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SAFETRACK: Real-Time IoT-Based Vehicle Accident Detection, Severity Analysis and Emergency Alert System

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Abstract: Road accidents are a major cause of fatalities worldwide, often worsened by delayed emergency response, drunk driving, and lack of real-time monitoring systems. This paper presents SAFETRACK, a real-time IoT-based vehicle safety system that integrates accident detection, accident severity analysis, alcohol detection, smoke detection, and automated emergency alerting into a single embedded platform. The system employs an accelerometer (MPU6050) to detect sudden vehicle impacts, an MQ-3 alcohol sensor to monitor driver sobriety, an MQ-2 smoke sensor to detect in-cabin smoke or gas, a GPS module (NEO-6M) for real-time location tracking, and a GSM module (SIM800L) for emergency SMS dispatch. Upon detection of any critical event, the microcontroller (ESP32/Arduino) processes sensor data, determines severity, and transmits alerts with GPS coordinates to pre-registered emergency contacts and uploads data to an IoT cloud dashboard. The system also disables the vehicle ignition upon alcohol detection. Experimental results demonstrate reliable detection, low response latency, and effective integration of cloud monitoring using ThingSpeak and Google Maps API.

Keywords: IoT, vehicle safety, accident detection, ESP32, MPU6050, GPS, GSM, alcohol detection, smoke detection, emergency alert, severity analysis

I. INTRODUCTION

Road accidents remain one of the leading causes of death and disability worldwide. In India alone, thousands of lives are lost every year due to vehicular accidents, many of which are caused by drunk driving, driver distraction, and delayed emergency response. Traditional accident reporting mechanisms rely entirely on bystanders or survivors to notify emergency services, resulting in critical time loss that can determine survival outcomes.

The proliferation of Internet of Things (IoT) technology has created new opportunities for designing intelligent, automated vehicle safety systems. By embedding multiple sensors into a vehicle and connecting them to a microcontroller, cloud services, and communication modules, it becomes possible to detect dangerous events in real time and respond automatically without human intervention.

This paper presents SAFETRACK, an integrated IoT-based system that addresses four critical vehicle safety challenges simultaneously: accident detection through vibration and impact sensing, accident severity classification, alcohol detection to prevent drunk driving, and smoke detection to identify cabin fire hazards or driver distraction. The system transmits emergency alerts with GPS-tagged location data and logs all events to an IoT cloud platform for remote monitoring.

II. REASON FOR THE PROJECT

Road accidents are one of the leading causes of death worldwide, and a significant number of fatalities occur due to delayed medical assistance rather than the severity of the accident itself. In many cases, victims are unable to call for help due to unconsciousness or lack of immediate support, especially in remote or less crowded areas. Existing emergency response systems largely depend on manual reporting, which can result in critical time loss. Therefore, there is a strong need for an automated system that can instantly detect accidents and notify emergency services without human intervention. The SAFETRACK system is proposed to address this issue by using IoT technology to provide real-time

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accident detection, analyze the severity of the crash, and send immediate alerts with location details. This helps in ensuring faster response times, reducing fatalities, and improving overall road safety.
subsequent services:

- Increasing number of road accidents worldwide
- Delay in emergency response leads to higher fatalities
- Dependence on manual reporting is unreliable
- Victims may be unconscious or unable to call for help
- Accidents in remote areas often go unnoticed
- Lack of immediate medical assistance after accidents

The Objectives of the system developed are:

- To design and develop a real-time vehicle accident detection system
- To utilize IoT technology for continuous monitoring of vehicle conditions
- To automatically detect accidents using sensors (accelerometer, vibration, etc.)
- To analyze the severity of the accident based on impact parameters
- To determine the exact location of the accident using GPS
- To send instant alerts to emergency services (ambulance, police)
- To notify family members or emergency contacts automatically
- To reduce response time and ensure quick medical assistance SYSTEM ARCHITECTURE

