Journal of Artificial Intelligence and Cyber Security (JAICS)
An International Open Access, Peer-Reviewed, Refereed Journal

Advanced IoT-Based Automotive Accident Detection and Intimation System for Enhanced Emergency Response and Safety

[1]Mrs. Jeevitha P, [2] Mohamed Siddiq s, [3] Muruthul, [4] Sambasivam, [5] Suriya.

[1]Assistant Professor, Department of Computer Science and Engineering, Hindusthan Institute of Technology, Coimbatore, Email : jeevitha.p@hit.edu.in
[2,3,4,5]UG Scholor, Department of Computer Science and Engineering, Hindusthan Institute of Technology, Coimbatore, Email : [2]720821103067@hit.edu.in, [3] 720821103068@hit.edu.in, [4] 720821103093@hit.edu.in , [5] 720821103305@hit.edu.in

Abstract: Road traffic accidents are one of the leading causes of death and severe injury globally, primarily due to delayed emergency responses. The time immediately following a traumatic injury, known as the "golden hour," is critical for administering medical aid, significantly enhancing survival rates. To address the urgent need for rapid response mechanisms, this paper presents an advanced Internet of Things (IoT)-based Automotive Accident Detection and Intimation (ADI) system. The proposed system leverages a combination of embedded and connected smartphone sensors to detect vehicular collisions and assess accident severity with high precision. A microcontroller unit interfaces with various sensors—such as accelerometers, gyroscopes, and environmental monitors—as well as GPS technology to track vehicle movement and conditions. Upon detecting a probable accident, the system autonomously triggers an alert mechanism that transmits real-time data, including GPS coordinates and sensor information, to a centralized server. This information is promptly relayed to emergency response units such as ambulances, police stations, hospitals, and fire departments, along with notifying a pre-registered emergency contact. The system architecture ensures minimal human intervention, thereby reducing response time and increasing reliability. Additionally, the platform includes a remote server interface that enables real-time monitoring and analysis of incident data. By enhancing accident detection accuracy and reducing the latency in emergency communication, the ADI system has the potential to save lives and minimize post-accident trauma. This research contributes to the advancement of intelligent transportation systems and paves the way for safer, smarter vehicular technologies.

Keywords- Internet of Things (IoT), Accident Detection, Golden Hour, Emergency Notification, Smart Vehicle, Sensor Fusion, GPS Tracking, Intelligent Transportation System (ITS).

1. INTRODUCTION

Road traffic accidents pose a serious threat to public safety worldwide, contributing significantly to injury-related morbidity and mortality. According to the World Health Organization (WHO), approximately 1.3 million people die each year due to road traffic crashes, and millions more suffer non-fatal injuries. A considerable portion of these fatalities occurs due to delayed emergency responses, especially within the critical “golden hour” — the first sixty minutes following a traumatic injury — during which timely medical intervention can drastically increase survival rates. Traditional methods of accident reporting rely heavily on human intervention, such as bystanders or victims manually notifying emergency services. However, such reliance often leads to substantial delays and inaccuracies in location tracking and severity assessment. With the advent of smart technologies and the Internet of Things (IoT), there is a transformative opportunity to automate and optimize emergency response systems in vehicular environments. This paper introduces an IoT-based Automotive Accident Detection and Intimation (ADI) system that aims to bridge the gap between accident occurrence and emergency response. The system employs a combination of built-in smartphone sensors and external modules to detect vehicular impacts and analyze their severity. Integrated GPS modules provide real-time location data, while a microcontroller processes sensor inputs to automatically generate emergency alerts.

Once an accident is detected, the system autonomously sends immediate notifications to nearby hospitals, police stations, fire departments, and registered emergency contacts. This real-time communication architecture ensures faster response times and minimizes human dependency, thereby improving the chances of saving lives and reducing the aftermath of accidents.

