International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 04 Issue: 05 May 2026
Page No: 3565-3570
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2026.0464

A Sensor Fusion and Yolo-Based Approach for Real-Time Vehicle Accident Detection

Anushka S. Gosavi[1], Shubhangi N. Wakchaure[2], Siddhi S. Pachpute[3], Aditi N. Ingale[4], Sharad M Rokade[5]
[1, 2, 3, 4] Department of Computer Engineering, Sir Visvesvaraya Institute of Technology, Nashik, Maharashtra, 422102, India.
[5]Associate Professor, Department of Computer Engineering, Sir Visvesvaraya Institute of Technology, Nashik, Maharashtra, 422102, India.
Email ID: *anushkagosavi2511@gmail.com[1], shubhangiwakchaure3@gmail.com[2], pachputesiddhi25@gmail.com[3], aditin2511@gmail.com [4], sharad.rokade@pravara.in [5]*

Abstract
Road accidents remain a critical global issue, often resulting in severe injuries and delayed emergency assistance, particularly in remote and high-speed environments. This paper proposes a smart accident detection and monitoring system that combines Internet of Things (IoT) devices with artificial intelligence techniques to enhance detection accuracy and response time. The system employs an ESP32 microcontroller integrated with an MPU6050 accelerometer to continuously monitor vehicle motion and identify sudden impacts based on predefined thresholds. To improve reliability, GPS-based speed analysis is incorporated to validate critical events. In addition, an OV2640 camera module captures real-time images, which are analysed using the YOLOv8n deep learning model for visual verification of accident conditions such as vehicle damage or fire. Upon confirmation, the system retrieves precise location data using a GPS module and transmits alert messages containing map coordinates to emergency contacts via a GSM module. Experimental results indicate improved detection accuracy and reduced false alarm rates compared to conventional single-sensor approaches. The proposed system is cost-effective, scalable, and suitable for real-time deployment, contributing to faster emergency response and enhanced road safety.

Keywords: *Accident detection; Computer vision; Internet of Things (IoT); Real-time monitoring; YOLOv8n.*

1. Introduction

Road traffic incidents continue to pose a major challenge worldwide, resulting in substantial loss of life and long-term injuries each year. A critical factor that often worsens the outcome of such incidents is delayed emergency assistance, particularly in isolated locations, high-speed roadways, or situations where victims are incapacitated and unable to seek help. Conventional safety mechanisms, including manual reporting and airbag-triggered alerts, frequently fall short in ensuring rapid and reliable response. This gap underscores the importance of developing an automated system capable of detecting accidents and communicating critical information without human intervention. Recent advancements in Artificial Intelligence (AI), the Internet of Things (IoT), and embedded technologies have enabled the development of more sophisticated accident detection solutions. For instance, Roy et al. (2020) presented a system that utilizes accelerometers along with GPS and GSM modules to detect sudden impacts and transmit alerts to predefined contacts. While effective in identifying abrupt physical changes, such approaches depend heavily on sensor readings and may produce inaccurate alerts under conditions such as rough terrain or sudden braking. In contrast, Venkadesh et al. (2025) explored a vision-based method employing deep learning models like YOLO and Convolutional Neural Networks (CNNs) to recognize accident scenarios from visual data. Although this method enhances detection accuracy through contextual analysis, it lacks an inherent mechanism for immediate alert generation and may require significant computational resources. The limitations observed in these approaches reveal a common issue: reliance on a single mode of detection. Systems based solely on either sensor data or visual input may not consistently deliver reliable performance under varying real-world conditions. This observation motivates the exploration of a hybrid framework that integrates multiple data sources to achieve improved accuracy and responsiveness. The Introduction presents the purpose of the studies reported and their relationship to earlier work in the field. It should not be an extensive review of the literature. Use only those references required to provide the most salient background to allow the readers to understand and evaluate the purpose and results of the present study without referring to previous publications on the topic.