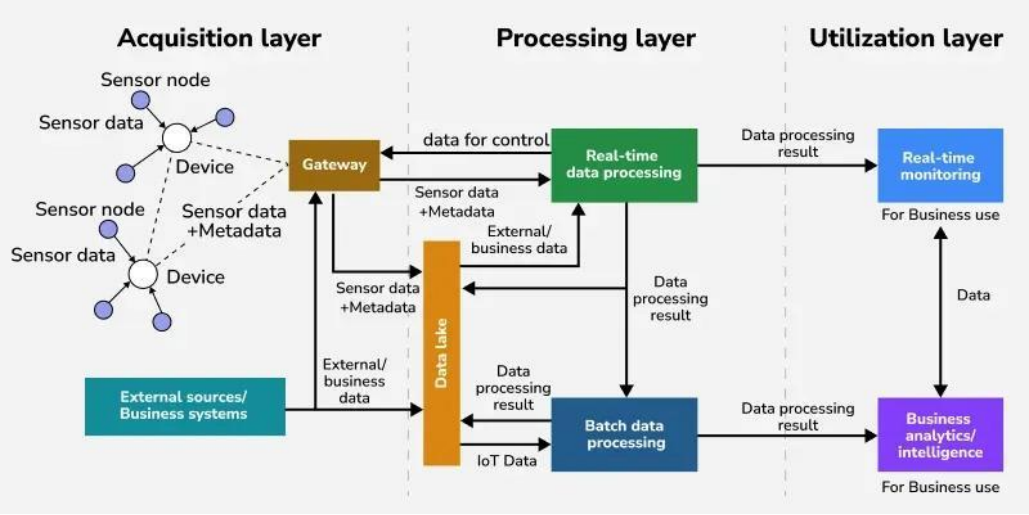

Fig. 1 Data Flow Diagram

The diagram represents an IoT-based system architecture divided into three main layers: acquisition, processing, and utilization. In the acquisition layer, sensor nodes and devices collect real-time data such as acceleration, vibration, and other vehicle parameters along with metadata. This data is then transmitted to the processing layer through a gateway. In the processing layer, the gateway forwards the data to different components like the data lake for storage and real-time processing units for immediate analysis. Real-time data processing helps in instantly detecting events such as accidents, while batch processing is used for analyzing stored data over time. External or business data may also be integrated at this stage to enhance decision-making. Finally, in the utilization layer, the processed data is used for real-time monitoring and business analytics or intelligence. In the context of SAFETRACK, this architecture enables quick accident detection, severity analysis, and efficient communication with emergency services, ensuring timely response and improved safety.

FUNCTIONAL SPECIFICATIONS USER SPESIFICATION

- The SAFETRACK system is designed to continuously monitor vehicle conditions using sensors and detect accidents in real time based on parameters such as acceleration and vibration. Once an accident is detected, the system analyzes its severity and retrieves the exact location using GPSUser (Customer and Car owner):

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- The system should be easy to install and use
- Users should receive instant alert notifications
- Users should be able to view accurate accident location
- The system should work automatically without manual input

MODULE SPECIFICATION

1.Sensor Module:
This module consists of sensors such as accelerometers and vibration sensors that continuously monitor the vehicle's motion and detect sudden changes or impacts. It is responsible for collecting real-time data related to speed, tilt, and collision.

2. Data Acquisition Module:
This module gathers data from the sensors and prepares it for processing. It ensures that the collected data is accurate and includes necessary metadata such as time and sensor values.

3. Processing and Decision Module:
This is the core module where the system analyzes sensor data to determine whether an accident has occurred. It compares the values with predefined thresholds and performs severity analysis (low, medium, high).

4. GPS Module:
This module is responsible for tracking the exact geographical location of the vehicle. When an accident is detected, it fetches real-time coordinates (latitude and longitude).

5. Communication Module:
This module uses GSM or internet connectivity to send alert messages. It transmits accident details and location to emergency services, hospitals, and registered contacts.

6. Alert and Notification Module:
This module generates emergency alerts in the form of SMS, calls, or app notifications. It ensures that all concerned parties are informed immediately after accident detection.

7. Data Storage Module (Optional):
This module stores accident-related data for future reference, analysis, or reporting. It may use cloud storage or local databases.

8. User Interface Module:
This module provides interaction with the user through a mobile app or dashboard. It allows users to view alerts, location details, and system status.

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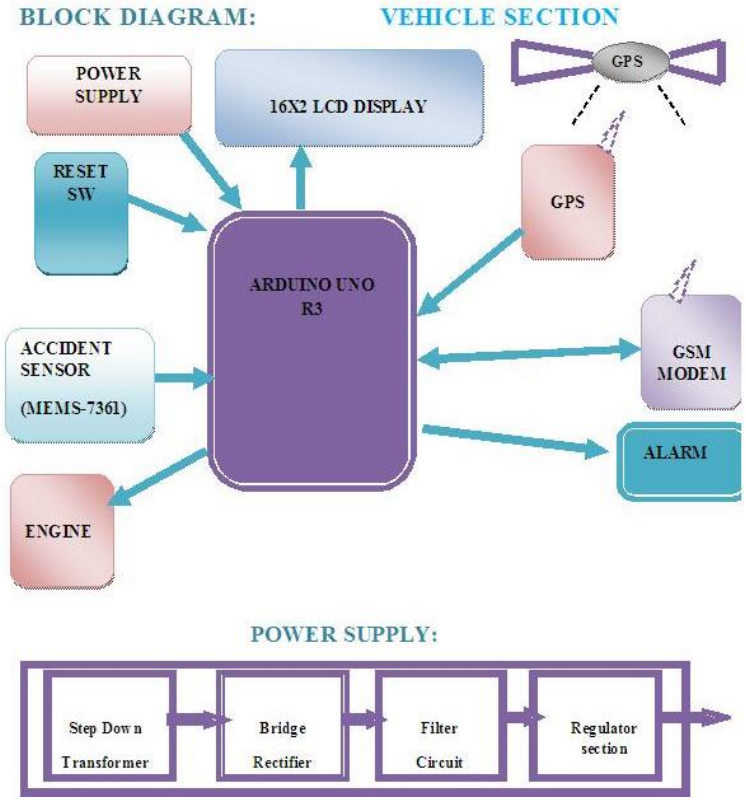

Fig. 2 Data Flow Diagram

III. CONCLUSION

The SAFETRACK system provides an efficient and reliable solution for real-time vehicle accident detection and emergency response using IoT technology. By integrating sensors, GPS, and communication modules, the system can automatically detect accidents, analyze their severity, and instantly notify emergency services and family members. This reduces the dependency on manual reporting and ensures faster medical assistance, which is crucial in saving lives. The system is cost-effective, easy to implement, and capable of operating in various environments. Overall, SAFETRACK enhances road safety by minimizing response time and improving coordination of emergency and subsequent services, thereby contributing to a significant reduction in accident-related fatalities.

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