



Accident Detection System Using Deep Learning And Edge Computing

Nithyashree N¹, Niveditha S², Pramithashree K M³, Jyothi K⁴, Dr.Suresha D⁵

1,2,3,&4 Students, Department of Computer Science and Engineering, Dr.Ambedkar Institute of technology,
Bengaluru, Karnataka, India

5 Associate Professor, Department of Computer Science and Engineering,
Dr.Ambedkar Institute of Technology, Bangalore, Karnataka, India

Abstract - In this research, we present an innovative Accident Detection and Alert System that combines Deep Learning (DL) and Edge Computing technologies. The system is designed to process live video feeds from surveillance cameras using DL models to detect traffic accidents in real-time. By leveraging edge computing, the system performs data processing near the data source, which significantly reduces latency and enables faster response times. Upon detecting an accident, the system autonomously alerts emergency services, thereby improving the efficiency of rescue operations. This seamless integration of DL and edge computing enhances the accuracy and speed of accident detection, which is vital for reducing the severity of injuries and saving lives on the road.

Key Words: Edge Computing, Deep learning, CCTV, Video processing, CNN

I. INTRODUCTION

Accurate and timely detection of traffic accidents is crucial for ensuring swift emergency response and minimizing the impact on victims. Traditional methods of accident detection often rely on manual reporting or centralized systems that can suffer from latency issues, delaying critical response times. This research introduces a novel Accident Detection and Alert System that utilizes the latest advancements in Deep Learning (DL) and Edge Computing to address these challenges.

The proposed system leverages DL models to continuously monitor and analyze live video streams from surveillance cameras, enabling real-time identification of traffic accidents. By deploying computational resources at the edge—closer to where the data is generated—the system minimizes latency, allowing for instantaneous processing and decision-making. This approach not only speeds up the detection process but also enhances the overall reliability of the system.

Upon identifying an accident, the system autonomously triggers alerts to emergency services, ensuring a rapid and coordinated response. This integration of DL and edge computing not only improves the precision and speed of accident detection but also plays a vital role in reducing the severity of injuries and potentially saving lives on the road. The combination of these technologies offers a transformative solution to the long-standing issue of delayed accident response, paving the way for safer and more efficient roadways.

II. Literature Survey

[1] Robinin M.S,Sukanya Mulakalapally, Maha Lakshmi " Car Accident Detection and Notification System Using Smartphone".Portability can provide accident detection and notification on phones using filters to prevent false positives. It is compatible with all types of

vehicles, including bicycles and motorbikes. It may not be possible to detect all accidents with smartphones due to the filters used to prevent false alarms: there may be instances of minor collisions that the application does not register.

[2] Heting Liu and Guohong Cao, Fellow, "IEEE Deep Learning Video Analytics Through Online Learning Based Edge-Computing" Predicting trajectories of traffic per clipart in traffic as well as their future local on. Use of a Convolutional LSTM Auto-Encoder. This method is unable to detect an accident if participants gets totally suspended.

[3] Ghosh, s., sunny, soju. And Roney "efficient vehicle accident detection system using CNN" It uses advanced Deep Learning Algorithms CNN in order to analyze the frames taken from the video provided. Deep cans usually suffer vanishing gradients.

[4] Tianxiang Tan and Gushing Cao "Deep Learning Video Analysis Through Edge Processing and NPU in Mobile" Use of open sourced a version of TensorFlow, and wide range of Google products and services. Node scheduling and placement algorithm were not sufficient enough to decide where to execute different node and when to execute.

[5] Sergio Robles-Serrano, German SanchezTorres "Automatic Detect on of TrafficAccidents from Video Using Deep-Learning Techniques"-2021 Use of GSM module and GPS for local on tracking. Lack of communica on mode with medical on department to provide hospitality to victims at accidental spot.

[6] Victor Adewopo, Nelly Elsayed "Smart City Transport on: Deep Learning Ensemble Approach for Traffic Accident Detec on"2023 The detection on method of car accidents is based on CCTVIS. Real- me performance is low.

[7] Loganathan, M.E, G. Ajay Kumar, S.T. Chandru, Hari Rajan "vehicle accidents detection and notification system using lorawan" Information about a accidents is transmitted via a GSM modem, eliminating the need for an internet connection to notify the rescue team. This system feature is particularly advantageous in areas lacking 3G or WiFi coverage. IR sensors detect

objects based on the reflection principle. However, a fundamental flaw of IR sensors is their decreased effectiveness with darker colored vehicles. This is due to the absorption of IR rays by darker colors.

