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AI CCTV ACCIDENT DETECTION

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Abstract: Road accidents are one of the major causes of injuries and fatalities around the world. In many cases, delays in identifying accidents and informing emergency services increase the severity of the situation. This project focuses on developing a system that can detect road accidents using CCTV cameras. and artificial intelligence techniques to automatically detect road accidents the system analyses video footage captured from surveillance cameras to identify vehicle movement and possible accidents. YOLO (You Only Look Once).

When an abnormal situation such as a collision or sudden stop is detected, the system determines the location of the accident using a grid-based mapping method and sends an alert to the nearest patrol unit via email. The proposed system is developed using Python and computer vision libraries. This approach helps in reducing the response time of emergency services and improving road safety.

Keywords: Artificial Intelligence, CCTV, Accident Detection, YOLO, Smart Surveillance

I. INTRODUCTION

Road transportation has become an essential part of modern society, but it also comes with serious safety challenges. In many situations, accidents are not reported immediately, which delays medical assistance and increases the risk of fatalities. With the advancement of artificial intelligence and computer vision technologies, it is now possible to monitor traffic automatically using surveillance cameras. The main objective of this project is to develop a system that can automatically detect road accidents using CCTV footage. The system identifies vehicles in the video using a deep learning model and analyses their movement patterns. If a collision or abnormal behaviour is detected, the system sends an alert message to the nearest patrol unit so that emergency action can be taken quickly.

II. OBJECTIVES

Artificial Intelligence-Based CCTV Accident Detection and Nearby Patrol Alert System

The main objectives of this project are explained below in simple student-level language.

A. *To Detect Road Accidents Automatically*

The first objective of this project is to automatically detect road accidents using CCTV cameras. The system analyses video footage and identifies accidents without the need for manual monitoring. This is done using an AI object detection algorithm called YOLO (You Only Look Once).

B. *To Monitor Traffic Using Artificial Intelligence*

Another objective is to use Artificial Intelligence to continuously monitor vehicles on the road. The system detects vehicles such as cars, bikes, buses, and trucks from CCTV video and tracks their movements to identify abnormal situations.

C. *To Reduce Accident Response Time*

In many cases, emergency help reaches late because accidents are not reported immediately. This project aims to reduce the response time by automatically detecting accidents and sending alerts to nearby patrol units or emergency services.

D. *To Send Alerts to Nearby Patrol Units*

When an accident is detected, the system sends an alert message to the nearest patrol team. This helps police or emergency services reach the accident location quickly and provide immediate help.

E. *To Divide the Monitored Area into Grids*

The project also aims to organize the monitored area using a grid system. The location of CCTV cameras and patrol units are mapped to different grids so that the nearest patrol team can be identified quickly.

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F. *To Use Existing CCTV Infrastructure*
Another objective is to make use of already installed CCTV cameras. Instead of installing new devices, the system processes the existing video footage to detect accidents, which makes the system cost-effective.

G. *To Improve Road Safety*
The final objective of the project is to improve road safety by detecting accidents quickly and ensuring that emergency services are informed immediately.

III. SYSTEM ARCHITECTURE

The proposed accident detection system consists of several components that work together to detect accidents and send alerts. First, CCTV cameras capture video footage of road traffic. These video streams are continuously processed by the system. The video frames are analysed using computer vision techniques to identify vehicles and monitor their movement. Next, the object detection module uses a deep learning model to detect vehicles such as cars, buses, trucks, and motorcycles in each frame. The movement of these vehicles is tracked across multiple frames to observe their speed and direction. The system also includes an accident detection module that identifies abnormal events such as vehicle collisions, sudden stops, or unusual movement patterns. To determine the location of the accident, the monitored area is divided into multiple grid sections. Each camera is associated with a specific grid location. When an accident is detected, the system identifies the grid in which it occurred. Finally, the alert module sends a notification to the nearest patrol unit through an automated email system so that emergency services can respond quickly

IV. METHODOLOGY

The proposed system works in several steps. First, the system receives video from CCTV cameras installed on roads. The video is divided into frames using **OpenCV**. Each frame is then checked by the detection model **YOLO (You Only Look Once)** to find vehicles in the video.