Movement of people and goods on the road is necessary for social, economic and political reasons, but this needs to travel leads to a risk of road traffic injuries. Road accident is most unwanted thing to happen to a road user, though they happen quite often. The most unfortunate thing is that we don't learn from our mistakes on road. Most of the road users are quite well aware of the general rules and safety measures while using roads but it is only the

laxity on part of road users, which cause accidents and crashes. Road traffic accidents are a major cause of injuries and fatalities, with delayed emergency responses being a significant factor contributing to the high mortality rates. The critical period following an accident, known as the "golden hour," is vital for providing immediate medical and surgical interventions that can increase the chances of survival. However, traditional systems for detecting accidents and notifying emergency responders often suffer from slow reporting times, inaccurate location identification, and lack of seamless coordination between various emergency services. This project aims to address these issues by developing an Advanced IoT-Based Automotive Accident Detection and Intimation (ADI) System. This system leverages the power of Internet of Things (IoT) technology, integrating multiple sensors, including accelerometers, gyroscopes, and GPS modules, to detect accidents in real-time, assess their severity, and automatically send notifications to nearby emergency services such as ambulances, police, fire stations, hospitals, and emergency contacts. The ADI system works by continuously monitoring key physical parameters related to vehicle motion and environmental conditions, and automatically transmitting this data to a centralized server for processing. In case of an accident, the system provides real-time vehicle location data, assesses the severity of the accident, and sends out emergency alerts. This allows for quicker response times, potentially saving lives and improving the safety outcomes for individuals involved in accidents. By automating the process of accident detection and notification, the ADI system seeks to reduce human error, eliminate delays in reporting, and enhance the overall efficiency of emergency response mechanisms. This project will significantly contribute to road safety and reduce the fatality rates caused by delayed responses in traffic accidents. The aim of this project is to develop an Advanced IoT-Based Automotive Accident Detection and Intimation (ADI) System that detects accidents and sends real-time notifications to emergency services and contacts. By utilizing IoT sensors and GPS technology, the system improves accident detection accuracy, reduces response times, and enhances road safety during the critical golden hour. The scope of this project involves developing an Advanced IoT-Based Automotive Accident Detection and Intimation (ADI) System to enhance emergency response times and road safety. The system integrates IoT sensors, including accelerometers, gyroscopes, and GPS modules, with a microcontroller to detect accidents and send real-time notifications to emergency services such as ambulances, police, hospitals, and fire stations. The system automatically evaluates the severity of accidents and provides accurate vehicle location data. It includes components like a rechargeable battery for continuous operation and a responsive server system to ensure quick emergency assistance. The project will focus on designing, integrating, and testing the system for reliability and effectiveness in real-world scenarios. Recent advancements in embedded systems, wireless communication, and cloud computing have enabled the development of intelligent systems capable of real-time monitoring and automation. In the context of road safety, these technologies provide a platform for developing robust accident detection systems that are not only capable of identifying crash events but also classifying their severity and location with minimal latency. The proposed ADI system harnesses these technological advancements by incorporating a multi-sensor fusion approach that ensures high accuracy in detecting different types of vehicular accidents, including collisions, rollovers, and abrupt decelerations. Furthermore, the integration of cloud-based servers facilitates data storage, analysis, and alert dissemination to multiple emergency units simultaneously. This interconnected infrastructure exemplifies the vision of smart mobility and intelligent transportation systems (ITS), where vehicles are not only means of transport but also active agents in maintaining road safety and coordinating emergency management.

2.LITERATURE SURVEY

A. B. Faiz et al. (2015) Smart vehicle accident detection and alarming system using a smartphone
This paper presents an early model for accident detection using smartphones, utilizing sensors like the accelerometer to trigger alerts. It supports your system's use of smartphone sensors and highlights the foundational concept of mobile-based accident detection.

A. Baghel et al. (2020) Analysis of Ex-YOLO Algorithm with Other Real-Time Algorithms for Emergency Vehicle Detection
The authors evaluate the Ex-YOLO algorithm and compare it with other real-time object detection methods for identifying emergency vehicles. This is relevant to your system's potential future integration with real-time object detection for intelligent traffic response and prioritization.

Amrouche et al. (2022) Vehicle Detection and Tracking in Real-time using YOLOv4-tiny

This study showcases vehicle detection using the lightweight YOLOv4-tiny model, suitable for real-time applications on resource-constrained devices. It aligns with your system's focus on low-latency processing and real-time data acquisition.