1.1.Background and Motivation

Accident detection technologies can generally be divided into two categories: sensor-driven systems and vision-based systems. Sensor-based approaches monitor parameters such as acceleration, vibration, and motion to identify abnormal events. However, these systems can misinterpret non-critical situations, such as sudden deceleration or uneven road surfaces, as accidents. On the other hand, vision-based systems analyze images or video streams using machine learning techniques, offering a more detailed understanding of the environment and the nature of the incident. Despite this advantage, they often depend on continuous processing and may not provide immediate detection without a triggering mechanism. Another practical limitation of existing solutions is their dependence on stable internet connectivity, which may not be consistently available, especially in rural or remote areas. These challenges highlight the need for a more robust and adaptive system that combines sensor inputs, location tracking, and intelligent visual analysis to minimize errors and enhance overall system dependability.

1.2. Problem Statement

Although considerable progress has been made in accident detection technologies, several key challenges remain unresolved:

- Limited detection accuracy due to dependence on a single data source
- Frequent false alarms caused by environmental factors and normal driving conditions
- Absence of integrated mechanisms for simultaneous location tracking and visual validation
- Reliance on user interaction during critical emergency situations
- Reduced effectiveness in regions with poor or unreliable network coverage

To address these issues, there is a need for a comprehensive system that can:

- Detect accidents autonomously using multiple complementary data inputs
- Accurately identify the location and assess the severity of incidents
- Instantly notify emergency contacts without requiring user intervention
- Maintain functionality in environments with limited connectivity

1.3. Objectives of the Proposed System

This study aims to design and implement a dependable and cost-efficient accident detection system by leveraging AI and IoT technologies. The key objectives include:

- Developing a mechanism to detect accidents using motion and acceleration sensors
- Integrating GPS functionality for precise real-time location identification
- Enabling automated alert transmission through GSM communication
- Incorporating AI-based visual analysis using YOLO to validate detected events
- Minimizing false positives through the fusion of sensor and visual data
- Providing a real-time interface for monitoring and visualization of system data

1.4.Scope of the Study

The proposed system is intended for application across a wide range of vehicles, including motorcycles, passenger cars, and commercial transport units. The scope of this work encompasses:

- Continuous monitoring and immediate reporting of accident events
- Seamless integration of sensor-based detection with AI-driven visual verification
- Operation under both connected and low-connectivity conditions
- Storage, access, and analysis of accident-related information via a web-based platform

Additionally, the system is designed with scalability in mind, allowing for future enhancements such as mobile application integration, cloud-based data

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 04 Issue: 05 May 2026
Page No: 3565-3570
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2026.0464

analytics, and direct linkage with emergency response networks to further improve system effectiveness.

2. Method

The proposed approach focuses on identifying road accidents as they occur by combining physical sensor measurements with intelligent image-based analysis. Instead of relying on a single detection technique, the system integrates multiple processes, including real-time sensing, event evaluation, visual confirmation, and automated communication. This layered methodology improves reliability while minimizing incorrect alerts.

2.1.System Architecture

The overall design is built around a compact embedded platform that connects sensing devices, communication modules, and processing units into a unified system. At the core of this setup is the ESP32 microcontroller, which manages data flow and decision-making across all connected components Figure 2. Motion sensing is handled by the MPU6050 module, while positional and velocity information is obtained through a GPS unit. A GSM module enables external communication by transmitting alerts, and a camera module is included to capture visual data when abnormal events are detected. Each component works in coordination under the control of the ESP32 to ensure smooth system operation.

