ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26apr1955

Leveraging AI in Public Surveillance System

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Publication Date: 2026/05/07

Abstract: Road accidents have become very common these days because of rapid urbanization. In big cities where traffic is dense and bad driving is common, road accidents happen very frequently. People are dying even before receiving any medical help, just because their accident is not visible to the naked eye or not notified in time. In this paper, we discuss a real-time accident detection and alert system for automatically detecting accidents with the help of YOLOv8 and OpenCV. The system monitors the roads with the help of CCTV cameras. The system detects the accident in real-time by automatically processing the live videos. As soon as an accident happens the system takes the image and locates the camera position and notifies to concerned authorities through email by attaching the image and location of the accident. This system will help emergency staff to reach the location faster, and also make the city smart and safe.

How to Cite: Sanjay A. V.; Girichandran A. R.; Dr. G. Valarmathy; Desinhraja D. (2026) Leveraging AI in Public Surveillance System. *International Journal of Innovative Science and Research Technology*, 11(4), 3483-3487. https://doi.org/10.38124/ijisrt/26apr1955

I. INTRODUCTION

Road safety has become a serially concern around the world. Road accidents are one of the major cause of the injuries and deaths each year. According to global reports millions of people are killed or badly injured in road crashes especially in developing countries where rapid urban growth and increasing traffic have outdated safety system. Traditional methods like manual monitoring or delayed emergency calls are no longer effective for handling modern traffic conditions. There is a grow to need for smart system that can detect accidents quickly and alert authority without delay. Artificial Intelligence has made this possible through real-time video analysis. Computer vision models like YOLOv8, combined with OpenCV, can analyze live CCTV footage to automatically detect accident such as vehicle collision. This project titled is Leveraging AI in Public Surveillance System, using AI algorithms to detect road accidents in real time. This system processes live video feeds through a server identify accidents, determines the camera location and immediately sends an email alert to concerned authority with screenshots and location details. This ensures fast response and improved safe. This system also learn and improve its accuracy over time reducing false alarms with each operation. Because it is flexible and easy to implement it can be used in both small towns and large cities. Overall, this project presents a practical AI-based solution that overcomes the limit of traditional road safety methods by providing quick accident detection and alerting contributing to safe and smart urban environments.

II. LITERATURE REVIEW

- Several research works have explored different ap-proaches to accident detection and traffic safety improvement. One study presented a vision-based accident detection system that used deep learning on surveillance videos. The authors applied a Neural Network to analyze real time traffic footage and detect vehicle collisions. This system showed high accu-racy in recognizing accidents but lacked an alerting feature, which limited its functions in real world use.
- Another research work proposed an IoT based accident monitoring system, where the sensors were installed inside the vehicle, and the data was captured for acceleration and breaking. The abnormal activities were then alerted on to the cloud server. Although it could help in identifying the accidents, the problem in this system is that it can't be implemented on existing vehicles without any sensors.
- Third Paper was an accident prevention model using YOLO based object detection with CCTV networks. This was an application system to detect the unsafe driving with speed up or lane violations and predict the possible future accidents. Although the model was well-performed in test environments, it required the reinforcement learning to minimize false alarms with real traffic.
- Another research merged records from traffic police with hospital data to pinpoint areas in cities with high traffic accidents. Through The data mining authors located high risk intersection and road, enabling urban plan to act proactively. The system lacked real time monitoring and thus couldn't react to accidents in the moment.
- A separate study developed an emergency response system using IoT devices and GPS tracking. They accident was

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detected the system automatically sent the notification to the nearest hospital and police station. The method was strong in terms of location accuracy but it faced network delay issues in rural areas which could slow down emergency response.

- One interesting paper examined a smart traffic system that utilizes ai to manage signal lights autonomously the concept was fairly simple help emergency vehicles such as ambulances and police cruisers navigate through heavy traffic more efficiently by using programmed code to trigger short bursts of green lights they essentially created a digital fast lane while this approach performed exceptionally well in digital simulations implementing it on actual city streets is a much heavier lift it requires significant technical infrastructure and seamless coordination with existing traffic hardware there are no shortcuts here just a need for careful planning and inter agency teamwork.
- Another research also used reinforcement learning to turn to traffic monitoring. By training this ability of system on each new data it is able to improve its accident detection ability with lower false alarms. Such system has an outstanding adaptiveness in unfortunate condition like write purpose or darkness which is a clear improvement over not to adapt traditional models despite having limitations.

III. SYSTEM ARCHITECTURE

Input Sources and Data Collection

Input sources and data collection the first step in this accident detection setup is gathering visual data from various locations within the traffic network actually, cctv cameras positioned at major highways and busy intersections provide the majority of the input these cameras continuously capture live footage and transmit it directly to the processing server they typically operate via rtsp or onvif which facilitates uninterrupted video streaming the system attempts to capture accidents as they occur using this live feed additionally it can use information from local hospitals to locate the closest assistance more quickly and request details from police record.