[8] Mari kirthima, rishabh verma, chinmayi rajashekar hegde, arundhati s shanbhag "intelligent accident prevention in vanets " In this system, a vehicular ad-hoc network (VANET) is utilized to transmit accident alerts to rescue services. VANET also assists these services in determining the most efficient route to the accident site through the use of the Abeona algorithm and a traffic signal module. This functionality can significantly reduce the response time for an ambulance to reach the accident location. Vane may encounter efficiency challenges in various road scenarios such as intersections, underpasses, or tunnels. Additionally, its performance might be affected by diverse environmental conditions, including inclement weather such as rain.

[9] Mohd Akram Khan, Nirbhay Pandey, Prof. Ajay Kumar Srivastava, Er. Shadab Ali" accident detection and alert system using android application" After detecting an accident, the system initiates a countdown for up to 10 seconds, during which you have the option to cancel it. Subsequently, it initiates a CALL to the emergency department. This remarkable feature serves to prevent the system from generating false alarms, ensuring its utmost reliability and accuracy. Different iterations of mobile phone models exhibit varying degrees of sensitivity, thereby influencing the efficacy of this system across the board. In addition to such sensitivity disparities, the processors embedded in these diverse models are endowed with distinct processing speeds and response times, thereby potentially impeding the timely and accurate detection of accidents.

[10] H. C. Impana, M. Hamsaveni, H. Chethana "A Review on Smart Helmet for Accident Detection using IOT Uses Sensors that are interfaced with PIC through the wires. Sensors such as gas sensor, load sensor, vibration sensor, IR sensor and mems sensors are used. Ensure good fallen detection of the workers in working place. Exactness and accuracy is high.

III. System Design

A) System Architecture

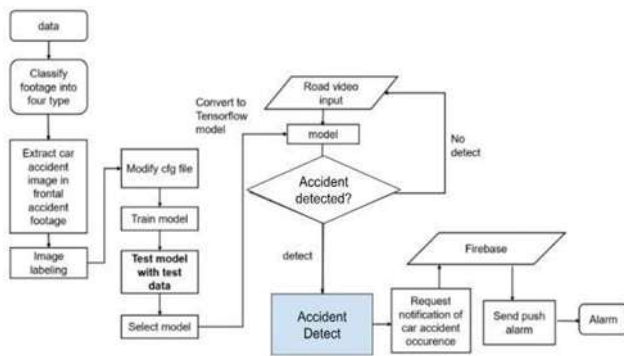


Fig-1: System Architecture

The Accident Detection and Alert System combines deep learning algorithms with edge computing technology to swiftly detect and respond to accidents on roads. Deep learning models, trained on large datasets, analyze sensor data in real-time for signs of accidents, such as sudden movements or collisions. Edge computing devices installed on roadside infrastructure process this data locally, reducing response time and dependency on external networks. When an accident is detected, alerts are promptly generated and sent to relevant stakeholders, facilitating rapid assistance. Continuous learning ensures the system's adaptability to evolving scenarios, making it a proactive tool for enhancing road safety.

B) Module Design

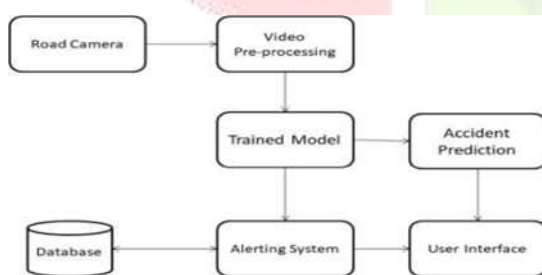


Fig -2: Module Design

The module design for the Accident Detection and Alert System incorporates various components, including data acquisition, pre-processing, deep learning models, edge computing, alert generation, communication, continuous learning, user interface, logging and reporting, security, and integration and deployment. Each module plays a specific role in the system's functionality, from gathering sensor data to notifying stakeholders of accidents. This modular approach

enhances system reliability, scalability, and adaptability and scalability

Data Acquisition Module: Responsible for gathering data from various sensors such as cameras, accelerometers, gyroscopes, and GPS modules. Interfaces with the edge computing devices to receive real-time data streams from vehicles or roadside infrastructure.

Pre-processing Module: Handles data cleaning, normalization, and formatting to prepare it for analysis. Filters out noise and irrelevant information to improve the accuracy of accident detection.