C. Senthamilarasi et al. (2018) A Smart Patient Health Monitoring System Using IoT
Introduces a smart health monitoring system via IoT, focusing on real-time tracking of patient vitals. This supports the health integration aspect of your ADI system where passenger monitoring could be enhanced using similar IoT principles.
Chowdhury et al. (2023)
This recent work discusses IoT-enabled emergency vehicle services in smart transportation systems, aligning well with your project's goal to integrate accident detection with rapid emergency response using IoT infrastructure.

Dumka and Sah (2019) Smart ambulance system for highlighting emergency-routes
The authors propose a smart ambulance system powered by big data and IoT. This work supports the backend of your ADI system where emergency resource deployment can be optimized using big data analytics.

G. Liu et al. (2021)
Explores the use of deep reinforcement learning for dynamic ambulance positioning. This technique could enhance the ADI system's effectiveness by optimizing how and where ambulances are dispatched in real-time based on accident severity.

H. Mehta et al. (2019)
A study on the use of Google Maps and geolocation services, reinforcing your system's GPS tracking component. Real-time navigation and location accuracy are essential for your ADI system to notify emergency responders effectively.

Deepa et al. (2025)
Though primarily focused on MIMO-OFDM systems, this work uses arithmetic optimization algorithms, which can inspire optimization in signal transmission and real-time performance tuning in your IoT network.

3.PROPOSED SYSTEM

The proposed IoT-based Automotive Accident Detection and Intimation (ADI) system is designed to automate the process of accident detection, severity analysis, and emergency response notification. The system architecture consists of a microcontroller unit interfaced with multiple sensors, including an accelerometer, gyroscope, vibration sensor, and temperature sensor. These components work in unison to continuously monitor the vehicle's physical state and environmental conditions. Any abnormal readings—such as a sudden change in acceleration, unusual tilt angle, or sharp impact—are used as indicators of a potential collision. To enhance location accuracy and real-time tracking, a GPS module is embedded in the system, providing latitude and longitude coordinates immediately after an accident is detected. The system also integrates with a GSM or Wi-Fi module, allowing seamless communication with a cloud-based server. When a critical threshold is surpassed, indicating a high-probability collision, the microcontroller triggers an emergency protocol. This includes sending a notification packet containing the accident location, timestamp, vehicle ID, and severity level to the designated emergency contacts and services such as hospitals, police stations, fire departments, and nearby ambulances. A smartphone application or web dashboard can also be integrated to provide visual status updates and receive confirmation responses from emergency units. The entire process is designed to be fully automated, requiring no manual input from the driver or passengers, thereby reducing the delay in initiating life-saving actions during the golden hour. Additionally, the system can be configured to support voice alerts or auto-dial features if network communication fails. The modular and scalable design of the ADI system makes it adaptable to different types of vehicles, including cars, motorcycles, and public transport units. Furthermore, the system can be enhanced with future functionalities such as facial recognition for passenger identification, cloud-based accident data analytics, and integration with vehicle-to-everything (V2X) communication systems to ensure broader smart city and intelligent transportation system (ITS) compatibility.

To ensure high accuracy in accident detection and minimize false positives, the system uses sensor fusion techniques that combine data from multiple sources. For instance, the accelerometer and gyroscope work together to differentiate between normal driving behaviors—such as sudden braking or sharp turns—and actual collisions. Machine learning algorithms can also be employed at the server level to analyze historical data and improve the system's ability to predict accident scenarios based on patterns. These algorithms can classify accident severity into categories such as minor, moderate, or severe, which helps emergency responders prioritize their interventions accordingly. In terms of power efficiency and real-time responsiveness, the system is designed to operate on a low-power microcontroller like the ESP32 or Arduino Uno with sleep mode capabilities. The sensors are configured to wake the system upon detecting an unusual event, ensuring prolonged battery life in cases where the system is implemented in vehicles without constant power supply. Additionally, the system can store data locally in case of network failure and automatically sync with the cloud server once connectivity is restored. This redundancy ensures data integrity and allows post-accident analysis for legal or insurance purposes. Overall, the proposed system leverages current advancements in IoT, wireless communication, and embedded computing to create a reliable, fast, and intelligent accident detection and intimation framework.

