Vehicle Tracking And Accident Alert System

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Abstract: *With the continuous growth of urban transportation and the rapid advancement of technology, ensuring road safety has become a critical concern. Despite improvements in vehicle design and traffic management, accident rates remain alarmingly high, often exacerbated by delayed emergency response. This research proposes a comprehensive, real-time Vehicle Accident Detection and Tracking System leveraging modern communication and sensing technologies. The system integrates GPS for location tracking, GSM for communication, and IoT-enabled microcontrollers like ESP32, alongside tilt and 3-axis accelerometer sensors, to detect accidents with high accuracy. Upon detection, the system instantly transmits the vehicle's coordinates and status to emergency contacts or monitoring centers via cloud platforms such as Firebase. The implementation of protocols like MQTT enhances real-time data exchange, while VANET-based routing ensures optimal message delivery. This intelligent solution not only automates accident detection and notification but also significantly reduces emergency response times, potentially saving lives and minimizing damage. The proposed system is scalable, cost-effective, and adaptable for modern smart transportation networks.*

Keywords: Accident Detection, GPS, GSM, IoT, ESP32, VANET, Firebase, MQTT, Real-time Tracking

I. INTRODUCTION

With the growing number of vehicles on the road every day, traffic accidents have become a serious problem worldwide. Many people lose their lives or get seriously injured because help does not arrive quickly enough after an accident happens. Often, this delay is caused by slow or unreliable communication between the accident site and emergency responders or family members. This shows how important it is to have a system that can detect accidents automatically and notify the right people as soon as possible [1-100]. Studies have shown that reducing the time it takes to get help after an accident can save many lives. Even saving a few minutes can make a big difference. However, traditional emergency systems still depend on witnesses or manual calls for help, which can cause delays. Therefore, there is a need for a smart, automatic accident detection and notification system[101-200]. Thanks to the development of technology, especially the Internet of Things (IoT), it is now possible to create such systems. IoT allows different devices to connect and communicate over the internet, making it easier to monitor and control things remotely. By using small, low-cost devices like the ESP32 or Node MCU microcontrollers, along with sensors such as vibration sensors and accelerometers, a system can be built to detect accidents in real time. When an accident happens, these sensors detect sudden movements or impacts and send the exact location to emergency services and family members through GPS and GSM technology.This project aims to design and implement an intelligent vehicle accident detection and tracking system using these modern technologies. The system will help reduce emergency response time, improve road safety, and ultimately save lives by making sure help arrives faster when it is needed the most[201-278].

II. PROBLEM STATEMENT

Every day, thousands of road accidents happen all over the world. These accidents cause many injuries and deaths, and they also lead to a lot of damage to vehicles and property. One of the biggest reasons why many people die in accidents is because help does not arrive quickly enough. When an accident happens, it is very important that emergency services and family members are informed immediately so that medical help can reach the accident site as soon as possible.

Unfortunately, most of the time, this does not happen on time because the current systems rely on people to report the accident manually. Sometimes, there are no witnesses, or the victim is unable to call for help, which causes dangerous delays.

Over the years, technology has improved a lot, and many efforts have been made to reduce road accidents and improve emergency response. Devices like sensors that detect sudden changes in movement, GPS for location tracking, and communication systems like GSM can help send automatic alerts when an accident happens. However, many of the existing accident detection systems are not fully reliable, or they take too long to send important information to the right people. Some systems also lack proper tracking features or real-time updates, which can cause confusion and further delay in help reaching the victims.

This shows a clear need for a better solution—a smart, automatic accident detection and vehicle tracking system that uses modern technologies to quickly detect when an accident occurs, find the exact location of the vehicle, and instantly send notifications to emergency services and family members. By using Internet of Things (IoT) devices, sensors like accelerometers and vibration sensors, and cloud platforms for live tracking, such a system can reduce the time it takes to get help. This can save many lives and reduce the damage caused by accidents.

Therefore, the main problem is to design and develop an efficient and reliable system that can detect vehicle accidents in real-time and notify the required people immediately. The system should be easy to install, cost- effective, and capable of providing accurate and fast information to emergency responders to improve the overall safety of road users.

