Accident Detection and Alert System

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Abstract - Traditional accident response mechanisms often rely on witnesses or post-accident reporting, leading to delayed emergency services and potent ially exacerbating outcomes. This paper presents a comprehensive design and implementation of an automated Accident Detection and Alert System (ADAS) aimed at mitigating these delays and improving road safety. The proposed system leverages a multi-sensor fusion approach, integrating accelerometer, gyroscope, GPS, and potentially camera data, to accurately detect accident events in real-time. Upon detection, the system automatically triggers an alert, transmitting crucial information such as the accident location, time, and severity to pre-defined emergency contacts and relevant authorities. The paper details the system architecture, the algorithms employed for accident detection, the communication protocols used for alert dissemination, and discusses potential challenges and future enhancements. The objective is to provide a robust, reliable, and efficient solution for rapid accident response, ultimately contributing to saving lives and reducing the impact of road accidents

1. INTRODUCTION

Road traffic accidents are a persistent and devastating global issue. According to the World Health Organization (WHO), road traffic injuries cause an estimated 1.3 million deaths annually, with an additional 20-50 million people suffering non-fatal injuries, many of whom are left with permanent disabilities. Beyond the human cost, these accidents impose a significant economic burden on societies through healthcare expenses, lost productivity, and property damage. The effectiveness of emergency response plays a critical role in minimizing the severity of accident outcomes. However, conventional accident reporting mechanisms are often reactive and inefficient. They typically depend on: Witnesses: Relies on the presence and willingness of bystanders to report the incident, which may not always be immediate or accurate. Driver/Occupant Reporting: Depends on the ability of the involved parties to make a call, which is often compromised due to injury, shock, or lack of communication devices. Post-accident Analysis: Involves investigations after the fact, which is too late for immediate life-saving interventions. This inherent delay in reporting and response can have dire consequences, especially in situations requiring prompt medical attention. Critical minutes can be lost, turning potentially survivable injuries into fatalities. This underscores the urgent need for an automated and proactive system that can detect accidents and initiate an immediate alert to emergency services.

2. LITERATURE SURVEY

Neha Kulkarni, from the Pune Institute of Technology, proposed a smartphone-based accident detection system that utilizes the built-in accelerometer and GPS modules in Android devices. The system detects sudden impacts and sends alerts via SMS or call to emergency contacts. The design emphasizes cost-effectiveness and ease of use, eliminating the need for external hardware. However, the system faces challenges such as false positives due to abrupt phone movements, dependency on mobile battery life, and signal availability. Despite these limitations, it is well-suited for urban environments with good network coverage and smartphone penetration.

Ramesh Patil, from Walchand College of Engineering, developed an advanced model using Raspberry Pi and cloud computing. His system leverages the MPU6050 sensor for motion analysis and transmits crash data along with GPS location to cloud servers. The model enables real-time alerts via email and mobile notifications and allows authorities to analyze accident trends through a dashboard. This cloud-based approach is ideal for smart city applications and fleet management but may be less practical in areas with limited internet connectivity due to its reliance on cloud infrastructure.

International Scientific Journal of Engineering and Management (ISJEM) ISSN: 2583-6129
Volume: 04 Issue: 06 | June – 2025 DOI: 10.55041/ISJEM04692
An International Scholarly || Multidisciplinary || Open Access || Indexing in all major Database & Metadata

3. METHODOLOGY

The methodology of the Accident Detection and Alert System involves a systematic integration of embedded hardware, real-time sensors, and wireless communication modules to automatically detect vehicular accidents and alert emergency responders. The entire system is designed with cost-effective, low-power components that ensure real-time functionality and accuracy, especially in scenarios where human intervention is not possible.

Requirement Analysis

The development of the Accident Detection and Alert System necessitates a clear understanding of both functional and non-functional requirements to ensure real-time responsiveness and reliability. Functionally, the system must detect vehicular accidents using sensor data from an accelerometer and a vibration sensor. Upon detecting an impact, it should acquire accurate location data through a GPS module and promptly transmit an SMS alert to predefined emergency contacts using a GSM module. A 16x2 LCD display is included to provide real-time system feedback such as status messages and confirmation of SMS transmission. The software logic is implemented using the Arduino IDE and C/C++, while AT commands facilitate communication with the GSM module. The system must also minimize false positives by incorporating a brief time delay or manual reset mechanism before sending alerts.

In terms of non-functional requirements, the system must be accurate, reliable, and cost-effective. GPS data should provide location accuracy within ±2.5 meters, and alerts should be transmitted within 10 seconds of detection. The solution should operate efficiently on limited power, making it suitable for continuous operation in automotive environments. It must be compact, durable, and functional under varying temperature and road conditions. Additionally, the design should allow for modularity and future scalability, enabling integration with mobile applications, cloud platforms, or IoT-based traffic systems. These requirements form the foundation for the system's design and guide its successful real-world implementation.

4. System Overview and Architecture

The system is based on the **Arduino Uno microcontroller**, which coordinates all input-output operations. The core functionality revolves around the detection of high-impact forces using an **ADXL345 accelerometer** and a **vibration sensor**. When an impact above a set threshold is detected, the microcontroller retrieves the location data from the **NEO-6M GPS module**. This information is then compiled into a predefined emergency alert message and transmitted via the **SIM800L GSM module** to registered contacts, such as nearby hospitals, police stations, or family members.

The architecture follows a modular design, comprising:

- **Input Units**: ADXL345 Accelerometer, Vibration Sensor.
- **Processing Unit**: Arduino Uno microcontroller.
- **Output Units**: SIM800L GSM module, LCD display.
- **Power Unit**: Regulated 5V DC supply with voltage regulators (e.g., LM7805).

