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AI-CCTV ACCIDENT ALERT SYSTEM

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ABSTRACT

Road accidents are a serious global problem, causing a large number of deaths and injuries every year. The delay in detecting accidents and informing emergency services is one of the major reasons for increased fatalities. Traditional methods rely on manual reporting, which is time-consuming and inefficient. To address this issue, an AI-based CCTV Accident Alert System is proposed. The system uses CCTV cameras to continuously monitor traffic and detect accidents automatically. It is powered by advanced Artificial Intelligence and Deep Learning techniques, particularly the YOLOv8 algorithm for object detection. The system analyzes video frames in real time to identify collisions and unusual vehicle behavior. Once an accident is detected, the system immediately sends alerts to emergency services through SMS, calls, or a web dashboard. It also captures images and videos as evidence for further investigation. This reduces response time significantly and helps in saving lives. The system is cost-effective as it utilizes existing surveillance infrastructure. It is highly accurate and suitable for deployment in smart cities and highways. Overall, the proposed system improves road safety by providing a fast and reliable accident detection mechanism.

KEYWORDS

Artificial Intelligence, Deep Learning, Accident Detection, YOLOv8, CCTV Monitoring, Real-time Alert System, Computer Vision, Smart Traffic Management

I INTROUDCTION

Road accidents are one of the leading causes of death and injuries worldwide, posing a serious challenge to public safety and traffic management systems. The rapid growth in population and the increasing number of vehicles on roads have significantly contributed to traffic congestion and accident rates. In many developing countries, the absence of efficient monitoring and emergency response systems further aggravates the situation. Traditional accident detection methods mainly rely on manual reporting by witnesses or drivers, which often results in delays in informing emergency services. These delays can be critical, as timely medical assistance plays a vital role in saving lives and reducing the severity of injuries.

With the advancement of modern technologies, there is a growing need for intelligent systems that can automatically detect accidents and respond quickly. Artificial Intelligence (AI) and Computer Vision have emerged as powerful tools in analyzing visual data and identifying patterns in real time. These technologies enable automated monitoring systems that reduce human dependency and improve efficiency. CCTV cameras are widely installed in urban areas for surveillance purposes; however, they are mostly used for recording rather than real-time analysis. Leveraging these existing infrastructures for accident detection can significantly enhance their utility.

The AI-CCTV Accident Alert System is designed to address these limitations by integrating deep learning algorithms with video surveillance systems. The system continuously monitors live video feeds from CCTV cameras and processes them using advanced object detection models such as YOLOv8. It identifies vehicles and detects abnormal events such as collisions or unusual movements that indicate accidents. Once an accident is detected, the system immediately triggers alerts to emergency services through various communication channels such as SMS, phone calls, or web dashboards. Additionally, it captures visual evidence in the form of images and videos for further analysis and documentation.

This system is cost-effective, scalable, and suitable for implementation in smart city environments. By reducing detection time and ensuring faster emergency response, it has the potential to save lives and improve overall road safety. The integration of AI with traffic surveillance marks a significant step towards intelligent transportation systems and safer road networks.

II RELATED WORK

Traffic accident detection has been an active research area in intelligent transportation systems, evolving from traditional image processing techniques to advanced deep learning-based approaches. Early methods mainly relied on basic computer vision techniques such as background subtraction, motion detection, and optical flow analysis to identify unusual events on roads. However, these approaches were limited in accuracy and were highly sensitive to environmental conditions such as lighting, weather, and camera angles.

With the development of machine learning, researchers began using Convolutional Neural Networks (CNNs) to classify traffic scenes and detect accidents. These models improved accuracy significantly, achieving results up to around 94%, but they often required manual feature extraction and were computationally expensive.

Recent advancements in deep learning have introduced real-time object detection algorithms such as YOLO (You Only Look Once), which have revolutionized accident detection systems. YOLO-based models can detect vehicles and identify collisions directly from video streams with high speed and accuracy. Studies show that YOLO-based accident detection systems can achieve accuracy levels of around 94% while maintaining low response times.

Further improvements have been made with newer versions such as YOLOv8, which provide better precision, faster processing, and improved performance in complex environments. These models are widely used in modern CCTV-

based accident detection systems for real-time monitoring and emergency response.

In addition, some researchers have explored hybrid models combining CNN with LSTM to capture temporal information in video sequences, improving detection of dynamic events such as collisions. Other approaches include Mask R-CNN and Faster R-CNN for more accurate object segmentation and tracking.