III. LITERATURE SURVEY

Every day, thousands of road accidents happen all over the world. These accidents cause many injuries and deaths, and they also lead to a lot of damage to vehicles and property. One of the biggest reasons why many people die in accidents is because help does not arrive quickly enough. When an accident happens, it is very important that emergency services and family members are informed immediately so that medical help can reach the accident site as soon as possible. Unfortunately, most of the time, this does not happen on time because the current systems rely on people to report the accident manually. Sometimes, there are no witnesses, or the victim is unable to call for help, which causes dangerous delays.Over the years, technology has improved a lot, and many efforts have been made to reduce road accidents and improve emergency response. Devices like sensors that detect sudden changes in movement, GPS for location tracking, and communication systems like GSM can help send automatic alerts when an accident happens. However, many of the existing accident detection systems are not fully reliable, or they take too long to send important information to the right people. Some systems also lack proper tracking features or real-time updates, which can cause confusion and further delay in help reaching the victims. This shows a clear need for a better solution—a smart, automatic accident detection and vehicle tracking system that uses modern technologies to quickly detect when an accident occurs, find the exact location of the vehicle, and instantly send notifications to emergency services and family members. By using Internet of Things (IoT) devices, sensors like accelerometers and vibration sensors, and cloud platforms for live tracking, such a system can reduce the time it takes to get help. This can save many lives and reduce the damage caused by accidents.Therefore, the main problem is to design and develop an efficient and reliable system that can detect vehicle accidents in real-time and notify the required people immediately. The system should be easy to install, cost-effective, and capable of providing accurate and fast information to emergency responders to improve the overall safety of road users.

IV. PROJECT DESCRIPTION

This project presents the design and development of an IoT-based smart system that can automatically detect vehicle accidents and provide real-time location tracking using GPS and GSM technologies. The main goal of the system is to minimize emergency response time and improve the chances of saving lives by immediately notifying concerned authorities or family members when an accident occurs.

The system is built using an ESP32 microcontroller, which collects data from multiple onboard sensors such as a vibration sensor and a 3-axis accelerometer. These sensors detect sudden impacts or abnormal vehicle movements. When an accident is detected, the system triggers an alert that includes the exact location coordinates gathered from a

GPS module. This data is transmitted to predefined mobile numbers via GSM (Global System for Mobile Communication).

Additionally, the project integrates with a real-time cloud platform such as Firebase to enable live tracking of the vehicle. This allows emergency services or family members to monitor the vehicle's position on a map even after the alert is sent. The use of IoT and cloud communication ensures fast, reliable, and scalable notification, making the system suitable for real-world application.

The system is compact, cost-effective, and easy to install in any vehicle. Unlike traditional accident alert systems that rely on manual reporting or basic alarms, this project introduces a fully automated solution that operates with minimal human interaction. This makes it especially useful in cases where the driver is unconscious or unable to call for help.

This project not only contributes to improving road safety but also demonstrates how modern technologies like IoT, GPS, and GSM can work together to solve real-life problems in a smart and practical way.

V. OBJECTIVE OF SYSTEM

As engineering students, our main objective is to design and develop an automated vehicle accident detection and real-time tracking system that uses modern IoT technologies to improve road safety and emergency

response. The specific objectives of our system are:

1. To create a low-cost and compact system that can be easily installed in any vehicle without the need for complex modifications or expensive hardware.

2. To automatically detect accidents using vibration and accelerometer sensors, eliminating the need for manual reporting in emergency situations.

3. To accurately identify the location of the accident using GPS technology and send the live coordinates to predefined contacts through GSM communication.

4. To enable live vehicle tracking using a cloud platform (such as Firebase), so that emergency responders or family members can monitor the vehicle in real-time after the accident is detected.

5. To reduce the response time of emergency services by instantly sending alerts and location details, which can help save lives and minimize the damage.

6. To design a user-friendly and energy-efficient system that consumes minimal power and works reliably in real-world driving conditions.

7. To explore the integration of IoT and cloud-based communication in the automotive field, showing how embedded systems and networking can work together to solve real-life problems.