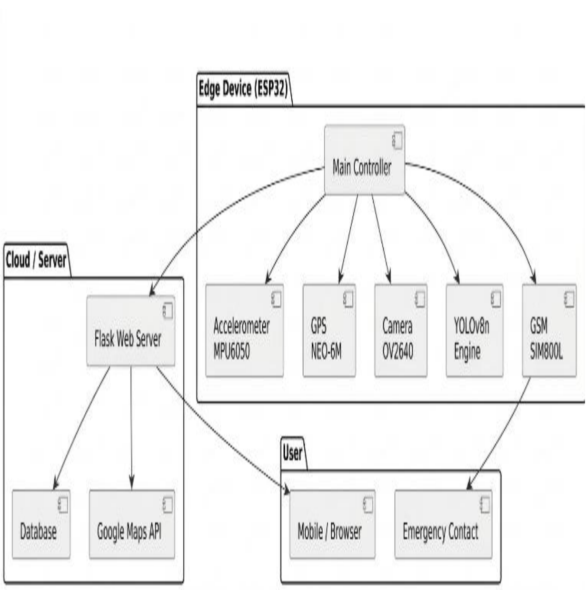

Figure 1 System Architecture of Proposed System

Table 1 Hardware Components Used in the System

Components	Model	Function
Microcontroller	ESP32	Controls system operations
Accelerometer	MPU6050	Detects motion and impact
GPS Module	NEO-6M	Provides location and speed
GSM Module	SIM800L	Send alert messages
Camera Module	OV2640	Captures images for verification

2.2.Data Acquisition and Preprocessing

The MPU6050 sensor continuously records acceleration values along three perpendicular axes. These readings are combined to compute the overall magnitude of motion, which serves as a key indicator of sudden impact or abnormal movement. At the same time, the GPS module supplies real-time updates on the vehicle's position and speed. The speed information is particularly useful in distinguishing between actual collisions and less critical events, such as minor vibrations or abrupt but non-dangerous stops. Before further processing, the collected data is filtered and organized to ensure consistency and accuracy.

2.3. Accident Detection Mechanism

Initial identification of a possible accident is based on detecting unusually high acceleration values. When the computed motion exceeds a predefined threshold, the system flags the event for further evaluation Figure 1.

To strengthen decision accuracy, this detection is not made in isolation. Instead, acceleration data is cross-checked with speed information from the GPS module. Only when both indicators suggest abnormal behaviour does the system treat the event as a probable accident. This combined evaluation helps reduce incorrect triggers caused by road irregularities or sudden braking[1].

e ISSN: 2584-2137
Vol. 04 Issue: 05 May 2026
Page No: 3565-3570
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2026.0464

2.4.AI-Based Visual Verification

Following the detection of a suspicious event, the system activates the camera to capture images of the surrounding environment. These images are then analysed using a YOLO-based deep learning model trained to recognize accident-related patterns[2]. The model examines visual cues such as vehicle deformation, unexpected object placement, or signs of damage. Based on this analysis, the system determines whether the detected event corresponds to a genuine accident. This additional verification layer significantly improves overall detection reliability.

2.5.Alert Generation and Communication

After confirming an accident, the system retrieves the exact geographic coordinates from the GPS module. It then composes an alert message containing essential location details, including a direct map link. This message is transmitted via the GSM module to a set of preconfigured emergency contacts. By delivering precise location information instantly, the system facilitates quicker response from rescue teams and nearby individuals[3].

2.6.Data Storage and Monitoring

Beyond immediate notification, the system maintains a record of all relevant event data. This includes sensor measurements, positional information, and captured images. The data is forwarded to an online dashboard designed for real-time access and analysis. Through this interface, users can monitor incidents, review historical records, and evaluate system behaviour. This capability not only improves transparency but also supports future enhancements by providing valuable operational insights[4].

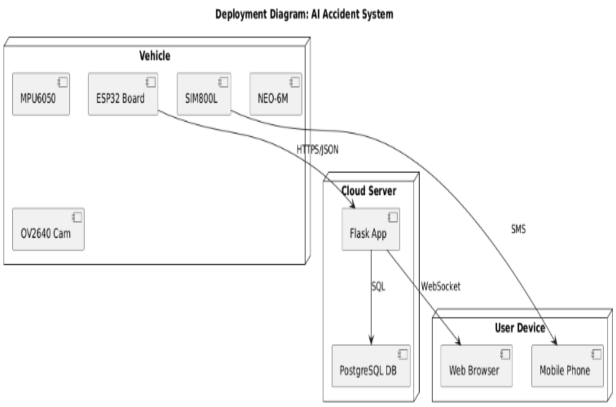

Figure 2 Deployment Diagram

3. Results And Discussion

3.1.Results

The developed accident detection system was evaluated through a combination of controlled testing and practical scenarios to examine its effectiveness in real-time operation. The system was exposed to different conditions such as normal driving, sudden braking, road disturbances, and simulated collision events. During testing, the accelerometer successfully captured motion variations, and high-impact events were identified when acceleration exceeded predefined limits. These events were further validated using speed data obtained from the GPS module, which helped distinguish between actual accidents and non-critical movements. For visual confirmation, the camera module captured images whenever a potential accident was detected. These images were processed using a YOLO-based deep learning model, which effectively identified accident-related situations. The model demonstrated the ability to detect collision scenarios and highlight them with bounding boxes, as shown in Figure 3.

