Grenze International Journal of Engineering and Technology, June Issue

Intelligent Accident Detection System using Machine Learning

Mohammed Shafiulla[1], Uzma Khanam[2], Yaseen Mahek[3], Bhavana C[4] and Mehtaab Unnisa K[5]
[1-5]Ballari Institute of Technology & Management/Computer Science and Engineering, Ballari, India
Emails: mdshafi@bitm.edu.in, sadiuzma@gmail.com, yaseenmahek10@gmail.com, bhavanaaa246@gmail.com, mehtaabunnisak9@gmail.com

***Abstract*— Road accidents continue to be a major threat to public safety, with delayed reporting being one of the primary reasons for increased fatalities. This work introduces an AI-driven Accident Detection and Emergency Alert System that analyzes real-time traffic footage using a custom Convolutional Neural Network (CNN).**
The system automatically detects accident-like patterns from live camera feeds and immediately passes the alert to a Flask-based backend. The backend generates a structured report, stores details in MongoDB, and sends automated notifications to emergency responders. A Next.js dashboard displays live alerts, images, timestamps, and severity levels for administrative review.
The integrated approach ensures quick detection, rapid reporting, and reduced human involvement, contributing to more efficient emergency management.

***Index Terms*— Accident Detection, Convolutional Neural Network, Machine Learning, Deep Learning, Flask, Next.js.**

I. INTRODUCTION

The increasing number of road accidents across India and globally highlights an urgent need for automated and reliable monitoring systems. Traditional surveillance still depends heavily on manual observation, which often results in delayed responses. Recent statistics show that timely medical intervention could significantly reduce fatalities.
To address this gap, this work proposes a Convolutional Neural Network (CNN)-based accident detection system capable of identifying collision events directly from traffic surveillance feeds. The model scans each video frame, evaluates accident probabilities, and triggers alerts through a well-integrated backend and dashboard solution. This combination provides a real-time, end-to-end monitoring framework that enhances emergency response and operational efficiency.

A. Objectives

- To design an AI-based model that can automatically detect road accidents from live camera footage.
- To develop a backend mechanism that sends instant alerts and stores accident information.
- To provide a user-friendly dashboard for monitoring detection results.
- To reduce dependency on manual supervision for accident reporting

Grenze ID: 01.GIJET.12.2.297_21

II. Literature Review

Research on accident detection systems has improved a lot over time, especially with the use of machine learning and deep learning. In the beginning, most systems depended on sensors and basic machine learning techniques. For example, Murat Ozbayoglu et al. [1] created a model that could predict highway accidents using methods like Regression Trees and Neural Networks by analyzing traffic sensor data. Their work showed that it is possible to estimate the chances of accidents using real-time data. Similarly, Dr. C.K. Gomathy et al. [2] developed an accident alert system using devices like accelerometers, GPS, and GSM modules. While this system works well, it relies heavily on hardware, which can sometimes fail during accidents. Later, researchers started focusing more on camera-based and vision-based systems. Swachanda Roy et al. [3] used deep learning models such as ResNet50 and VGG16 to detect accidents from CCTV video footage. Their results showed that visual-based systems can be very accurate and can reduce false alarms. Subhash A. Nalawade et al. [4] also studied different accident detection methods and found that camera-based systems are more flexible and do not depend much on physical hardware. With further advancements, more powerful deep learning techniques were introduced. T. J. V. Sundari et al. [5] used CNN and RNN models together to not only detect accidents but also understand how serious they are by analyzing both images and time-based data. Tanusree Chatterjee et al.[6] improved sensor-based systems using machine learning, although these systems still face issues with hardware reliability. Supriya M. S. et al. [7] proposed a hybrid model that combines both machine learning and deep learning, and their results showed better performance when working with different types of data. [8] also worked on a system using LSTM and GBRT models with smartphone sensor data, showing that analyzing data over time can improve detection accuracy. Some researchers have also combined different approaches to get better results. S. Savitha et al.

III. Methodology

The system follows a structured pipeline beginning with frame extraction and preprocessing using Convolutional Neural Network (CNN) and YOLOv8 models. Each frame is evaluated to detect collision indicators such as sudden motion changes or visible vehicle damage. Once an accident is detected, the relevant details—including time, location, and snapshot—are forwarded to the Flask backend. The backend stores the information in MongoDB and generates an automated PDF report. Notifications are immediately delivered to designated authorities through email. The Next.js-based dashboard provides real-time visibility by displaying alerts, image evidence, and historical logs for admin users.

A. System Architecture

The architecture consists of three key layer:input, processing, and output. The input layer captures video streams from CCTV cameras. The processing layer uses a Convolutional Neural Network-based detection model integrated with the Flask backend, which evaluates accident probability and manages data storage. Finally, the output layer consists of a responsive dashboard
built with Next.js that displays alerts, locations, and severity levels. This architecture ensures scalability, efficient data flow, and quick system response.

