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ACCITRACK: Real-Time Accident Detection and Emergency Response System using YOLOv8

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***Abstract*—Delayed emergency response during the golden hour following road traffic accidents leads to significant loss of life. ACCITRACK is an AI-based real-time accident detection and response system that utilizes live video feeds and integrates the YOLOv8 deep learning model for automatic detection of road accidents and assessment of their severity. Upon detection, the system generates instantaneous alerts along with location details and forwards them to nearby hospitals and police stations through a Python-based communication mechanism. The system incorporates an ESP32 microcontroller integrated with a GPS module to obtain real-time location information. By enabling automated detection and rapid alert transmission, the proposed system minimizes response time and reduces reliance on manual reporting. Overall, the system enhances emergency response efficiency and contributes to improved road safety, making it suitable for smart traffic management and smart city applications.**

***Index Terms*—Accident Detection, YOLOv8, Computer Vision, ESP32, GPS, Emergency Alert System, Smart Cities**

I. INTRODUCTION

Road traffic accidents are a major global safety concern, causing millions of injuries and fatalities each year. A significant number of deaths occur due to delays in providing medical assistance during the critical “golden hour.” Traditional accident reporting methods rely on manual intervention, such as eyewitness reports or emergency calls, which may be delayed or unavailable, especially in remote areas. With advancements in Artificial Intelligence and Computer Vision, automated accident detection has emerged as an effective solution. Deep learning models, particularly the YOLO family, enable real-time detection of accidents from video streams with high accuracy.

The proposed system is an AI-based real-time accident detection and emergency response system that uses YOLOv8 to identify accidents from live or recorded video feeds. It classifies accidents into moderate and severe categories to prioritize emergency response, where moderate cases notify police, and severe cases alert both police and hospitals. The system integrates an ESP32 microcontroller with a GPS module to obtain real-time location data and uses a Python-based communication module to send alerts. A web dashboard is also included for monitoring and data visualization. By combining detection, location tracking, and automated alerts, the system reduces response time and enhances road safety.

II. LITERATURE SURVEY

Recent advancements in deep learning have enabled efficient accident detection using computer vision techniques [1], [2]. Traditional methods based on sensors and manual reporting were less reliable and time-consuming [3]. Modern approaches use YOLO-based models for real-time detection due to their high accuracy and speed [15].

Many systems also integrate GPS and communication technologies to provide location-based alerts to emergency services [4], [10]. Some studies further include severity classification to improve response prioritization [8].

However, existing systems often lack full integration of detection, classification, location tracking, and alert mechanisms [9], [13]. The proposed ACCITRACK system addresses these limitations by combining all these features into a unified framework for faster and more reliable emergency response.

III. PROBLEM STATEMENT

To develop a real-time AI-driven accident detection system using YOLO-based computer vision and GPS technology that can automatically detect road accidents,

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analyze their severity, and send immediate alerts to nearby authorities to enable rapid emergency response.

IV. OBJECTIVES

- To develop an AI-based accident detection system using YOLOv8 for real-time identification.
- To classify accidents into moderate and severe categories.
- To integrate GPS for accurate location tracking.
- To design an automated alert system for notifying hospitals and police.
- To develop a web dashboard for monitoring and visualization.

V. EXISTING SYSTEM

Traditional accident detection systems rely on manual reporting methods such as eyewitness communication or emergency calls, which often lead to delays in response time [3]. These approaches are not always reliable, especially in remote areas. Sensor-based systems using accelerometers and vibration sensors have also been developed [7]. Recent approaches utilize deep learning models such as YOLO for accident detection from video streams [12], [15]. However, most systems lack full integration and severity classification.

VI. PROPOSED SYSTEM

A. System Overview

The proposed system, ACCITRACK, is an AI-based real-time accident detection and emergency response system designed to reduce response time and improve road safety. The system processes live or recorded video input and uses the YOLOv8 deep learning model to detect accident occurrences.