After detecting the vehicles, the system tracks their movement in the next frames. It observes how the vehicles move on the road. The system then checks for accident situations such as vehicle collision, sudden stop, or vehicles overlapping with each other. If these conditions happen, the system considers it as a possible accident.

After detecting the accident, the system finds the grid location of the camera where the accident happened. Then it checks the database and identifies the nearest patrol unit in that grid area. Finally, the system sends an email alert to the emergency authorities with details such as camera ID, grid location, and accident time.

V. PROPOSED SYSTEM

This chapter explains the design, development, and implementation of the software-based Realtime telemetry data comparison system. It includes the system flow, module

A. *System Design Overview*
The design of the system is divided into several stages that work together to detect accidents and send alerts.
Video Input Stage: In this stage, the CCTV cameras installed on roads capture live traffic video. This video is continuously sent to the processing system.
Frame Processing Stage: The video stream is divided into multiple frames because the detection algorithm works on individual images. Each frame is processed one by one.
Vehicle Detection Stage: In this stage, the YOLO algorithm analyses each frame and detects vehicles present in the scene. The system identifies vehicles such as cars, bikes, trucks, and buses.
Vehicle Monitoring Stage: After detecting vehicles, the system observes their movement across frames. The system checks whether vehicles are moving normally or showing abnormal behaviour.
Accident Detection Stage: The system checks for accident situations such as: Two vehicles colliding, Sudden stop of a vehicle**,** Vehicles overlapping in the same position**,** Irregular movement after collision
If such conditions are detected, the system identifies that an accident might have occurred.
Alert Generation Stage: Once the accident is confirmed, the system finds the location of the camera and the grid area where the accident occurred. Then it identifies the nearest patrol unit and sends an alert message.

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B *Modules*

The proposed system is divided into several modules so that each task can be handled separately.

*CCTV Video Input Module***:** This module collects the live video from CCTV cameras installed on roads. It acts as the input source for the accident detection system.

Functions are to capture live traffic video and transfer video to the processing system.

Frame Extraction Module: This module converts the continuous video stream into multiple frames. These frames are used for object detection and analysis.

Functions are to split video into frames and prepare frames for processing.

Vehicle Detection Module: In this module, the system detects vehicles in the frames using the YOLO algorithm. It identifies different types of vehicles present in the video.

Function are Detect vehicles from video frames, draw bounding boxes around detected vehicles and Identify vehicle position in the frame.

Accident Detection Module: This module analyses vehicle movement and determines whether an accident has happened.

Functions are Track movement of vehicles, detect sudden stops, detect collision between vehicles and identify abnormal movement

Grid Mapping Module: In this module, the monitored area is divided into grids. Each camera and patrol unit is assigned to a particular grid.

Functions are Identify accident grid location, Map CCTV cameras to grid areas and Find patrol unit assigned to the grid

Alert Notification Module: This module sends an alert message when an accident is detected.

Functions are Generate accident alert message, Send email notification, Display alert in control system.

C *System Flow Diagram*

Start→ Capture video from CCTV camera → Detect video from YOLO algorithm→ Track vehicle movement→ If Accident Detect→ Email Alerts→ Nearby Patrol

VI. FRONTEND IMPLEMENTATION

The frontend of the system can be developed using basic web technologies such as HTML, CSS. These technologies help in creating a simple and user-friendly web page that can display information clearly.

A *Main Functions*

Display CCTV Video: The frontend shows the live or recorded CCTV video on the screen. The video is processed by the backend system and the output is displayed in the interface so that the operator can monitor traffic activity.

Show Detected Vehicle: When the system detects vehicles using **YOLO (You Only Look Once)**, the frontend displays bounding boxes around the detected vehicles in the video frame. This helps the user understand how the system is analysing the traffic and identifying vehicles on the road.

Display Accident alert: If an accident is detected, the frontend shows an alert message on the screen. The alert may include important details such as: Camera ID, Grid location, Time of accident, Alert message.

The alert can be highlighted with a warning colour so that the operator can notice it quickly.

Accident Information Panel: The system may also include an information panel that displays accident details. This panel shows recent accident alerts and related information. It helps the operator monitor accident events and maintain records for future reference.