Deep Learning Model Module: Contains trained deep learning models (e.g., CNNs, RNNs) for accident detection. Executes inference on incoming data streams to identify patterns indicative of accidents.

Edge Computing Module: Manages the deployment and execution of deep learning models on edge computing devices. Optimizes resource utilization and processing efficiency to ensure real-time analysis.

Alert Generation Module: Generates alerts and notifications upon detecting accidents or hazardous situations. Communicates with emergency services, nearby vehicles, and authorities to facilitate swift response.

Communication Module: Handles communication protocols and interfaces for transmitting alerts to relevant stakeholders. Supports various communication channels such as SMS, email, and dedicated communication networks.

Continuous Learning Module: Incorporates mechanisms for continuous learning and model adaptation. Updates deep learning models based on new data and feedback to improve accuracy and robustness.

User Interface Module: Provides a user-friendly interface for system configuration, monitoring, and management. Displays real-time alerts, status updates, and diagnostic information for stakeholders.

Logging and Reporting Module: Logs system events, alerts, and performance metrics for monitoring and analysis. Generates reports and analytics to evaluate system effectiveness and identify areas for improvement.

Security Module: Implements security measures to protect data integrity, confidentiality, and privacy. Enforces access controls, encryption, and authentication mechanisms to prevent unauthorized access or tampering.

IV. ADVANTAGES

1. Reduced Latency: Faster accident detection and alert response.
2. Real-Time Processing: Accurate live video analysis using DL.
3. Autonomous Alerts: Immediate notification to emergency services.
4. Bandwidth Efficiency: Minimal data transmission by local processing.

V. DISADVANTAGES

1. High Costs: Significant investment in edge hardware.
2. Maintenance Complexity: Challenging management of multiple devices.
3. Security Risks: Increased vulnerability to cyber threats.
4. Privacy Issues: Potential surveillance and data privacy concerns.

VI. APPLICATIONS

1. Traffic Management: Real-time monitoring and accident detection on roads.
2. Public Safety: Enhanced emergency response in public areas.
3. Smart Cities: Integrated with urban infrastructure for efficient city management.
4. Workplace Safety: Monitoring and alerting in industrial and construction sites.

VII. Result



Fig 1:FrontEnd for capturing an image and classify

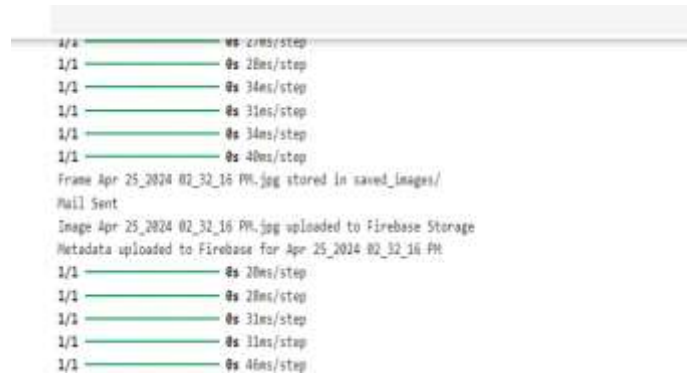


Fig 2: captured frame sending to Gmail and Firebase



Fig 3.Data will be stored on to the firebase Realtime- Database

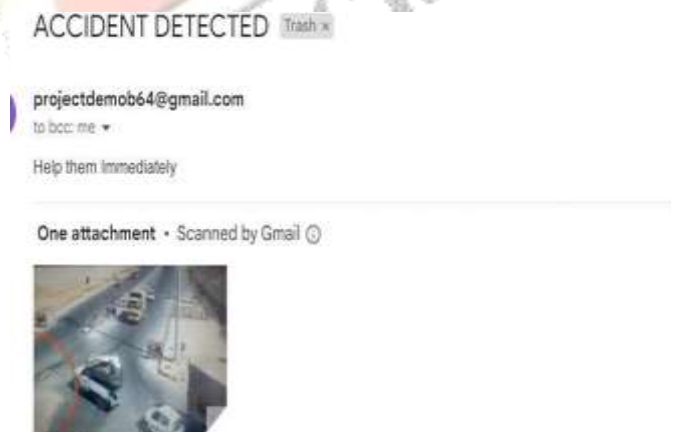
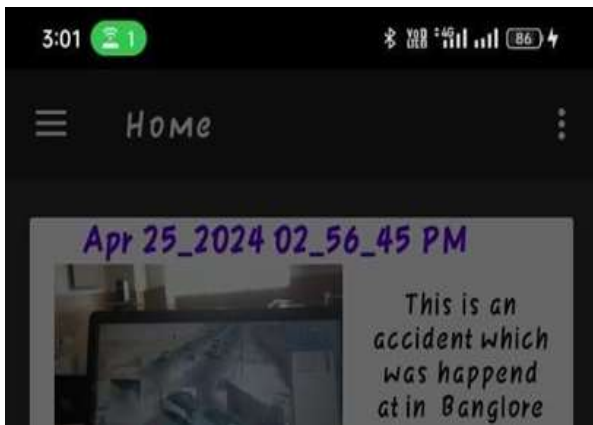


