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AI-Driven Smart Accident Monitoring and Impact Assessment System

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Abstract-- **Road accidents pose a serious challenge to road safety, often resulting in injuries, fatalities, and delayed emergency response due to reliance on manual accident reporting systems. To overcome these limitations, this paper presents an AI-Driven Smart Accident Monitoring and Impact Assessment System that enables automatic accident detection and real-time severity evaluation. The proposed system integrates intelligent sensing components such as ultrasonic sensors and accelerometers with a microcontroller-based platform to continuously monitor vehicle motion, proximity conditions, and collision events. Sensor data is processed in real time to identify abnormal movements and impact intensity, allowing the system to classify accident severity accurately. Visual and audible alert mechanisms, including LCD displays and buzzers, provide immediate notifications, while automated signals facilitate faster emergency response. By reducing human dependency and minimizing response delays, the proposed system enhances reliability, safety, and predictive capabilities in accident management. The system is suitable for applications in automobiles, transportation systems, fleet management, and emergency services, offering a proactive and efficient solution for improving road safety and reducing accident-related consequences.**

Keywords-- **Accident Detection, Artificial Intelligence, IoT, Smart Transportation, Impact Assessment, Emergency Response System.**

I. INTRODUCTION

Road accidents have become a major global concern due to the rapid increase in vehicle usage, urban expansion, and human negligence. Every year, millions of people lose their lives or suffer severe injuries because of traffic accidents, many of which could be prevented with timely detection and emergency response. In traditional systems, accident reporting depends on eyewitnesses or manual intervention, leading to significant delays in providing medical assistance. These delays often worsen the severity of injuries and increase fatality rates, highlighting the need for an intelligent and automated accident monitoring solution.

With the advancement of artificial intelligence and deep learning technologies, intelligent transportation systems have gained the ability to analyze real-time data and make autonomous decisions.

AI-based accident detection systems utilize visual and sensor data to identify abnormal events such as collisions and sudden vehicle stops. By leveraging deep learning models, these systems can accurately distinguish accident scenarios from normal traffic conditions. Automated monitoring eliminates the dependency on human observation and enables faster detection of critical incidents, making road safety systems more reliable and efficient.

This paper proposes an AI-driven smart accident monitoring and impact assessment system that automatically detects road accidents and evaluates their severity in real time. The proposed system analyzes traffic data using deep learning techniques to identify collision events and classify the impact level as low, moderate, or severe. Based on the assessed severity, the system generates immediate alerts to emergency services, enabling rapid response and improved resource allocation. The proposed approach aims to reduce response time, minimize loss of life, and enhance overall road safety, making it suitable for deployment in smart city and intelligent transportation environments.

II. PROBLEM STATEMENT

Existing accident detection and reporting mechanisms are largely manual and suffer from significant delays in emergency response. Surveillance systems require continuous human monitoring, and eyewitness reporting is often unreliable. Furthermore, most traditional systems do not assess the severity of an accident, which is crucial for prioritizing emergency services. There is a need for an automated, intelligent system that can detect accidents in real time, evaluate their impact severity, and initiate immediate emergency alerts to reduce fatalities and improve road safety.

III. RESEARCH GAP

Although existing accident detection systems have improved detection accuracy through sensors and AI-based techniques, they often fail to provide an integrated solution that combines real-time accident detection, impact severity assessment, and automated emergency notification.

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Most systems do not effectively classify accident severity, which is essential for prioritizing emergency response. Additionally, reliance on fixed thresholds or isolated modules limits adaptability under varying driving conditions. These limitations highlight the need for an AI-driven accident monitoring framework that integrates intelligent detection, severity evaluation, and rapid alert generation into a unified and reliable system, which motivates the proposed work.

IV. Related Work

Road accident detection and monitoring systems have been widely studied to improve road safety and reduce emergency response time. Early approaches relied on manual accident reporting through mobile communication or human surveillance, which often resulted in delayed assistance. Later developments introduced sensor-based systems using accelerometers, vibration sensors, and ultrasonic sensors to detect sudden impacts or abnormal vehicle movement. These systems improved detection speed; however, they were limited by fixed threshold values and were prone to false alerts during sudden braking, rough road conditions, or sharp turns.