B *Frontend Workflow of the System*

1. The backend system processes the CCTV video.
2. Vehicle detection and accident detection are performed.
3. The processed video and detection results are sent to the frontend.
4. The frontend displays the video with detected objects.
5. If an accident is detected, an alert message appears on the interface.

VII. ALGORITHM FOR ACCIDENT DECTECTION

Algorithm: AI-Based CCTV Accident Detection

Input: CCTV Video Stream

Output: Accident Alert and Patrol Notification

1: Start the system

2: Capture video stream from CCTV camera.

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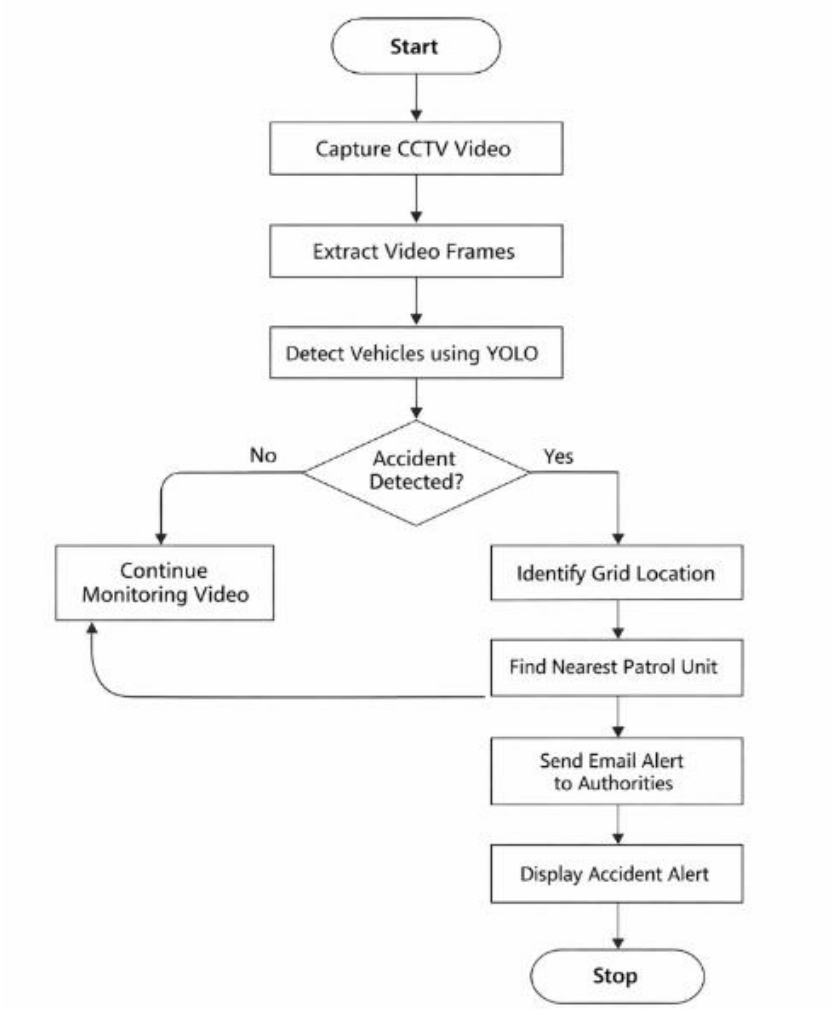
3: Convert video into frames using computer vision library.
4: Apply object detection model to identify vehicles in each frame using the algorithm YOLO (You Only Look Once).
5: Track vehicle positions across consecutive frames.
6: Calculate movement and speed of vehicles.
7: Check accident conditions:

- Vehicle bounding boxes overlap
- Sudden drop in vehicle speed
- Abnormal vehicle movements

8: If accident condition is detected:

- Identify the grid location of the camera.
- Retrieve patrol unit assigned to that grid.

9: Send alert message via email to emergency authorities.
10: Continue monitoring the video stream.
11: End.