Fig4:Gmail sent to the Authorized Users (Police,Ambulance and Hospital)



CASE DETAILS



Fig 5: Alert notification will be sent to the Android App

VIII. CONCLUSIONS AND FUTURE ENHANCEMENT

The integration of deep-learning & edge computing in accident detection systems represents a paradigm shift in enhancing road safety. This synergy enables real-time, accurate detection with reduced latency, improving responsiveness to potential incidents. The scalability, cost-efficiency, and adaptability of this approach make it versatile for diverse environments. Customizable alerting mechanisms prioritize user preferences, while the integration with IoT devices enriches overall system intelligence. Emphasizing data security and privacy, this holistic solution holds great promise in advancing safety measures on roads and aligning with the evolving landscape of autonomous vehicles.

The efficiency and performance of neural networks. It includes techniques such as adjusting hyper parameters, employing advanced optimization algorithms like Adam or Respro, and utilizing regularization methods. Through these approaches, and Techniques of deep learning models are fine-tuned to achieving better accuracy, faster convergence, and improved generalization on diverse datasets, contributing to the overall effectiveness of machine learning applications.

An accidents detection using deep-learning and edge computing offers a transformative approach to real-time safety. By seamlessly combining advanced video analysis with local processing on edge devices, the system achieves swift, accurate detection, and reduced latency. Its scalability, cost-efficiency, and adaptability make it applicable across diverse environments, with customizable alerting mechanisms ensuring user-centric responses. The integration with IoT devices enhances overall system intelligence, while prioritizing data security and privacy. This comprehensive proposition carries substantial promise in enhancing road safety and bolstering the growth of autonomous vehicles.

REFERENCES

- [1] Victor Daewoo, Nelly Essayed "Smart City Transportation: Deep Learning Ensemble Approach for Traffic Accident Detection"2023
- [2] Sergio Robles-Serrano "Automatic Detection of Traffic Accidents Video Using Deep Learning Techniques"- 2021
- [3] Lee, K.B. and Shin, H.S, August. An application of a deep learning algorithm for automatic detection of unexpected
- [4] accidents under bad CCTV monitoring conditions in tunnel
- [5] Hadid Ghahremannezhad, Hang Shi, Chongjin Liu "Real-Time Accident Detection in Traffic Surveillance Using Deep Learning"-2022
- [6] Nelly Essayed "Smart City Transportation:Deep Learning Ensemble Approach for Traffic Accident Detection"2023
- [7] Sergio Robles-Serrano "Automatic Detection of Traffic Accidents from Video Using DeepLearning Techniques"- 2021
- [8] Hadid Ghahremannezhad, Hang Shi, Chongjin Liu "Real-Time Accident Detection in Traffic Surveillance Using Deep Learning"-2022.
- [9] Raja Babe, Ranjith B. "Accident Detection through CCTV Surveillance"-2022
- [10] Mohr Aram Khan, Nir hay Pandey, Prof. Ajay Kumar Srivastava, Err. Shadab Ali" accident detection and alert system using android application"-2023
- [11] Tainting Tan and Gushing Cao, "Deep Learning Video Analytics Through Edge Processing and NPU in Mobile" 2020
- [12] Hating Liu and Gushing Cao, Fellow, "IEEE Deep Learning Video Analytics Through Online Learning Based Edge Computing"-2022
- [13] Tiago Matanuska, Matheus Gomes Cordia, "Deep Learning applied to Road Accident Detection with Transfer Learning and Synthetic Images"-2022
- [14] H. C. Impana, M. Hamsaveni, H. Chethana "A Review on Smart Helmet for Accident Detection using IOT
- [15] A. Mari Kirthima, Rishabh Verma, Chinmayi Rajashekar Hegde, Arundhati S Shanbhag "Intelligent AccidentPrevention in VANETs"-2020.