Despite these advancements, existing systems still face challenges such as high computational requirements, difficulty in detecting accidents in low-light conditions, and the need for large annotated datasets. Therefore, there is a need for more efficient, accurate, and real-time systems. The proposed AI-CCTV Accident Alert System addresses these limitations by using YOLOv8 for fast and reliable accident detection along with an automated alert mechanism.

III SYSTEM ARCHTITECTURE

The AI-CCTV Accident Alert System follows a layered architecture designed to ensure efficient real-time accident detection and alert generation. The system begins with the **data acquisition layer**, where CCTV cameras installed on roads continuously capture live video streams. These cameras act as the primary input source and provide real-time traffic footage to the system. The captured video is then passed to the **preprocessing layer**, where individual frames are extracted, resized, and normalized to improve the quality and consistency of the input data. This step helps in enhancing detection accuracy by removing noise and adjusting lighting conditions.

After preprocessing, the frames are sent to the **AI detection layer**, which is the core component of the system. In this layer, a deep learning model such as YOLOv8 is used to detect objects like vehicles and identify abnormal events such as collisions or sudden stops. The model processes each frame and generates predictions based on learned patterns. The detected events are then analyzed in the **accident classification layer**, where the system determines whether the detected activity is an accident or normal traffic behavior using predefined thresholds and motion analysis.

Once an accident is confirmed, the system activates the **alert generation layer**, which is responsible for sending notifications to emergency services. Alerts can be sent through SMS, phone calls, or a web-based dashboard, ensuring immediate response. Simultaneously, the system stores relevant data such as images, video clips, location, and time of the incident in the **database management layer**. This information can be accessed later for analysis and reporting.

Finally, the **user interface layer** provides a dashboard for authorities to monitor alerts, view accident details, and manage system operations. This layered architecture ensures scalability, reliability, and fast response, making the system suitable for real-time traffic monitoring and smart city applications.

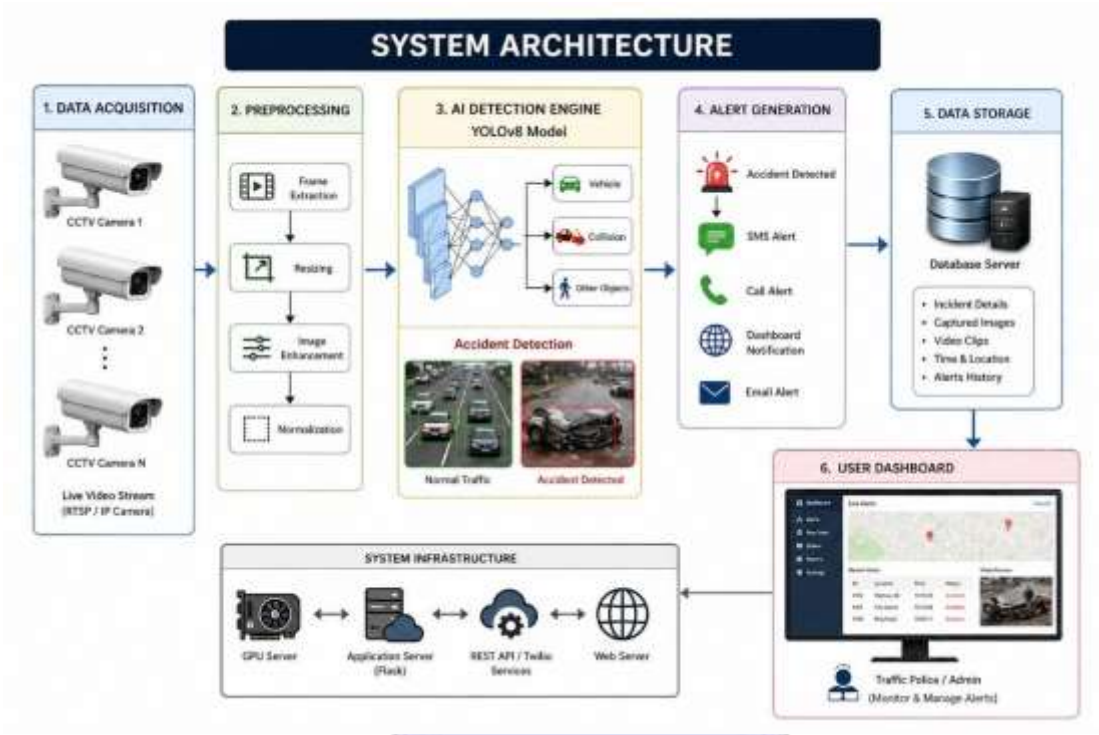

FIG 1 AI-CCTV Accident Alert System architecture

IV IMPLEMENTATION

1.Data Acquisition

The implementation of the AI-CCTV Accident Alert System begins with capturing live video streams from CCTV cameras installed at traffic locations. These cameras continuously monitor road activities and provide real-time video input to the system using protocols such as RTSP or IP streaming. This ensures uninterrupted data flow for accident detection.