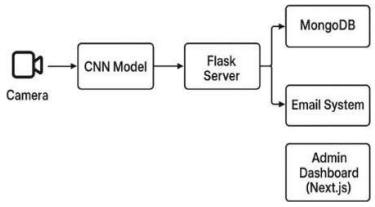

Fig. 1. System Architecture

The system architecture captures real-time camera input, processes it through a CNN model, and sends the results to a Flask server for further actions.

B. Flowchart Diagram

The system workflow begins with video input acquisition, followed by accident prediction through AI-based analysis. Detected events are uploaded to the backend, where severity is evaluated and stored. A sequence of automated tasks—PDF generation, email notification, and dashboard update—is then executed to complete the reporting cycle.

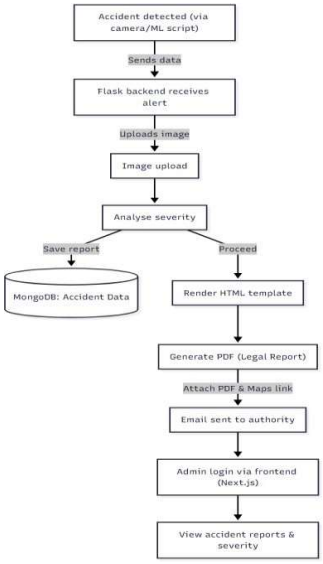

Fig. 2. Flowchart

The system detects accidents using an ML-enabled camera, uploads evidence to the Flask backend, analyzes severity, and stores the report in MongoDB.

IV. Result and Discussion

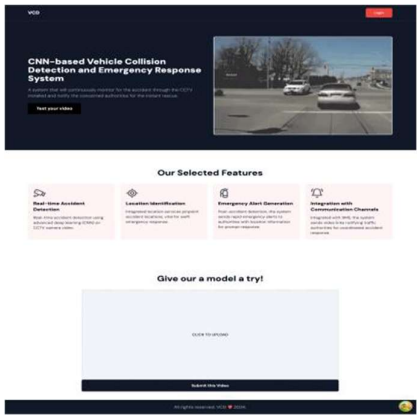

Fig. 3. Homepage of the Accident Detection System with integrated video upload feature for real-time accident detection

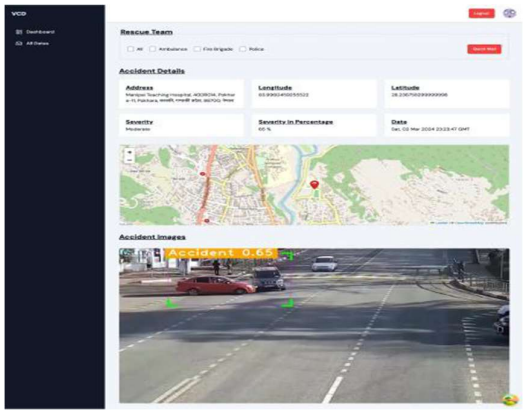

Fig. 4. Accident Detection details along with the Google Map location

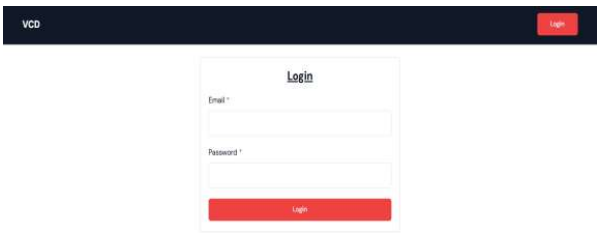

Fig. 5. User Login Page of the System

The system provides a secure admin login interface that authenticated access through email and password credentials.

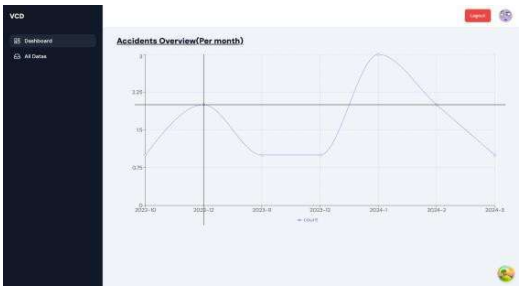

Fig. 6. Dashboard displaying system controls

The monthly accident data illustrates a clear pattern requires of volatility with a notable surge in incidents observed during the transition into early 2024, followed by a subsequent decline.

Fig. 7. Email Alert Notification for detected accident with Generated Legal Report in PDF format.

A. System and Software Requirements

The system was developed with a modern, cross-platform architecture, leveraging a Next.js/ React.js front-end for the user experience, powered by a Flask (Python) back-end, storing data in MongoDB, and utilizing Google Maps API for mapping functionalities.

B. Comparative Analysis

Our new accident detection system takes a smarter, camera-based approach, completely eliminating the need for expensive hardware inside every vehicle. It uses advanced Artificial Intelligence (AI) specifically a deep-learning model—to watch real-time traffic or surveillance camera feeds. When a crash happens, the system immediately recognizes it, and our web tools alert emergency services right away. This design makes the solution much faster, more reliable, and far easier to set up across a large city, offering a cost-effective upgrade to current systems.