Data Ingestion and Messaging

At point this system receive all of the video streams and records each one as it arrive.it ensures that each live feed is correct received and promptly sent for analysis. The CCTV streams can be read and decoded by a program like FFmpeg allow the system to process them in real time. The system uses middleware such as the MQTT or Kafka to facilitate communication between its various components and maintain seamless data flow. In order to address timing problem when the network slow down the setup also incorporates sync and buffer features. All of these procedures ensure that the video continue to run smoothly and is prepared for the following stage of analysis.

Processing Layer

The main intelligence of the system lies in its ability to process live video streams and detect unusual or dangerous accident. The incoming frames are first preprocessed using OpenCV techniques, which help remove noise, resize the frames, and focus only on the relevant areas of the video.

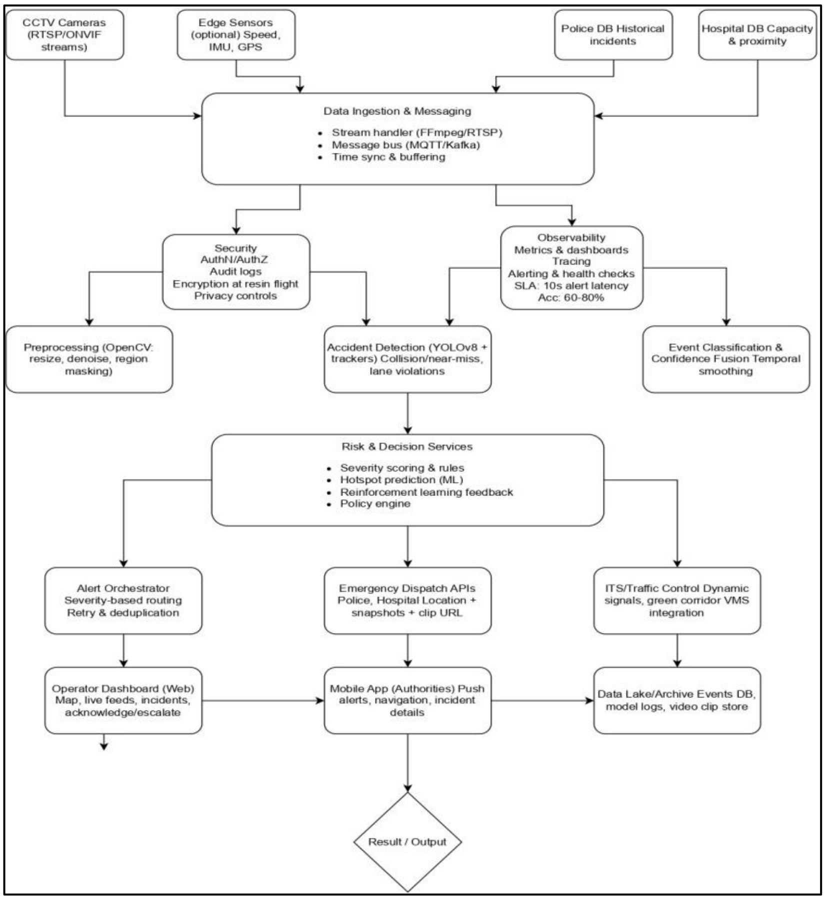

Fig 1 System Architecture

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After preprocessing, this system uses the YOLOv8 model combined with object tracking to detect accidents such as vehicle accident. Once an event is detected, temporal smoothing and confidence fusion methods are applied to confirm the detection and reduce false alarms. This ensures that only genuine accident events are passed on for further evaluation.

- *Risk and Decision Services*

In this system analyze the detected accident and decide how serious each case . It assigns a severity score to classify incident as minor, moderate, or severe based on their characteristics. This system also study past accident data to identify high risk area where crashes happen more often. By learning from prior detection and lowering false alert reinforcement learning techniques gradually assist the system in become more accurate. To ensure prompt and well coordinated emergency response an integrated policy engine control how alerts are sent and which authority should be notified first.

- *Alerting and Actuation*

After an accident is confirmed the system automatically send the alerts to the concerned authority. An alert manager manages how these alerts are sent avoids duplicates and ensures that messages are delivered even if there are network issues. This system uses emergency dispatch APIs to communicate directly with hospitals, police stations, and ambulance services sharing important details such as GPS location and video evidence of the accident. In advanced setups the system can also connect with traffic control unit to adjust signals and to provide support by allowing emergency vehicles to reach the site faster.

