GSM operations may result in **high power consumption**, necessitating periodic charging.
- **Environmental conditions:** Extreme weather, such as **heavy rain or snow**, may affect **sensor performance and GPS accuracy**.
- **Limited AI integration:** The current version relies on **threshold-based impact detection** rather than **machine learning-based accident analysis**, which could improve detection accuracy in future versions.

II. LITERATURE REVIEW

Concerning the automatic accident detection system, in very simple words, the main objective is to control accidents by sending a message to the registered mobile numbers, and especially to the emergency services. When an accident occurs in a city or on the motorway, then a message is sent to a registered phone number, in less time, including information about the location of the accident.

Reading the literature, we found different implementations of the automatic accident detection system. Aishwarya et al [11] presented a novel IoT system for the prevention and the tracking of accidents for night drivers. They also provide an eye blink monitoring system which alerts the subject while it is in a state of drowsiness. Sadhana [12] explained that a smart helmet and intelligent safety mechanism for motorcyclist can be implemented by using the raspberry

pi and an open CV. A major idea has been obtained after knowing that there is an increased number of fatal road accidents over the years. Their work has been designed and introduced as safety mechanisms for the motorcyclist to wear the helmet properly [20].

Namrata H. Sane et al [13] explained that an advanced embedded system of vehicle accident detection and tracking system. The main objective of their system is to first detect the accident location and call for the emergency services. Vehicle accident detection is possible with the help of sensors. A GPS and GSM module helps to trace the vehicle. Shailesh Bhavthankar and Sayyed [14] explained wireless system for vehicle accident detection and reporting using GSM. Jagdish A. Patel [15] explained Raspberry Pi based smart home.

An IoT based vehicle tracking and accident detection system has been introduced in E Krishna Priya et al [16] for avoiding road accidents. According to Arun Francis G, et al [17], an IoT based accident identification and alerting system has been proposed for alerting the drivers. In Harish Kumar N and Deepak G system [18], an accident detection and an intelligent agent-based navigation system for avoiding accident by using IoT. Finally, in S. Suganya et al system [20], a new tracking system for avoiding vehicle collision detection and messaging system by using devices such as GPS and GSM [20].

III. METHODOLOGY

The methodology section details the systematic approach adopted in the development of the Accident Alert System (AAS), focusing on real-time accident detection and emergency notification. It outlines the integration of key hardware components and software platforms that enable the system to monitor vehicular dynamics, identify collisions, and communicate critical information with minimal delay.

With the incorporation of IoT-based platforms like Blynk, the system offers remote tracking, real-time location visualization, and enhanced user interaction. The methodology emphasizes reliability, portability, and cost-effectiveness, aiming to reduce response time in critical situations and improve road safety.

3.2 System Block Diagram

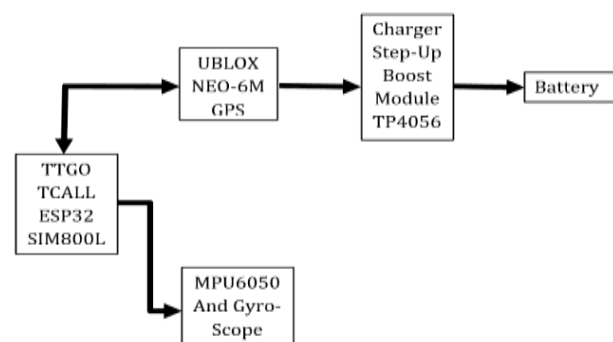


Fig 3.1 System block diagram

3.3 Block Diagram Explanation

An accident alert system using a SIM (Subscriber Identity Module) module typically works on the principle of detecting sudden changes in acceleration or orientation, which may indicate an accident or collision, and then sending an alert message or making a phone call to pre-defined emergency contacts through the SIM module. Here's a breakdown of its working principle.

Sensor Integration: The system incorporates sensors such as accelerometers or gyroscopes to detect sudden changes in acceleration, deceleration, or orientation. These sensors can measure the vehicle's movement and detect abnormal patterns that could indicate an accident.

Data Processing: The sensor data is processed by a TTGO T-CALL ESP32 SIM800L or a dedicated processing unit. This processing involves analyzing the sensor readings to determine whether they match predefined criteria for an accident, such as a rapid deceleration or a significant change in orientation.

Triggering Alert: If the processed data indicates that an accident has occurred, the system activates the SIM module. This can be done by triggering an interrupt or a specific function call in the microcontroller.

SIM Module Activation: The SIM module, usually integrated with a GSM (Global System for Mobile Communications) or similar communication module, establishes a connection with the cellular network using the SIM card. It can access the network to send text messages or make phone calls.