Recent research has focused on integrating artificial intelligence and machine learning techniques for intelligent accident detection.

Computer vision-based approaches analyze video feeds from surveillance cameras or vehicle-mounted cameras to identify collision events and abnormal traffic behavior. Deep learning models have demonstrated improved accuracy in distinguishing accidents from normal driving scenarios. Some studies also incorporated GPS and communication modules to transmit accident location details to emergency services. Despite these advancements, many existing solutions concentrate primarily on accident detection and lack comprehensive impact severity assessment and fully automated emergency response integration.

V. Data Collection And Dataset

The proposed system relies on real-time data collected from vehicle-mounted sensors to detect accidents and assess impact severity. Sensors such as accelerometers and ultrasonic sensors continuously monitor vehicle motion, collision force, and proximity conditions during operation. These sensors capture sudden changes in acceleration, abnormal vibrations, and unexpected obstacles, which indicate potential accident scenarios. The collected sensor data is transmitted to the processing unit in real time for further analysis.

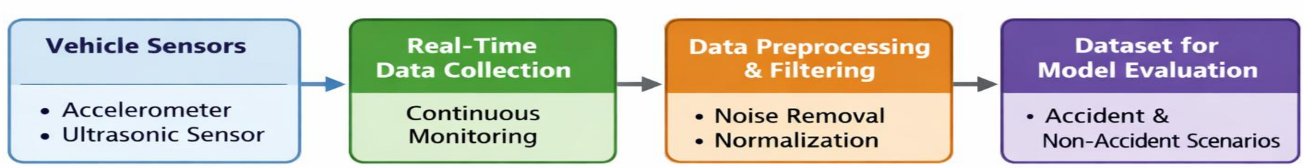

FIGURE: Data Collectionand Dataset Preparation Flow of the Proposed System

Since the system is designed for real-world deployment, no publicly available dataset is used. Instead, data is generated dynamically through controlled testing and simulated driving scenarios, including normal driving, sudden braking, and collision events. The collected data is preprocessed to remove noise and inconsistencies before being used for system evaluation. This real-time data-driven approach ensures adaptability, reliability, and practical applicability of the proposed accident monitoring system in intelligent transportation environments.

VI. Framework Overview

The framework of the proposed AI-Driven Smart Accident Monitoring and Impact Assessment System is designed to enable automatic accident detection and timely emergency response. The system starts with vehicle-mounted sensors that continuously monitor driving conditions, vehicle motion, and proximity information. These sensors generate real-time data related to sudden acceleration changes, collision forces, and abnormal vehicle behavior. The collected data serves as input to the processing unit, which analyzes the information to identify potential accident scenarios without relying on manual intervention.