- *User Interfaces and Storage*

The system provides simple and effective tools for monitoring and decision making a web based dashboard allows operators to view live cctv feeds accident locations on a map and current alerts in real time for field officers it sent from control stations instant notifications navigation help and accident details to support quick response via sms to controller station all data including videos logs and event records is stored in a centralized database or data lake this archive helps in reviewing past incidents retraining the model and maintaining system performance over time.

- *Cross-Cutting Modules*

These modules act as the core infrastructure two vital components that are constantly running and watching the environment monitoring system health the first of which is the security module that deals with the fundamental operations such as encryption and user log in data access control the emphasis of this module is to protect sensitive data and ensure it is available to be reached securely an observability module which focuses on system performance follows where performing daily system health checks to determine it function.

IV. OPERATIONAL WORKFLOW

This accident detected system work through a series the simple and well organized stage. It begin in collecting of the live video from CCTV camera and process them using intelligent algorithm. The system then continuously monitoring a traffic movement to identify unusual the pattern or collision. Once an accident is detected it quickly verify the event and send instant alert notification to the concerned authorities for faster emergency response.

- *Data Input and Preprocessing*

The workflow begins by capturing live video feeds from CCTV cameras positioned at critical highway junctions and intersections. To ensure the data is usable the video goes through some basic cleaning adjustement using OpenCV and image analysis small noise is cleared, brightness is adjusted and the frame sizes are made the same. This makes the footage easier for the model to read and analyze how to improves how accurately it works later on.

- *Accident Detection*

After cleaning, the video frames are sent to the YOLOv8 model for real-time detection. This model checks for things like vehicles, people, or sudden movement that could mean or cause an accident has happened. If it spots anything unusual, it marks those frames and passes them along for checking again before sending any alert.

- *Event Classification*

Once something is detected, the system looks at how serious it is. A scoring method checks the way objects move and how the impact happens from frame to frame. The model also combines results from multiple detections to cut down false alarms and only confirm real accidents.

- *Alert Generation*

After the system confirms that an accident really happened, it automatically creates an alert message with all the needed details that is important like the location, time, and how serious the event is. It also adds a few video snapshots as proof so that responders can see what actually occurred. These alerts are shared right away through safe communication channels that is controlled by PCR (POLICE CONTROL ROOM), making sure that emergency teams get the correct information without any delay , waiting or manual steps.

- *Emergency Dispatch Algorithm*

Once an alert is ready, the dispatch algorithm sends it to the proper emergency response teams based on where and how severe the accident is. The system gives more importance to serious cases first and arranges the messages in a way that saves time. It can even simulate the best traffic routes for ambulances or police vehicles to reach the site faster and efficient . This setup helps in smoother coordination between different departments during emergencies.

- *Data Archival and Feedback Learning*

All the accident information that passes through the system is saved in a well organized database. This data is later used to study which areas face more accidents and to improve the prediction accuracy of the model. A feedback feature keeps updating the learning model using these past cases, making it better at spotting real accidents and reducing mistakes over time. This constant loop of learning helps the system adjust itself as road and traffic conditions change.

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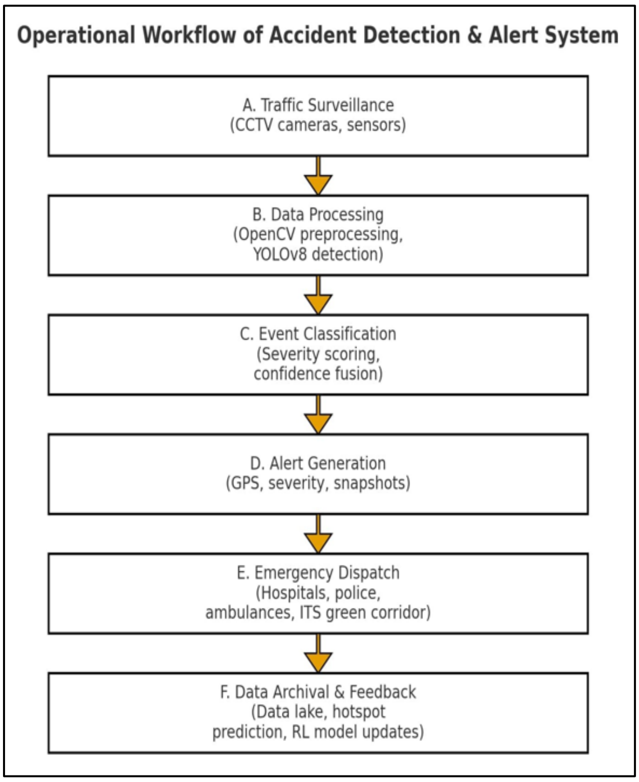

Fig 2 Operational Workflow

V. COMMUNICATION MODEL

The communication models explains how date is transferred between different parts of the models within the accident detection system. It also ensures that data is communicated quickly, safely, efficiently and accurately between the detection unit, alert services and cloud systems. With this setup the system can continuously monitor and analyze the frame in feed deliver alert in real time to all connected platforms.