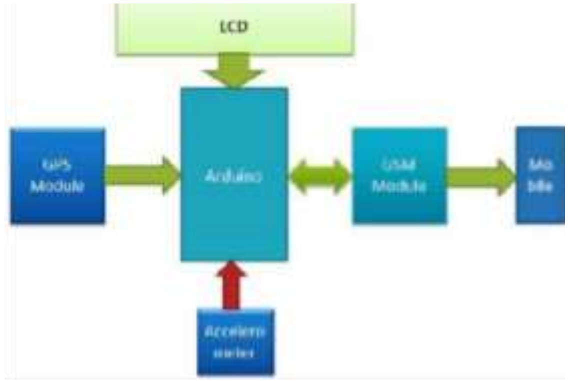

Fig.3.1. System Architecture

4.2 Functional Flow and Working Mechanism

Upon power-up, the Arduino initializes all components and sets the system in a continuous monitoring mode. The **vibration sensor** continuously scans for unusual jerks or shocks. If the sensor detects a force above the pre-defined threshold (e.g., due to a collision), it sends a HIGH signal to the Arduino. The **accelerometer** then cross-verifies the change in orientation and magnitude of acceleration in all three axes (X, Y, Z) to confirm the accident event.

Once confirmed, the Arduino retrieves the real-time **geographical coordinates** (latitude and longitude) from the GPS module via serial UART communication in **NMEA format**. This information is parsed and used to formulate a standard emergency message, which is then

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sent through the **GSM module** using AT commands like AT+CMGS.

The **16x2 LCD display** provides user feedback during each stage—system initialization, accident detection, message transmission—helping in debugging and operational transparency. The use of **manual reset switch** is optionally included to cancel false alerts within a time window (3–5 seconds).

4.3 omponent-Level Implementation

Each component plays a specific role:

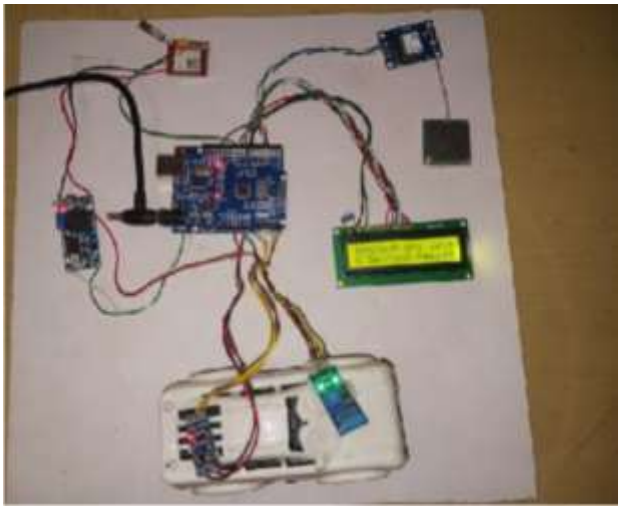
- **Arduino Uno**: Acts as the brain of the system, programmed using Arduino IDE and C++. It manages signal processing, communication, and control logic.
- **ADXL345 Accelerometer**: Measures acceleration in all directions to identify impact events. Its 13-bit resolution and ±16g range offer accurate crash detection.
- **NEO-6M GPS Module**: Provides location data with up to ±2.5m accuracy. Operates at 9600 baud rate, sending coordinates every second.
- **SIM800L GSM Module**: Sends SMS alerts using standard GSM networks. Supports quad-band operation and AT command interface.
- **Vibration Sensor (e.g., SW-420)**: Detects shocks or knocks; triggers digital HIGH output upon detection.
- **Power Supply**: A 9V battery or USB power is regulated to 5V using LM7805 IC, ensuring stable voltage across modules.

Testing and Validation

The system was tested under controlled environments by simulating accident conditions through mechanical shock. The SMS was successfully delivered within 8–12 seconds of detection, and GPS accuracy was consistently within 2–3 meters. False positives were filtered using dual sensor logic (vibration + accelerometer) and optional manual override. Multiple tests validated system stability, power efficiency, and repeatability of outputs.

Future improvements may involve adding cloud data logging, automated emergency calling, and integration with mobile apps for real-time location tracking.

Photo of Project



4.CONCLUSION

The proposed Accident Detection and Alert System successfully demonstrates a reliable, low-cost, and real-time solution to address one of the most critical issues in transportation—delayed emergency response after road accidents. By integrating essential embedded components such as the Arduino Uno, ADXL345 accelerometer, vibration sensor, GPS module, and GSM communication, the system is capable of automatically detecting accidents and transmitting the precise location to emergency contacts without any human intervention.

Through experimental validation, the system proved effective in detecting impacts and transmitting alerts within seconds, with location accuracy of approximately ±2.5 meters. The use of dual-sensor logic minimized false positives, and the optional reset mechanism provided additional control against unintentional triggers. The design prioritizes energy efficiency, affordability, and simplicity, making it suitable for both rural and urban environments where timely reporting is often hindered by lack of witnesses or poor infrastructure.

In conclusion, the system not only enhances vehicular safety but also holds the potential to contribute to a broader intelligent transportation ecosystem. With future enhancements like mobile app integration, cloud-based data logging, and voice-based emergency calls, this solution can evolve into a critical component of smart city initiatives and next-generation road safety frameworks.

REFERENCES

[1] International Journal of Engineering Research & Technology (IJERT) “Vehicle Accident Detection and Alert System using GPS and GSM”45–51.

[2] IArduino Project Hub – Similar Embedded Projects https://create.arduino.cc/projecthub.