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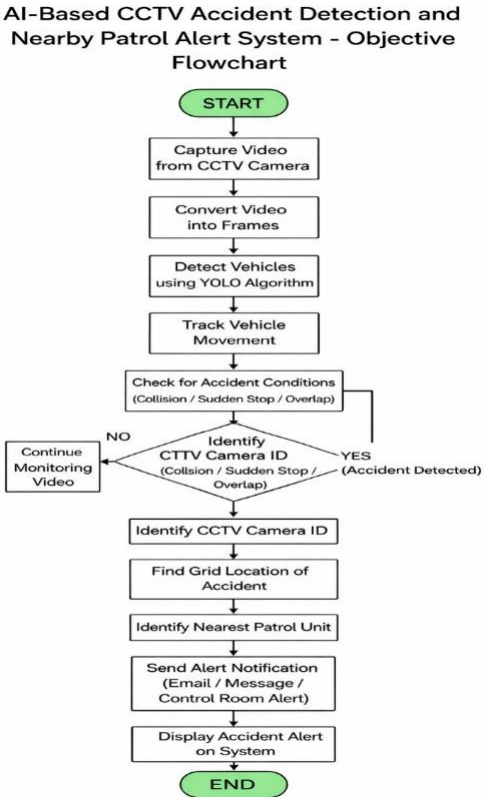
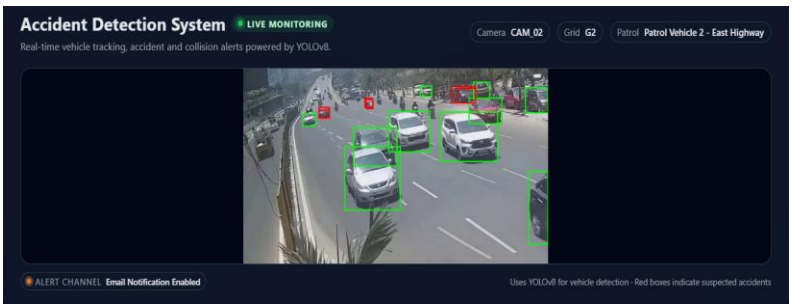


VIII. RESULT AND DISCUSSION

The proposed system was tested using sample traffic videos containing multiple vehicles. During testing, the YOLO model successfully detected vehicles in different traffic conditions. The system was able to identify situations where vehicles collided or stopped abruptly. When such events occurred, the accident detection logic triggered an alert. The email notification system also worked successfully by sending alert messages to the specified email address. These results indicate that the proposed system can help reduce the delay in accident reporting and improve emergency response time. **Observations**: The red colour indicates overspeed that are above a safe limit. The green colour indicates that are within a safe limit.



IX. CONCLUSION AND FUTURE WORK

This project focuses on developing a system that can detect road accidents using CCTV cameras. The system uses modern technologies such as **Artificial Intelligence** and computer vision to analyse traffic videos automatically. By using the object detection algorithm **YOLO (You Only Look Once)**, the system can detect vehicles in video frames and monitor their movement on the road. The system checks for abnormal situations such as collisions, sudden stops, or overlapping vehicles. When such conditions are detected, the system considers it as a possible accident. After detecting the accident, the system identifies the camera location and the grid area where the accident occurred. Then it finds the nearest patrol unit and sends an alert message to inform the authorities. The main advantage of this system is that it reduces the need for manual monitoring of CCTV cameras. It helps detect accidents quickly and sends alerts immediately. This can reduce

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the response time of emergency services and help provide faster assistance to accident victims. Overall, the proposed system improves road safety and helps traffic authorities monitor accidents more efficiently.

In the future, this system can be improved by using more advanced technologies to make accident detection faster and more accurate. One improvement is to use advanced **Artificial Intelligence** models that can detect accidents more accurately even in heavy traffic or poor lighting conditions. The system can also be connected with **Internet of Things (IoT)** devices so that sensors on roads or vehicles can send additional information about accidents. This will help the system confirm accidents quickly. Another improvement is to integrate the system with **5G** networks for faster data transmission. This will allow accident alerts and video data to reach control rooms and emergency services without delay. The system can also include **real-time GPS tracking** so that the exact location of the accident can be shared with nearby patrol vehicles and ambulance services.

In addition, a **mobile application** can be developed so that traffic police and emergency teams receive instant notifications on their phones. Cloud technology can also be used to store accident data and monitor multiple CCTV cameras from different locations. With these new technologies, the accident detection system can become more reliable and useful for smart city traffic management and road safety.

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