Figure 3 Accident Detection using YOLOV8n Model

Once an accident was confirmed, the system generated alert messages containing essential details such as the time and geographical coordinates. These alerts were delivered through multiple platforms to ensure reliability[5]. The Telegram-based notification system provided instant alerts in a structured format, as illustrated in Figure 4. The message includes accident status along with timestamp and location details, enabling quick understanding.

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 04 Issue: 05 May 2026
Page No: 3565-3570
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2026.0464

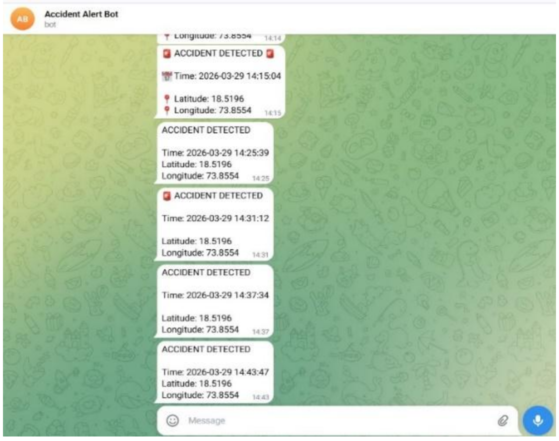

Figure 4 Telegram Bot Alert Showing Real-Time Accident Notifications

Similarly, email notifications were sent to registered users, as shown in Figure 5. These messages contained key information related to the detected event, ensuring accessibility across different communication channels.

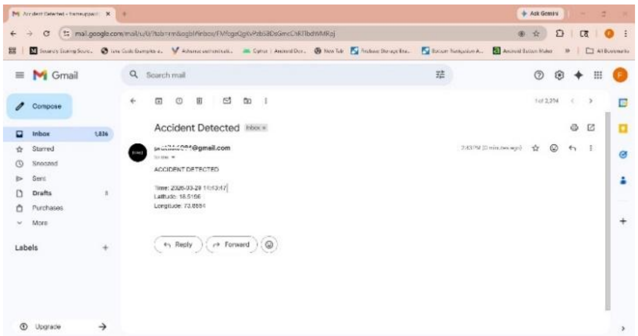

Figure 5 Email Alert Generated After Accident Detection with Location Details.

Overall, the system demonstrated consistent performance in identifying accident scenarios and delivering alerts within a short duration, making it suitable for real-time applications Figure 5.

3.2.Discussion

The observed results highlight the advantages of combining multiple technologies for accident detection. The use of accelerometer data enables rapid identification of sudden impacts, while GPS information provides additional context by verifying movement conditions and supplying location data[6].The integration of a YOLO-based model further strengthens the system by introducing visual validation Figure 3. This reduces the chances of incorrect detections that may arise from sensor-only approaches, thereby improving overall system dependability. The alert mechanism plays a crucial role in ensuring timely communication. By utilizing both Telegram and email platforms, the system ensures that notifications are delivered through more than one channel, increasing the likelihood of immediate response. The inclusion of time and location information enhances the usefulness of these alerts in emergency situations. Despite its effectiveness, certain challenges remain. Environmental factors such as poor lighting or motion blur may affect image quality, which can influence the accuracy of visual detection. Additionally, the performance of communication modules depends on network availability, which may limit real-time alert delivery in remote locations. In comparison to traditional methods, the proposed approach achieves a better balance between speed and accuracy by integrating sensor fusion with AI-based analysis. This combination allows the system to operate efficiently while maintaining reliable detection performance[7]. Overall, the system demonstrates strong potential for real-world deployment, offering a practical and scalable solution for improving road safety and emergency response Figure 4.