Once an accident is detected, the system classifies it into moderate or severe categories. Based on the severity, alerts are generated accordingly. Moderate accidents trigger notifications to nearby police stations, while severe accidents send alerts to both police and hospitals for immediate action.

The system integrates an ESP32 microcontroller with a GPS module to obtain real-time location data. A Python-based communication module is used to transmit alerts through SMS or API services. Additionally, a web dashboard is provided for monitoring accident data and maintaining records.

B. System Architecture

The system consists of multiple modules where video input is processed using OpenCV and passed to the YOLOv8 model for accident detection. A classification module categorizes the accident, and location data is obtained using ESP32 with GPS. Alerts are then sent to the appropriate authorities, and a web dashboard is used for data visualization and storage.

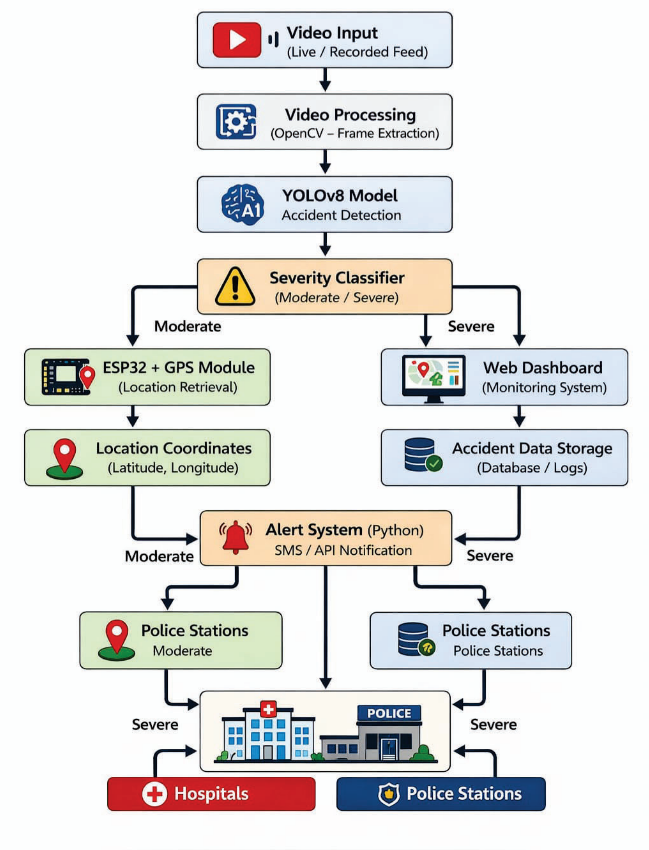

Fig. 1. System Architecture of ACCITRACK

VII. METHODOLOGY

A. Dataset Preparation

The dataset consists of accident and non-accident images collected from public sources, including the Roboflow dataset [17].. It includes different categories such as moderate and severe accidents. The dataset is prepared to train the model for accurate accident detection.

B. Data Preprocessing

Preprocessing techniques such as image resizing, normalization, and annotation using bounding boxes are applied to improve model performance. The dataset is also split into training and testing sets.

C. Model Development

he YOLOv8 model is used for accident detection due to its high accuracy and real-time processing capability. Transfer learning is applied using pre-trained weights,

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and the model is trained on the prepared dataset. Performance metrics such as precision, recall, and loss are monitored during training.

D. System Workflow

The system takes video input and processes it frame by frame. The trained YOLOv8 model detects accidents and classifies them into moderate and severe categories. Based on the classification, location tracking and alert generation processes are triggered.