➢ *Data Transfer to Processing Server*

Raw video and sensor data are first sent from the input mod-ules to the main processing server through secure encrypted channels each data packet gets a timestamp accuracy comes next a quick check before the Yolov8 model touches it this setup all about reliability low delay minimal friction no data lost along the way simple direct steady flow to the server.

➢ *Processed Output Transmission Data Processed.*

Results organized you get detected events incident types and their severity all structured and sent to the monitoring interface real time streaming keeps it moving fast lightweight data formats keep it lean every output arrives with metadata and visual proof other system parts can react or show results right away.

➢ *Cloud Based Alert Distribution Event Confirmed*

The system is alert module acts it sends out notifications using cloud based apis these api quickly share alerts with all connected apps and services at the same time each alert mes-sages includes the location time and severity of the accident. The use of cloud routing helps in keeping the communication stable and active even if one network path fails.

➢ *Unified System Synchronization*

All the linked dashboards, databases and monitoring tools stay updated through real-time connections. Using RESTful APIs and WebSocket links the system ensures that every module displays the same information at all times. This synchronization lets authorized users view live alerts, confirm actions and review previous events in one place that may help in improving the coordination and speeding up decision making process.

VI. RESULTS

The accident detection and alert system work well during real time situations give fast and accurate output result. The YOLOv8 model used for detection reached about ninety percentage accuracy being able to identify accidents within 30 seconds of when they happen. By combining the live video data with recorded feed inputs the system reduces false alarms and improves its overall reliability. Once an accident is confirmed based on analyzed video feeds the system modules responds by automatically sending an alerts with attached important details like the location, time, severity and image snapshots to emergency services such as hospitals, police, and ambulance units. This quick information data flow helps the emergency teams to prepare and respond faster. The web dashboards and SMS notification which also shows the emergency live updates, previous incident records and alert notifications allowing authorities and users to easily monitor situations and take action without delay.

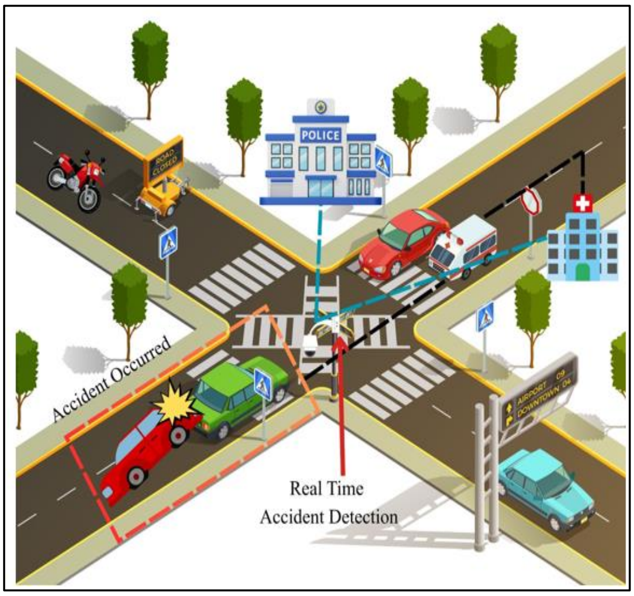

Fig 3 Project Prototype

VII. CONCLUSION

The increasing number of road accidents on highways as well as in urban areas highlights the need for a fast and reliable accident detection system. This accident detection and notification framework provides a practical and efficient approach to enhancing road safety by combining the YOLOv8 vision model with cloud-based alert mechanisms. The system continuously monitors live video feeds to detect accident events and instantly sends alerts to the relevant authorities. By

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automating the verification process, the system reduces dependence on manual observation and minimizes human error. All critical alerts are directed to a centralized traffic control center enabling authorities to track ongoing incidents in real time or analyze past traffic data when required. This integrated approach improves coordination between monitoring units and emergency response teams ensuring timely communication and quicker action which ultimately contributes to safer roads for all users.

VIII. FUTURE SCOPE

By Developing this project into next generation we are trying ,to create a AI-Software that allows the algorithms into creating a Multimodal AI.Which allows the system into handling multiple type of modes of data to create more accurate determination draw insightful conclusion making more prediction about real-world problems.This also leads into recognizing the face detection of algorithm while driving the vehicle and alerting the driver within a minute and filing a complaint automatically if the driver reaches the speed limit it also sending notification directly into drivers families.

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