ACCIALERT - REAL TIME IOT- BASED ACCIDENT DETECTION AND SMART EMERGENCY COMMUNICATION SYSTEM

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Introduction:

Road accidents remain one of the leading causes of injury and death worldwide, with millions of lives affected annually. In many cases, delayed detection and slow emergency response worsen the impact, especially in remote or rural areas where medical aid may not be readily available. Traditional accident reporting methods often rely on human intervention or basic GPS systems, which are prone to delays and inaccuracies.

With the rise of the Internet of Things (IoT), there is a growing opportunity to build smarter systems that automatically detect and report accidents in real-time. IoT-based solutions can integrate sensors such as accelerometers, gyroscopes, and sound sensors to monitor a vehicle's motion and surroundings continuously. When an abnormal event occurs—like a sudden collision—these sensors can quickly analyse the data and determine the likelihood of an accident.

Recent research has shown that combining IoT with communication technologies like LoRa (Long Range) and GPS enables accident alerts to be sent to nearby hospitals

and authorities, even in areas with weak or no mobile networks. Machine learning algorithms further enhance detection accuracy by reducing false alarms through intelligent pattern recognition.

This project, **AcciAlert**, aims to develop an affordable and scalable accident detection and communication system using IoT sensors, GPS, LoRa modules, and machine learning techniques. The goal is to provide rapid, reliable alerts and improve emergency response times—potentially saving lives and reducing the severity of injuries in road accidents.

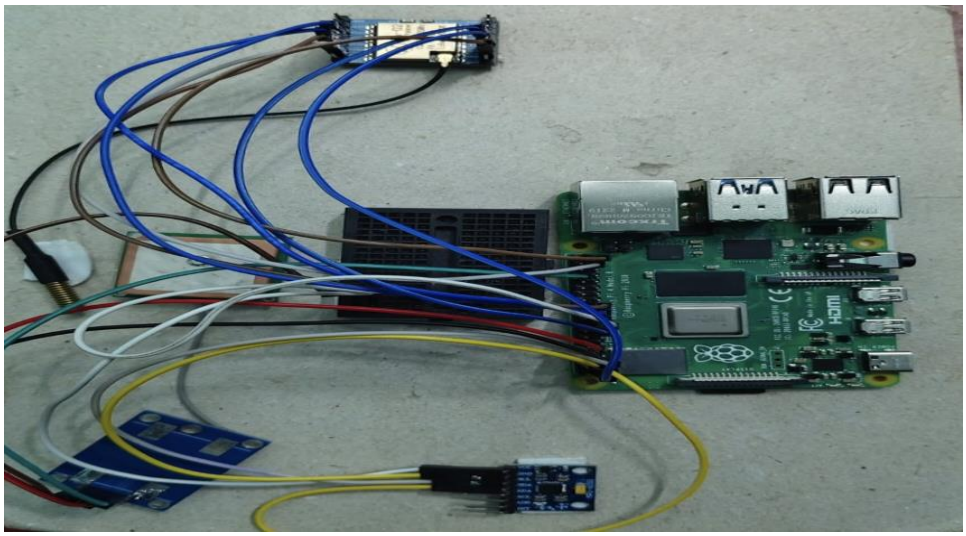

Figure 1: AcciAlert System.

Objectives:

1. To design and create a scalable IoT-based system for detecting accidents.
2. To incorporate sensors like the MPU6050 (which includes an accelerometer and gyroscope), sound sensors, and GPS for detailed accident analysis.
3. To apply machine learning algorithms, particularly KNN, to ensure precise accident detection based on sensor data thresholds.
4. To enable communication in areas with low connectivity using LoRa technology.
5. To build a web application to store accident data and notify nearest hospitals.