Conclusion

The study addressed the critical issue of delayed accident detection and response by developing an intelligent system that combines sensing technologies with AI-based analysis. The results obtained from experimental evaluation confirm that the proposed approach is capable of accurately identifying accident events and generating timely alerts[8]. The system integrates motion sensing, location tracking, and visual verification to improve detection reliability. The use of acceleration data enables quick identification of abnormal events, while GPS information provides contextual validation and precise location details. In addition, the implementation of a YOLO-based model enhances the system's ability to verify accident scenarios through image analysis, thereby reducing false alarms. The findings discussed in the results section demonstrate that the system performs effectively in real-time conditions, delivering alerts through multiple communication channels such as Telegram and email. This ensures that critical information reaches users without delay, supporting faster emergency response. Furthermore, the proposed solution offers a practical and scalable design that can be implemented in different types of vehicles. Its ability to operate with minimal infrastructure and provide reliable outputs makes it suitable for real-world applications. In conclusion, the developed system successfully overcomes the limitations of conventional accident detection methods by combining sensor fusion and AI techniques, thereby contributing to improved road safety and efficient monitoring.

Acknowledgements

The authors would like to express their sincere gratitude to the faculty members and project guide for their continuous support, valuable suggestions, and guidance throughout the development of this work. Their insights and encouragement played a significant role in the successful completion of this project. The authors also extend their thanks to the department and institution for providing the necessary resources, infrastructure, and technical support required for the implementation and testing of the system. Furthermore, appreciation is given to all individuals who directly or indirectly contributed to this work and helped in improving the quality of the research.

References

[1] Sarker, S., Rahman, M. S., & Sakib, M. N. (2019). An approach towards intelligent accident detection, location tracking and notification system. *2019 IEEE International Conference on Telecommunications and Photonics (ICTP)*. 10.1109/ICTP48844.2019.9041759 .

[2] Yadav, D. K., Renu, Ankita, & Anjum, I. (2020). Accident detection using deep learning. 2020 2nd International Conference on Advances in Computing, Communication Control and Networking (ICACCCN).10.1109/ICACCCN51052.2020.936288

[3] Razali, S. N., Abu Samah, K. A. F., Ahmad, M. H., & Riza, L. S. (2021). IoT based accident detection and tracking system with Telegram and SMS notifications. 2021 6th IEEE International Conference on Recent Advances and Innovations in Engineering(ICRAIE).10.1109/ICRAIE52900.2021.9703970.

[4] Samba, S. H., Agranata, I. Y. B., Tsanaullailla , L., & Hamami, F. (2024). Traffic accident detection analysis using YOLOv9 algorithm. 2024 Ninth International Conference on Informatics and Computing(ICIC). 10.1109/ICIC64337.2024.10957461.

[5] Madhavi, R. S., & Muskan, S. (2025). Accident detection and alert system using YOLO model. 2025 10th International Conference on Communication and Electronics Systems (ICCES). 10.1109/ICCES67310.2025.11337080.

[6] Singh, A. B., K. P., S., Adamsab, K., Raju, R., & Raj, A. (2025). Real-time road accident detection and emergency notification system using YOLOv11. 2025 2nd International Conference on Electronic Circuits and Signaling Technologies (ICECST). 10.1109/ICECST66106.2025.11307404.

[7] Venkadesh, P., Divya, S. V., Jayaprathap, P., Kumar, K. D., Aravindh, R., & Jeevanandham, N. (2025). An AI hybrid model for road accident detection based on YOLO and CNN algorithm. 2025 8th International Conference on Circuit, Power & Computing Technologies (ICCPCT). 10.1109/ICCPCT65132.2025.11176592.

[8] Shrikavin, B., Antony, C., & Chitradevi, D. (2023). Automated accident detection and reporting system with GPS and GSM integration. IEEE Conference Publication. 10.1109/ICTBIG64922.2024.10911216.