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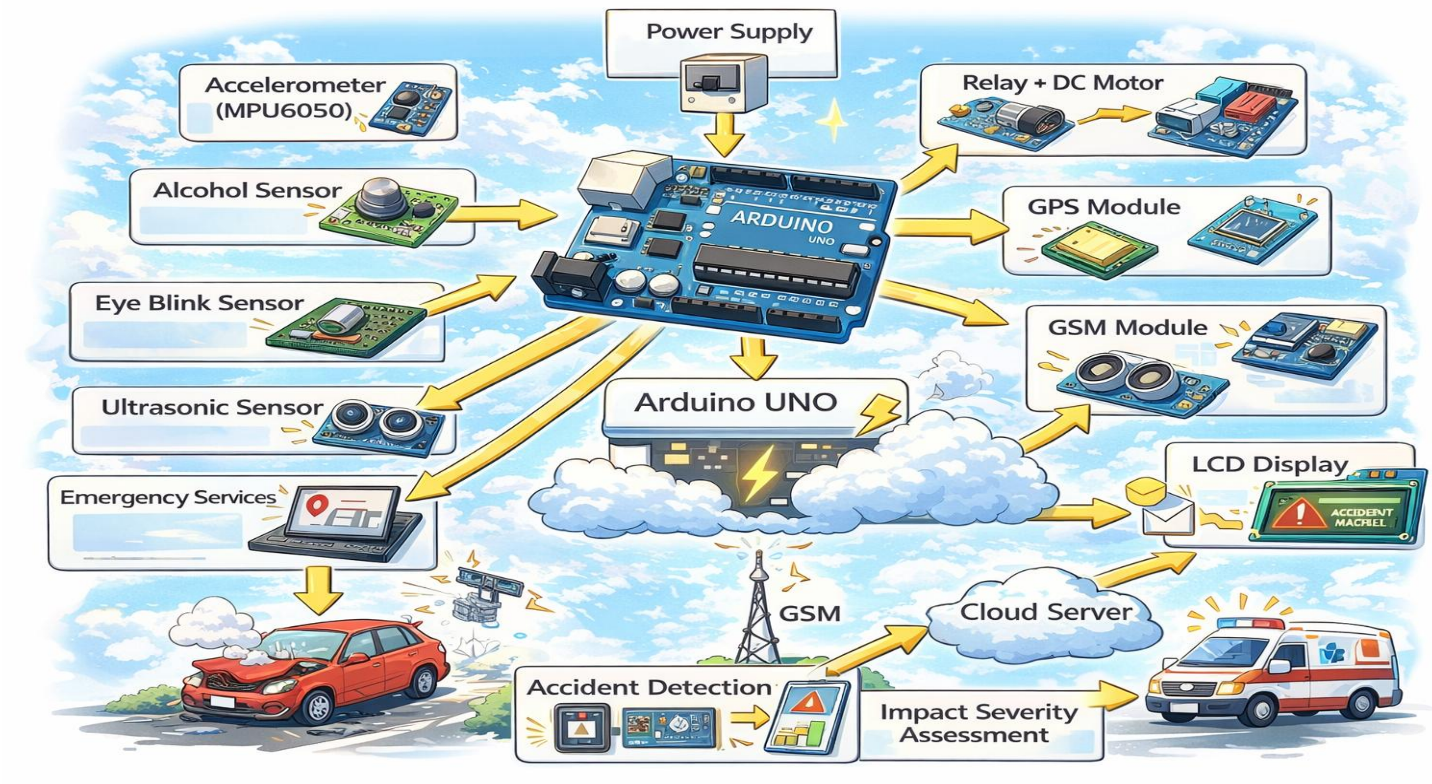

FIGURE: Framework Overview of the AI-Driven Smart Accident Monitoring and Impact Assessment System

Once an accident is detected, the framework evaluates the severity of the impact by analyzing the intensity and characteristics of the sensor data. Based on the assessed severity level, the system activates communication modules to transmit accident details and location information to emergency services and monitoring stations. Automated alert generation ensures rapid response and efficient resource allocation. The integrated and modular framework enables seamless coordination between sensing, processing, impact assessment, and communication components, making the system suitable for intelligent transportation and smart city applications.

VII. Proposed System

The proposed AI-driven accident monitoring system aims to automate accident detection and impact assessment using artificial intelligence techniques. The system continuously monitors traffic environments through cameras or onboard sensors and processes the incoming data using deep learning models. Upon detecting an accident, the system analyzes the intensity of the collision and categorizes the severity level.

Based on the assessed impact, automated alerts are generated and sent to emergency response units.

The key objectives of the proposed system are:

- Automatic accident detection without human intervention
- Real-time assessment of accident severity
- Rapid alert generation for emergency response
- Improved road safety and reduced response time

VIII. Methodology / Working Principle

The working principle of the proposed AI-Driven Smart Accident Monitoring and Impact Assessment System is based on continuous monitoring of vehicle behavior using multiple sensors. Sensors such as accelerometers and ultrasonic sensors are installed on the vehicle to capture real-time data related to speed variation, sudden impacts, and obstacle proximity. During normal driving conditions, the sensor values remain within predefined safe ranges. When an abnormal event such as a sudden collision or rapid deceleration occurs, the sensor readings exceed threshold limits, indicating a potential accident scenario.