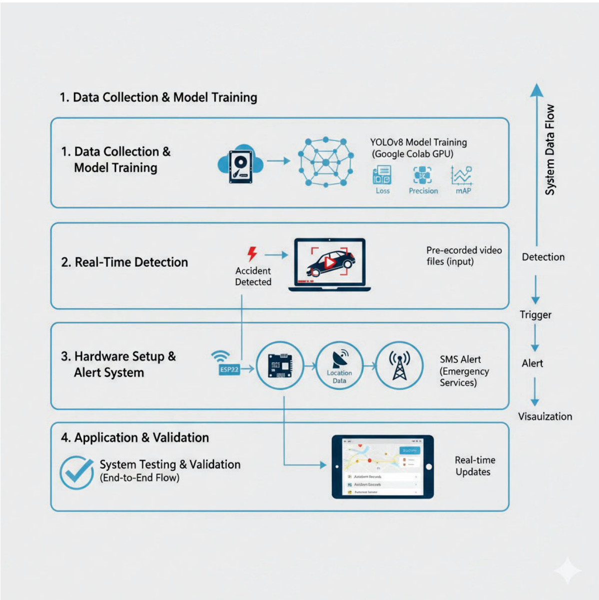

Fig. 1. System Workflow

E. Real-Time Accident Detection

The trained model processes video streams in real time to detect accident events. Once detected, the system classifies the accident based on severity to enable prioritized emergency response.

F. Alert Generation and Location Tracking

The system integrates an ESP32 microcontroller with a GPS module to obtain real-time location data. A Python-based communication module sends alerts based on severity. Moderate accidents notify police, while severe accidents notify both police and hospitals.

G. Web Dashboard

A web-based dashboard is separately implemented for both hospital and police to view accident details such as location, severity, and time. It also stores historical data for monitoring and analysis.

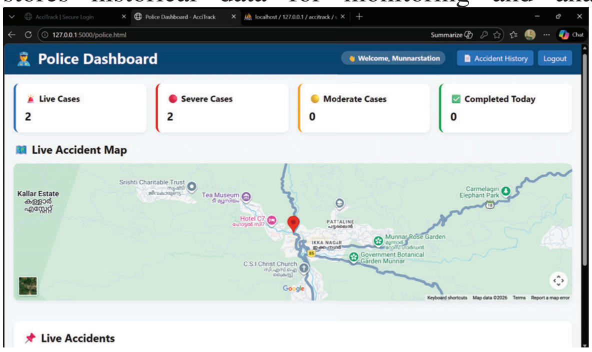

Fig. 2. Police Dashboard of ACCITRACK

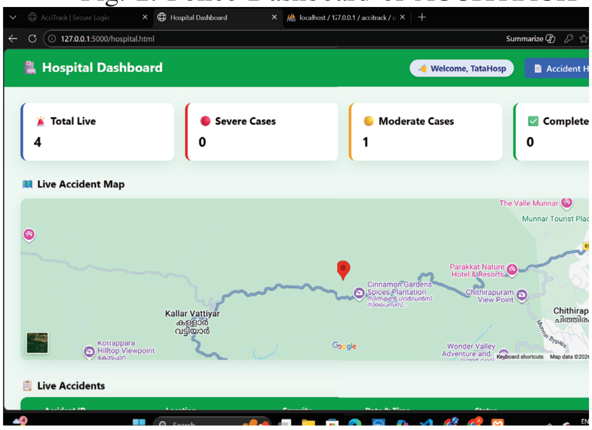

Fig. 3. Hospital Dashboard of ACCITRACK

VIII. RESULTS AND PERFORMANCE ANALYSIS

The proposed ACCITRACK system was evaluated using a dataset consisting of accident and non-accident images. The YOLOv8 model was trained and tested to assess its ability to detect accidents in real-time video streams. The performance of the model was evaluated using standard metrics such as accuracy, precision, recall, and F1-score. The system achieved high accuracy in detecting accident events and demonstrated reliable performance in differentiating between moderate and severe cases.

A. Performance Metrics

- Accuracy: 97%
- Precision: 98.5%
- Recall: 98.4%
- F1-Score: 98.4%

The results indicate that the model is effective in identifying accident scenarios with minimal false detections. The high precision ensures fewer false alarms, while good recall ensures most accident cases are detected.