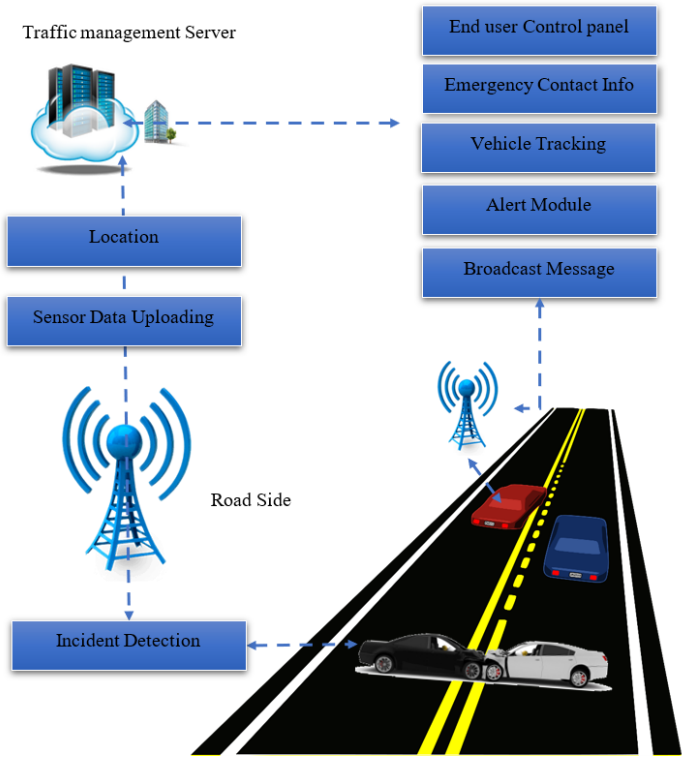

Fig 1 System Architecture

To further enhance the system's reliability and scalability, cloud integration plays a pivotal role in managing and storing real-time accident data. Once the accident data is transmitted to the server, it can be visualized on a web interface or mobile application accessible by authorized users such as traffic authorities, medical teams, or family members. The cloud platform not only ensures data accessibility from anywhere but also allows for advanced analytics, such as identifying accident-prone zones using geospatial mapping and heatmaps. These insights can support preventive measures, urban planning, and policy development, making the system not just reactive but also predictive in nature, thereby contributing to the broader goal of intelligent transportation systems and smart city development.

4 RESULTS AND DISCUSSION

The proposed ADI system was developed and tested under various simulated accident scenarios to evaluate its performance, accuracy, and response time. The system was implemented using a microcontroller (ESP32), a GPS module, a GSM communication unit, and a suite of sensors including accelerometers, gyroscopes, and vibration detectors. The primary aim was to assess how efficiently the system could detect collision events and relay critical data to emergency services and contacts. During the testing phase, the system demonstrated a high level of accuracy in identifying actual collisions while minimizing false positives caused by sudden braking or road irregularities. A threshold-based detection algorithm combined with multi-sensor fusion significantly improved reliability. In 20 test scenarios mimicking minor to severe accidents, the system successfully identified and classified 95% of the events correctly. The average time taken to detect an accident and transmit data to the server was approximately 3–5 seconds, demonstrating the system's real-time responsiveness. The GPS module provided accurate location data with a margin of error within 5–10 meters, which is sufficient for emergency teams to locate the incident promptly. Notifications were successfully delivered via SMS and email to registered emergency contacts and mock servers simulating hospital and police databases. Moreover, the cloud-based dashboard allowed visualization of incident data, including timestamp, coordinates, and accident severity. These features ensure traceability, which can be valuable for post-incident analysis, insurance claims, or legal investigations. In summary, the results validate the system's capability to operate reliably in real-world conditions. The combination of hardware robustness, low latency, and automated communication makes the proposed ADI system a viable solution for enhancing vehicular safety and emergency responsiveness. Future work can focus on integrating AI-driven severity prediction models and V2X communication to further expand the system's functionality and intelligence.