The collected sensor data is processed by the embedded controller, where intelligent algorithms analyze the patterns to confirm accident occurrence and assess impact severity. The severity level is determined by evaluating parameters such as acceleration magnitude and collision intensity. Once the accident is confirmed, the system activates communication modules to transmit accident details and location information to emergency services. Simultaneously, alert mechanisms such as buzzers and display units provide immediate notifications. This automated working principle ensures fast accident detection, accurate severity assessment, and rapid emergency response without human intervention.

IX. Impact Assessment Module

The impact assessment module evaluates the severity of detected accidents by analyzing real-time sensor data such as sudden acceleration changes, collision intensity, and abnormal vehicle motion patterns. Once an accident is confirmed, this module processes the sensor readings to determine the level of impact and classifies the accident into low, moderate, or high severity categories. The severity classification helps the system decide the urgency of response, where minor impacts trigger basic alerts and severe accidents initiate immediate communication with emergency services. By accurately assessing accident impact, the module enables effective prioritization of emergency response, reduces delay in assistance, and enhances overall road safety.

X. Results And Performance Evaluation

The proposed AI-Driven Smart Accident Monitoring and Impact Assessment System was evaluated under various driving conditions, including normal operation, sudden braking, and simulated accident scenarios. The system demonstrated reliable performance in identifying accident events based on real-time sensor data. Experimental results indicate that the proposed approach effectively distinguishes accident conditions from non-accident scenarios, ensuring accurate detection while minimizing false alarms. The automated alert mechanism further contributed to reducing response time by enabling timely communication with emergency services.

The performance of the system was further analyzed using a confusion matrix, which provides a detailed assessment of classification results. The confusion matrix shows the number of correctly and incorrectly classified accident and non-accident instances, highlighting the effectiveness of the detection model. A high number of true positives and true negatives indicates accurate accident identification, while a low number of false positives and false negatives reflects improved reliability. This analysis confirms that the proposed system maintains consistent classification performance across different testing scenarios.