B. Detection Performance

The system successfully detects accidents in real-time video streams with minimal delay. It accurately identifies

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accident regions and classifies them based on severity. The integration of YOLOv8 enables fast processing and high detection speed, making the system suitable for real-time applications.

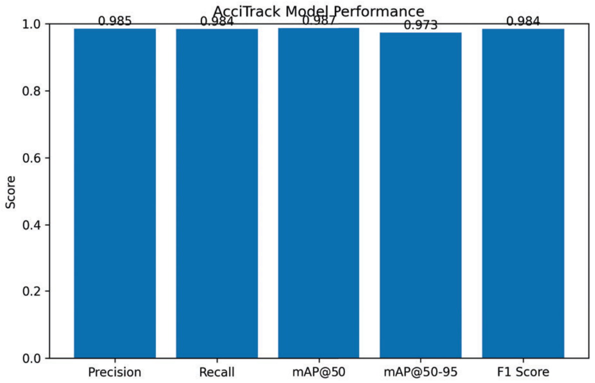

Fig. 2. Performance Metrics of the Proposed System

C. System Evaluation

The system was tested under different conditions, including varying lighting and traffic scenarios. The results show that the system performs consistently well, although slight variations may occur in complex environments.

The integration of GPS and alert mechanisms ensures that emergency notifications are sent promptly after detection. The web dashboard effectively displays accident data and supports monitoring and analysis.

Overall, the proposed system demonstrates efficient performance in real-time accident detection, classification, and alert generation, making it suitable for practical deployment.

IX. DISCUSSION

The system provides an effective approach for real-time accident detection using the YOLOv8 model. The system is capable of identifying accident scenarios from video streams with good accuracy and processing speed. The inclusion of severity classification into moderate and severe categories supports better prioritization in emergency response.

The integration of GPS-based location tracking and automated alert generation enhances the practical usability of the system. The web dashboard offers a convenient interface for monitoring accident data and maintaining records, contributing to improved situational awareness.Certain limitations are observed under challenging conditions such as low-light environments, poor video quality, and dense traffic scenarios, which may affect detection performance. The system also depends on stable network connectivity for real-time alert transmission and dashboard updates. Additionally, hardware integration may introduce constraints during real-world deployment.Overall, the system provides a reliable framework for accident detection and emergency response. With further improvements, it can be extended for large-scale deployment in intelligent transportation systems and smart city applications.

X. CONCLUSION

The ACCITRACK system presents an effective solution for real-time accident detection and emergency response using deep learning and IoT technologies. The integration of the YOLOv8 model enables accurate and fast detection of accident events from video streams. The classification of accidents into moderate and severe categories supports prioritized emergency response.The incorporation of an ESP32 microcontroller with a GPS module ensures accurate location tracking, while the alert system enables timely notification to police and hospitals. The web dashboard further enhances the system by providing real-time monitoring and data visualization.

The results demonstrate that the system achieves high accuracy and reliable performance in detecting accidents and generating alerts. By reducing response time and minimizing reliance on manual reporting, the system contributes to improved road safety and supports the development of intelligent transportation systems.

XI. FUTURE WORK

The proposed system can be further enhanced by integrating advanced deep learning models to improve detection accuracy under challenging conditions such as low light, weather disturbances, and dense traffic. The use of larger and more diverse datasets can also help in improving model generalization.

Future improvements may include full hardware implementation with ESP32, GPS, and GSM modules for independent operation without relying on external systems. Integration with cloud platforms can enable real-time data storage, analytics, and large-scale deployment.

Additionally, incorporating multi-sensor data such as IoT sensors, LiDAR, or radar can improve detection reliability. The system can also be extended to include automatic emergency call services and direct integration with smart city infrastructure for enhanced traffic management and faster emergency response.

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