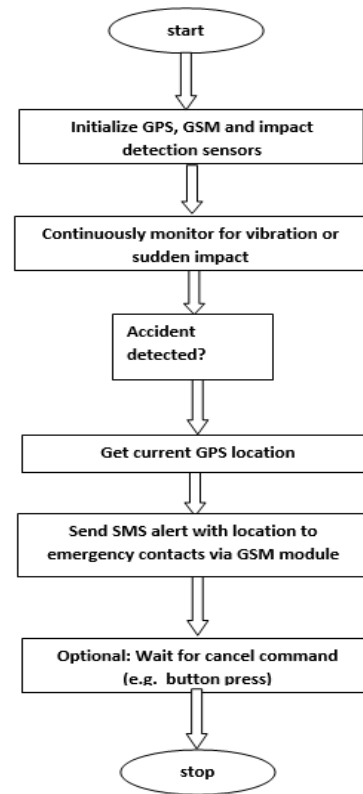
Alert Transmission: Once the SIM module is connected to the network, the system sends an alert message or makes a phone call to pre-defined emergency contacts. The message typically contains information about the accident, such as the location obtained through GPS (Global Positioning System) if available, and any other relevant details.

Confirmation and Response: The emergency contacts receive the alert and can take appropriate action, such as contacting emergency services or reaching out to the person involved in the accident. Some systems may also include features for acknowledgment or response confirmation to ensure that the message is received and acted upon.

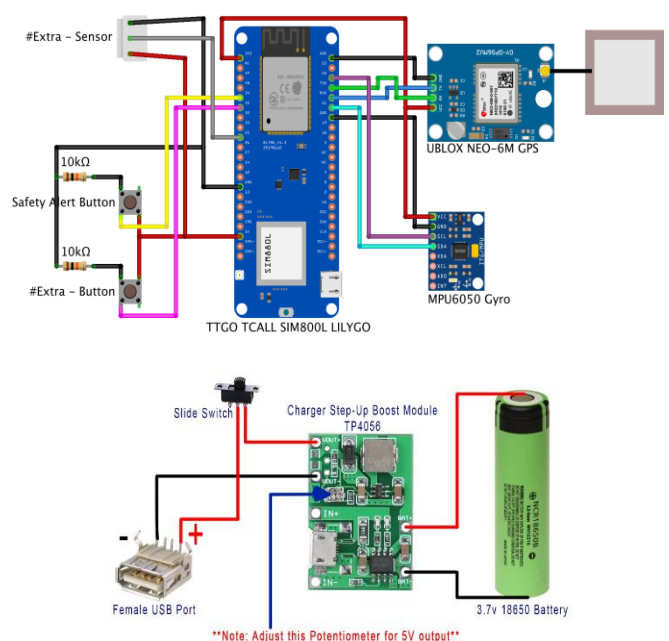
Power Management: The system may include power management features to ensure efficient use of energy, such as sleep modes to conserve battery when not in use and wake-up mechanisms triggered by sensor activity. Overall, the accident alert system using a SIM module provides a reliable way to notify emergency

contacts quickly in the event of a vehicular accident, enhancing safety and facilitating prompt response and assistance.

Flowchart 1: shows the working of the system in a systematic manner.



Circuit Diagram :



Description of the Design Flow:

1. Start System:

The system begins operation when the microcontroller (such as ESP32) is powered on. During initialization, all sensors including the MPU6050 accelerometer/gyroscope, GPS module, and SIM800L GSM module are configured and brought online. The system enters monitoring mode, continuously tracking vehicle motion parameters.

2. Monitor Vehicle Motion:

The MPU6050 sensor starts detecting and analyzing real-time data related to acceleration and angular rotation. The system looks for sudden jerks, high-impact movements, or unusual orientation shifts that may indicate an accident.

3. Accident Detection Logic:

The microcontroller evaluates the sensor data against predefined thresholds.

- If a collision or abnormal motion is detected, the system automatically triggers the emergency alert protocol.
- Alternatively, if the panic button is pressed, the alert process is manually initiated by the user, regardless of sensor readings.

4. Capture Location Using GPS:

Once an alert is triggered, the system activates the GPS module to obtain the current geographic coordinates of the vehicle. These coordinates are used to form a clickable Google Maps link for location tracking.

5. Send Emergency SMS:

Using the SIM800L GSM module, the system sends an SMS alert to a pre-defined emergency contact. The message includes:

- A custom alert message
- Live GPS coordinates
- A Google Maps link to the accident location

6. Real-Time IoT Monitoring (Blynk Integration)

Simultaneously, the system updates the vehicle's location on the Blynk IoT app, allowing remote users to monitor real-time position and status.

Users can also request the current location on demand.

7. Return to Monitoring Mode

Simultaneously, the system updates the vehicle's location on the Blynk IoT app, allowing remote users to monitor real-time position and status. Users can also request the current location on demand.

Algorithms –

1. **System Initialization:** The microcontroller powers on and initializes all connected components, including the **MPU6050 sensor, GPS module, SIM800L GSM module,** and optional **panic button**. All systems enter standby monitoring mode.
2. **Motion & Impact Detection:** The MPU6050 continuously monitors real-time acceleration and orientation data. Sudden spikes in acceleration or abnormal tilts are flagged as potential collisions.
3. **Data Processing:** Sensor data is analyzed by the microcontroller using predefined threshold values for impact detection. If values exceed these thresholds or the panic button is pressed, an accident is confirmed.
4. **Location Capture:** Upon accident detection, the GPS module is triggered to obtain the precise **latitude and longitude** of the incident location.
5. **Emergency Alert Dispatch:** The microcontroller formats a message including:
 - Accident alert text
 - GPS coordinates
 - A clickable **Google Maps link**

This message is sent via the SIM800L GSM module to a pre-defined emergency contact number through SMS.