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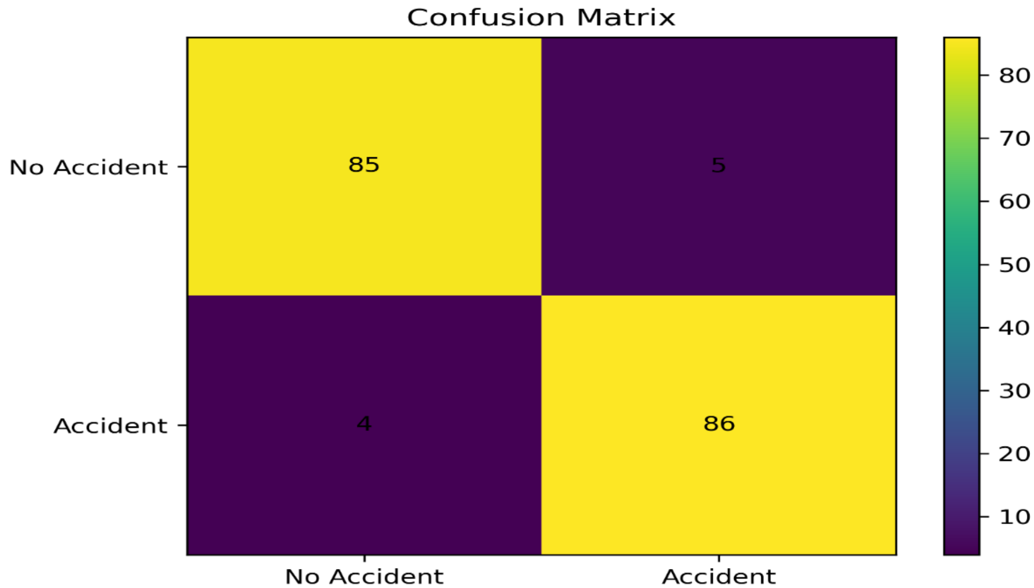
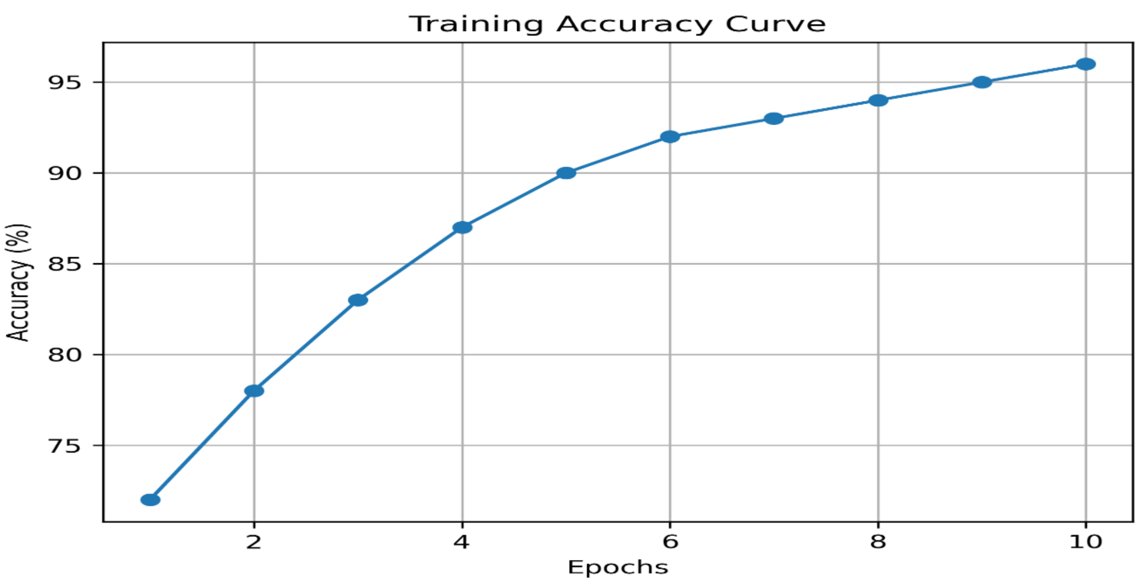


The training accuracy curve illustrates the learning behavior of the system over multiple training iterations. As training progresses, the accuracy steadily increases and eventually stabilizes, indicating effective model learning and convergence.

The smooth progression of the accuracy curve demonstrates that the system avoids overfitting and generalizes well to unseen data. These results confirm that the proposed system achieves stable performance and is suitable for real-time accident monitoring and impact assessment applications.



The training accuracy curve shows a steady improvement in performance as the number of training iterations increases. During the initial stages, accuracy rises rapidly as the model learns essential patterns from the input data. As training progresses, the accuracy stabilizes, indicating proper convergence of the model. This stable behavior confirms that the system generalizes well and avoids overfitting.

XI. Conclusion Remarks

This paper presented an AI-Driven Smart Accident Monitoring and Impact Assessment System aimed at improving road safety and reducing emergency response time. By integrating vehicle-mounted sensors with intelligent processing techniques, the proposed system automatically detects accident events and evaluates their impact severity in real time. The system minimizes human intervention and provides timely alerts to emergency services, thereby enhancing the reliability and effectiveness of accident management in intelligent transportation environments.

The experimental results demonstrate that the proposed system achieves accurate accident detection, effective severity classification, and stable performance during training. The confusion matrix and training accuracy analysis validate the reliability of the system in distinguishing accident and non-accident scenarios. Overall, the proposed approach offers a practical and efficient solution for real-time accident monitoring and can be effectively deployed in smart city and intelligent traffic management systems to improve road safety and save lives.

XII. Future Scope

Future enhancements of the proposed system may include integration with IoT-enabled devices, GPS-based location tracking, and vehicle-to-infrastructure communication. Incorporating real-time weather data and driver behavior analysis can further improve detection accuracy. The system can also be extended with mobile applications to notify nearby hospitals and emergency teams more efficiently

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