By completing this project, we aim to apply our theoretical knowledge of electronics, embedded systems, and communication networks into a practical solution that can have a real-world impact on improving vehicle safety.

VI. SYSTEM ARCHITECTURE

To better understand the working of the proposed IoT-based smart vehicle accident detection and tracking system, a block diagram representation is presented below. This diagram outlines the integration of different components and modules that collectively help in accident detection, fire detection, distance sensing, data communication, and emergency notification. The system is built using Arduino UNO as the central controller, which communicates with sensors, communication modules, and output devices to ensure a timely and efficient response in case of an accident or emergency

The block diagram illustrates the architecture of the IoT-based smart accident detection and notification system using Arduino UNO. Here's a breakdown of the components:

- Arduino UNO: Acts as the central processing unit, handling data collection from sensors and executing control logic for alerts and communication.
- Vehicle Accident Detection Sensor: Detects any abrupt collision or impact, indicating an accident scenario.
- Flame Sensor: Senses fire or excessive heat in case of a vehicle catching fire after an accident.

IJARSCT

International Journal of Advanced Research in Science, Communication and Technology

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

Volume 5, Issue 6, May 2025

ISSN: 2581-9429

Impact Factor: 7.67

- Ultrasonic Sensor: Measures distance from surrounding objects or barriers to assist in crash analysis or collision prevention.
- LCD Display: Displays real-time system status, sensor values, or accident alerts for local monitoring inside the vehicle.
- Wi-Fi Module: Sends sensor data to the cloud server for remote monitoring and storage. Enables live tracking through IoT platforms.
- Relay Drive and Engine Connection: Controls the engine circuit. Can automatically shut down the engine in critical scenarios to prevent further damage or hazard.
- GSM Module: Sends SMS alerts to concerned persons (e.g., family members, police, hospital) including the accident message and location coordinates.
- Power Supply: Supplies power to the Arduino and all connected components.
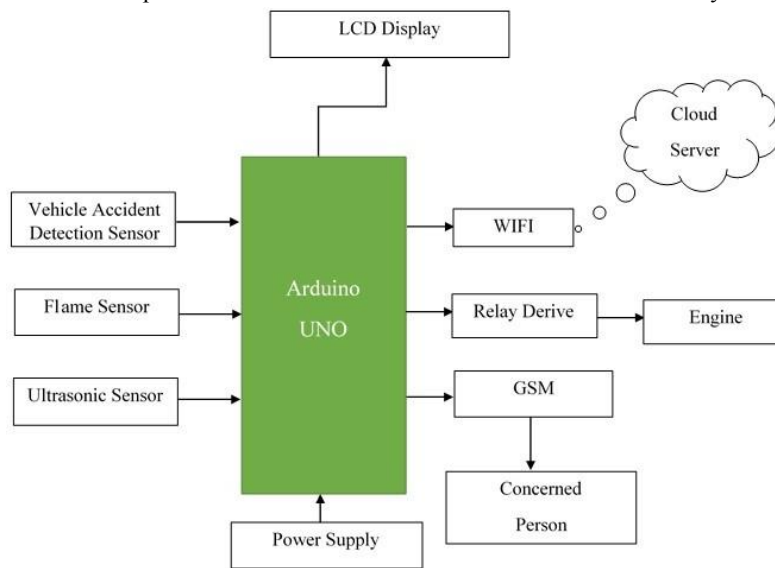- Cloud Server: Stores and processes data sent via Wi-Fi for remote access and analysis.

Figure-1 Block diagram of System Architecture of Smart Vehicle Monitoring and Accident Alert System

VII.CONCLUSION

This project successfully shows how technology can be used to improve road safety and save lives. By using IoT tools like Arduino, sensors, GPS, GSM, and Wi-Fi, the system can detect accidents quickly and send emergency alerts to the right people. It helps reduce the time between the accident and medical help, which can save many lives. The live tracking and alert system keeps family members, hospitals, or police informed in real time. This smart solution is low-cost, useful, and can be installed in vehicles to prevent loss of life and property in road accidents. In the future, this system can be improved further by adding more features like health monitoring, speed control, or automatic emergency calls.

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DOI: 10.48175/IJARSCT-26728

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2581-9429
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