Methodology:

The AcciAlert system utilizes a combination of IoT sensors, machine learning, and communication technologies to detect and report road accidents in real time. A Raspberry Pi 4 acts as the main processing unit, interfacing with multiple sensors including the MPU6050 (which contains an accelerometer and gyroscope), a sound sensor, and a GPS module. These sensors monitor the vehicle's movement, orientation, and environmental sounds to detect crashes. The data is collected continuously and analysed using a K-Nearest Neighbours (KNN) machine learning algorithm, which has been trained to identify accidents based on threshold values—acceleration exceeding 0.99g and gyroscope readings above 20°/s. If an accident is detected, the GPS coordinates are captured and transmitted through a LoRa communication module. This ensures alerts are sent even in areas with poor or no internet connectivity.

To facilitate emergency response, the system includes a web application built using Django. The application features role-based access for hospitals, police, and ambulance services and stores accident data in an SQLite/MySQL database. It also uses LocationIQ API and Geopy for precise mapping. In addition, the system includes image uploads of accident victims to retrieve medical data using image recognition. The below diagram illustrates the flow from sensor input to alert output. The hardware setup is compact, using a breadboard and battery, making it suitable for mobile deployment. All these technologies work together to enable real-time accident detection, reliable communication, and rapid emergency response, significantly reducing delays in medical assistance.

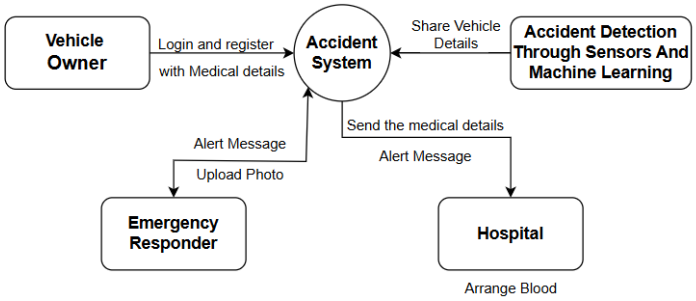

Figure 2 : Zero level DFD.

Result and Conclusion:

The AcciAlert system successfully demonstrated the integration of IoT sensors, machine learning, and wireless communication to detect and report road accidents in real time. Key findings from the project indicate that the system could detect accidents with high precision using motion-based thresholds—specifically, acceleration values greater than 0.99g and gyroscope values over 20°/s. The K-Nearest Neighbors (KNN) algorithm used for classification achieved a 98% accuracy during test scenarios, validating its effectiveness in differentiating between normal driving conditions and crash events.

One of the notable observations was the robustness of the LoRa communication module, which reliably transmitted accident alerts even in low-connectivity or remote areas. Real-time location data was accurately retrieved using the GPS module and visualized on a map via the LocationIQ API. The web application provided seamless role-based access for hospitals, police, and ambulance staff, ensuring that all stakeholders received alerts instantly. The system also supported uploading victim photos and retrieving medical details using image matching, which is a key enhancement in emergency response.

In conclusion, AcciAlert successfully fulfills its goal of providing a cost-effective, scalable, and real-time IoT-based accident detection and alert system. It bridges the communication gap during emergencies, especially in areas with limited infrastructure. With 98% detection accuracy during testing, rapid response time, and dependable hardware-software integration, the system holds promise for deployment in smart cities, highways, and rural transportation. Future enhancements could include

additional biosensors, solar power integration, and deployment at a larger scale for further validation.

Future Scope:

The future scope of this project includes:

1. Advanced Machine Learning Models: Explore the use of deep learning algorithms (e.g., CNNs, LSTMs) for improved accident detection accuracy and reduced false positives.
2. Real-Time Video Surveillance Integration: Incorporate camera modules or external CCTV feeds for visual validation of accidents using video processing.
3. Power Optimization and Solar Integration: Introduce solar panels to power the system in remote areas, increasing deployment lifespan and energy efficiency.
4. Government and Emergency System Integration: Connect AcciAlert with official emergency services, hospitals, and traffic departments for automated alerts and quicker rescue operations.