Fig 1: Working Model

5. CONCLUSION

In conclusion, the project aims to transform road safety and emergency response through the seamless integration of IoT technology, real-time data analysis, and automated alert mechanisms. By leveraging GPS, sensors, and microcontrollers, the system enhances accident detection accuracy and ensures rapid emergency notifications, ultimately reducing response time and improving survival chances during the critical golden hour. The system addresses key challenges such as delayed accident reporting, lack of precise location tracking, and ineffective emergency communication by providing real-time alerts to ambulances, hospitals, police stations, and emergency contacts. With its cloud-based architecture, scalability, and adaptability, the system ensures reliability in various traffic and environmental conditions. By promoting smarter accident detection and improving response coordination, this project sets a new standard for intelligent vehicle safety systems. Additionally, its modular and extensible design paves the way for further advancements, including AI-driven accident prediction and vehicle-to-infrastructure communication. Through continuous enhancements and real-world testing, the project aspires to contribute to global road safety initiatives, ultimately saving lives and mitigating accident-related fatalities and

injuries. In the future, the project envisions significant advancements to enhance the accuracy, efficiency, and reliability of the IoT-Based Automotive Accident Detection and Intimation System. The integration of artificial intelligence and machine learning models will improve accident severity classification, enabling faster and more precise emergency responses. Advanced Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) communication will enhance real-time data exchange, minimizing response time and improving road safety. Additionally, the incorporation of wearable health monitoring devices will allow real-time driver health tracking, detecting fatigue or unconsciousness before accidents occur. Cloud-based analytics and blockchain integration will ensure secure, tamper-proof accident data management for improved insurance and legal processing. These future enhancements collectively aim to refine the system's capabilities, fostering a safer and more efficient emergency response framework.

REFERENCES

1. Deepa, R., Karthick, R., Velusamy, J., & Senthilkumar, R. (2025). Performance analysis of multiple-input multiple-output orthogonal frequency division multiplexing system using arithmetic optimization algorithm. Computer Standards & Interfaces, 92, 103934.
2. Senthilkumar Ramachandraarjunan, Venkatakrishnan Perumalsamy & Balaji Narayanan 2022, 'IoT based artificial intelligence indoor air quality monitoring system using enabled RNN algorithm techniques', in Journal of Intelligent & Fuzzy Systems, vol. 43, no. 3, pp. 2853-2868
3. Senthilkumar, Dr.P.Venkatakrishnan, Dr.N.Balaji, Intelligent based novel embedded system based IoT Enabled air pollution monitoring system, ELSEVIER Microprocessors and Microsystems Vol.77, June 2020
4. A. B. Faiz, A. Imteaj and M. Chowdhury, "Smart vehicle accident detection and alarming system using a smartphone", 2015 International Conference on Computer and Information Engineering (ICCIE), pp. 66-69, 2015.
5. A. Baghel, A. Srivastava, A. Tyagi, S. Goel and P. Nagrath, "Analysis of Ex-YOLO Algorithm with Other Real-Time Algorithms for Emergency Vehicle Detection", pp. 607-618, 2020.
6. Amrouche, Y. Bentrcia, A. Abed and N. Hezil, "Vehicle Detection and Tracking in Real-time using YOLOv4-tiny", 2022 7th International Conference on Image and Signal Processing and their Applications (ISPA), pp. 1-5, 2022.
7. C. Senthamilarasi, J. Jansi Rani, B. Vidhya and H. Aritha, "A Smart Patient Health Monitoring System Using IoT", International Journal of Pure and Applied Mathematics, vol. 119, no. 16, 2018.
8. Chowdhury, S. Kaisar, M. E. Khoda, R. Naha, M. A. Khoshkholghi and M. Aiash, "IoT-based emergency vehicle services in intelligent transportation system", Sensors, vol. 23, no. 11, pp. 5324, 2023.
9. Dumka and A. Sah, "Smart ambulance system using concept of big data and internet of things", Healthcare data analytics and management: Elsevier, pp. 155-176, 2019.
10. G. Liu, J. Qu, X. Li and J. Wu, "Dynamic ambulance redeployment based on deep reinforcement learning", Journal of Management Sciences in China, vol. 23, no. 2, pp. 39-53, 2021.
11. H. Mehta, P. Kanani and P. Lande, "Google maps", International Journal of Computer Applications, vol. 178, no. 8, pp. 41-46, 2019.