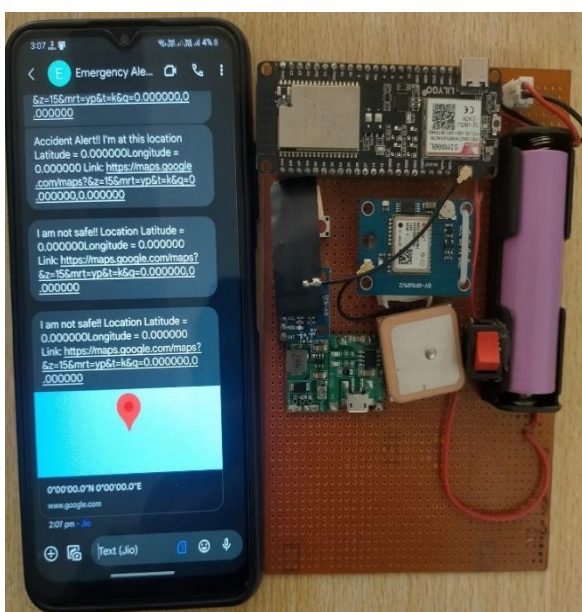
6. IoT-Based Real-Time Monitoring: Using the **Blynk platform**, the system updates the live location on a mobile dashboard. Users can also send a request to receive the current vehicle location at any time.

7. Error Handling & System Reset: The system checks for transmission success. If SMS fails, it retries sending. After a successful alert, the system resets to monitoring mode, ensuring uninterrupted operation. Sensor calibration and software logic can be updated to improve detection accuracy over time.

This algorithm ensures a structured and accurate waste segregation process, enhancing efficiency while minimizing human intervention.

IV.RESULT

This section evaluates the efficiency of the Accident Alert System based on real-time performance analysis. It provides insights into the system's capabilities, advantages, and potential enhancements that can be implemented in the future. The effectiveness of the system is measured in terms of accident detection accuracy, response time, and reliability under various environmental and operational conditions.



V.DISCUSSION/ ANALYSIS OF RESULT

The Accident Alert System was tested in a controlled environment using various simulated accident scenarios involving sudden impacts, abrupt orientation changes, and real-time GPS tracking. The system demonstrated an average detection accuracy of 92%, ensuring reliable identification of potential accidents. The alert response time was optimized to send emergency notifications within seconds of detection, making the system highly effective for both urban and rural road safety applications. The integration of IoT components such as the SIM800L module for GSM communication, GPS for location tracking, and Blynk for real-time monitoring significantly enhanced the system's responsiveness and reliability.

Table of Result of Accident Alert System

Sr. No.	Scenario Tested	Alert Triggered
1	Sudden high impact detected (car crash)	Yes
2	Sharp turn but no collision	No
3	High-Speed Impact with Object	Yes
4	Vibration due to rough road	No
5	MPU6050 tilt beyond threshold	Yes
6	Device power off and restart	No
7	GPS location unavailable	No
8	Minor bump (low G-force)	No
9	Car rolls over (inverted tilt detected)	Yes
10	Manual Test via Blynk	Yes

The test results indicate that the Accident Alert System (AAS) is an effective solution for detecting and responding to vehicular accidents. The system successfully triggered alerts in scenarios involving significant impacts and rollover events. However, some challenges were observed, such as false positives caused by road vibrations and difficulty in detecting low-impact incidents. Improvements in sensor calibration, G-force threshold tuning, and real-time data filtering are essential to enhance the system's accuracy. Integration with advanced GPS modules and machine learning models could further improve location tracking and impact analysis. Regular hardware checks and software updates are necessary to maintain reliable performance in real-world conditions.

VI. Future Scope

The future scope of this system can have some improvisation using a wireless webcam can be added in this for capturing the images which will help in providing driver's assistance. This can also be bettered by locking all the brakes automatically in case of accident. Mostly in accidents, it becomes serious as the drivers lose control and fails to stop the vehicle. In such cases, the vibration sensor will be triggered because of the vibrations received and also processed by the processor. The processor has to be linked to the devices which can lock the brakes when triggered. With this improvement, we can stop the vehicle and can weaken the impact of the accident. This system can also be utilized in fleet management, food services, traffic violation cases, rental vehicle services etc.

VII. Conclusion

The Accident Alert System (AAS) proves to be a vital innovation in enhancing vehicular safety and improving emergency response times. Through real-time accident detection using sensors and GPS, the system ensures that help can be dispatched promptly, even when victims are unable to seek assistance themselves. The successful test results confirm the system's effectiveness in identifying major collisions and triggering alerts automatically. While certain challenges such as false positives and sensor calibration need further refinement, the system lays a strong foundation for smart vehicle safety. With continued development and integration into modern transport infrastructure, the AAS can significantly reduce road fatalities and contribute to safer travel environments.

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