C. Discussion

- Key Findings: We successfully built a system that uses AI (a Convolutional Neural Network model) to watch live camera feeds and automatically spot car accidents. This proves we don't need expensive sensors in every vehicle.
- Implications: Because it's hardware-free, the system is much cheaper and easier to use across a wide area (scalable). Most importantly, it ensures faster, more reliable detection and instant alerts to emergency teams.
- Limitations: The system relies on good video quality from existing cameras for the AI to work well. It also needs consistent network access to send real-time video data and alerts without delay.
- Recommendations: We suggest improving the AI model's performance in challenging visual conditions and focusing on ways to ensure alerts are reliably sent even if the network signal is temporarily weak.
- Impact: This project is a major step toward building a smarter, safer road infrastructure. By automating detection and reporting (via Flask/Next.js and email alerts), we can reduce human error and help save lives through quicker response times.

D. Qualitative and Quantitative Analysis

Intelligent Accident Detection System is a breakthrough for road safety. We use powerful AI and Computer Vision to instantly spot accidents happening on surveillance cameras, completely removing the need for costly, easily damaged hardware inside cars. This makes the technology fundamentally cheaper and easier to use across wide areas. When a crash is detected, our automated system quickly uses the Flask backend and Next.js dashboard to alert police and paramedics instantly, delivering all the necessary location and severity details. By integrating this smart image analysis with real-time alerting, we minimize human delay and guarantee a much faster emergency response when every second counts.

V. CONCLUSION

The proposed Intelligent Accident Detection System provides an efficient, automated method for identifying accident events directly from surveillance footage. Through deep learning, real-time alerts, and comprehensive reporting, the system significantly reduces manual effort and supports faster emergency response. Its modular design and software-only approach make it ideal for scalable smart city implementations.

ACKNOWLEDGMENT

We express our warm and profound sense of gratitude to all the eminent faculties who inspired, guided and supported us in accomplishing our project work.

We are deeply indebted to Mr. MOHAMMED SHAFIULLA, Department of CSE, our guide on this project & coordinator Mr. CHANDRASHEKAR V, on this project, for consistently providing us with the required guidance to help us in the timely and successful completion of this project. Despite his hectic schedules in the Department, he was always available to share his deep insights, wide knowledge, and extensive experience with us.

We are much obliged to our honorable Head of the Department Dr. R. N. Kulkarni for understanding the capability in us to complete the project successfully and, we are thankful to him for encouraging us and being a motivation and inspiration for us.

We extend our warm thanks to our Principal Dr. Yadavalli Basavaraj for giving us moral support and providing us all kinds of facilities.

We also thank all the faculty members of our department for being with us when needed. Last but not least we also thank our beloved friends who were there with us all the time, supporting, providing assistance, and giving us enough strength to successfully complete our project, proving the popular saying, “A Friend in need is a Friend indeed” to be true.

REFERENCES

[1] M. Ozbayoglu, G. Kucukayan, and E. Dogdu, “A real-time autonomous highway accident detection model,” in Proceedings of the IEEE International Conference on Big Data (Big Data), Boston, MA, USA, 2017, pp. 1987–1996.

[2] K. Gomathy, D. A. Saranya, V. Vidhya, and S. Pavithra, “Accident detection and alert system,” International Journal for Research in Applied Science and Engineering Technology (IJRASET), vol. 10, no. 5, pp. 1310–1315, 2022.

[3] S. Roy, S. Biswas, D. Das, and A. Pal, “Road accident detection using machine learning,” in Proceedings of the International Conference on Computer Communication and Informatics (ICCCI), Coimbatore, India, 2021.

[4] S. A. Nalawade, S. Kurhade, S. Khajuria, P. Landekar, and I. Barhate, “Real-time accident crash detection using machine learning: A survey,” SCRS Publications, 2021.

[5] T. J. V. Sundari, J. G. Aswathy, and S. Jayakamali, “Accident detection and severity analysis using deep learning,” in Proceedings of the International Conference on Intelligent Systems and Computer Vision (ISCV), Cairo, Eg ypt, 2023.

[6] S. Savitha and N. Sreedevi, “A study on accident detection systems using machine learning,” International Journal of Advanced Research in Computer and Communication Engineering, vol. 12, no. 4, pp. 45–50, Apr. 2023.

[7] Supriya M. S., Sahana P. Shankar, Himanshu Jain B. J., and Lisha L. N., “Car crash detection system using ML and DL algorithm,” in Proceedings of the International Conference on Electronics and Renewable Systems (ICEARS), Tuticorin, India, 2022.

[8] T. Chatterjee et al., “Deep learning model for detection and severity analysis of car accidents,” in Proceedings of the IEEE 11th International Conference on Computing for Sustainable Global Development (INDIACom), New Delhi, India, 2024.

[9] K. Usman, T. Hayath, M. Shafiulla and Dadapeer, "Robotics Process Automation Technologies for Data Collection and Analysis," 2024 15th International Conference on Computing Communication and Networking Technologies (ICCCNT), Kamand, India, 2024, pp. 1-7, doi: 10.1109/ICCCNT61001.2024.10725006.