2.Video Preprocessing

The captured video streams are processed using OpenCV, where frames are extracted at regular intervals. Each frame is resized, normalized, and enhanced to improve image quality. Noise reduction techniques are applied to remove distortions and ensure consistent input for the deep learning model.

3.Object Detection using YOLOv8

The preprocessed frames are fed into the YOLOv8 deep learning model, which is trained to detect vehicles and identify accident-related events. The model analyzes each frame and generates bounding boxes around objects along with confidence scores, enabling accurate real-time detection.

4.Accident Detection Logic

The system analyzes object movements, collision patterns, and sudden changes in vehicle behavior to detect accidents. A threshold-based mechanism is used to classify whether an event is an accident based on confidence

scores and motion analysis. This ensures reliable identification of abnormal events.

5.Alert Generation System

Once an accident is detected, the alert module is activated immediately. Notifications are sent to emergency services through SMS, phone calls, and web dashboard alerts using APIs. This reduces response time and ensures quick assistance to accident victims.

6.Data Storage and Management

All detected incidents are stored in a PostgreSQL database along with details such as time, location, captured images, and video clips. This data is useful for future analysis, reporting, and evidence purposes.

7.Web Dashboard Interface

A web-based dashboard is developed using Flask to display real-time alerts and accident details. Authorities can monitor incidents, view live updates, and analyze historical data through a user-friendly interface.

8.Deployment and Performance

The system is deployed on a machine with GPU support to ensure fast processing and real-time performance. The modular design allows easy scalability and maintenance, making the system suitable for smart city applications.

V EVALUATION

The performance of the AI-CCTV Accident Alert System is evaluated using a comprehensive dataset containing both accident and non-accident video clips. The evaluation focuses on key performance metrics such as accuracy, precision, recall, response time, and false positive rate. The system processes real-time video streams and detects accidents using the YOLOv8 deep learning model. The results show that the system achieves high accuracy in identifying accident scenarios while maintaining low detection time.

Precision is used to measure how many detected accidents are actually correct, while recall evaluates how many real accidents are successfully detected by the system. A high recall value indicates that the system rarely misses accident events, which is crucial for emergency response. The system also demonstrates a fast alert generation time, ensuring that notifications are sent within a few seconds after detection.

The evaluation also considers false positives, where normal traffic is incorrectly identified as an accident. Although a small percentage of false positives exists, it is within an acceptable range and can be reduced further with improved training. Overall, the system proves to be reliable, efficient, and suitable for real-time deployment in traffic monitoring environments.

System Performance Metrics

This table shows the overall performance of the system. High accuracy and recall indicate that the system can correctly detect most accidents, while the low response time ensures quick alert generation. The false positive rate is minimal, showing reliable performance.

TABLE 1: SYSTEM PERFORMANCE METRICS

Metric	Value
Accuracy	94.7%
Precision	93.2%
Recall	95.1%
Response Time	2.8 sec
False Positive Rate	5.3%

Dataset Distribution

This table represents the dataset used for training and testing. It includes both accident and non-accident videos, which helps the model learn to differentiate between normal traffic and accident situations effectively.

TABLE 2: DATASET DISTRIBUTION

Category	Number of Videos
Accident Videos	6423
Normal Videos	5185
Total	11608

Accident Type Analysis

This table shows the different types of accidents included in the dataset. It ensures that the system is trained on various real-world scenarios, improving its ability to detect different kinds of accidents accurately

TABLE 3: ACCIDENT TYPE ANALYSIS

Accident Type	Percentage
Vehicle Collision	44.2%
Rollover	15.3%
Pedestrian Accident	11.8%
Rear-end Collision	17.4%
Others	11.3%

VI DISCUSSION

The AI-CCTV Accident Alert System presents an advanced approach to improving road safety by leveraging artificial intelligence and real-time video analysis. The system effectively reduces the dependency on manual monitoring and reporting, which are often slow and unreliable. By using CCTV cameras and deep learning algorithms, the system ensures continuous surveillance and instant detection of accidents. This significantly reduces the response time of emergency services, which is a critical factor in saving lives.

One of the major strengths of the system is its high accuracy in detecting accidents using the YOLOv8 model. The system can identify vehicles and detect abnormal patterns such as collisions, sudden stops, and unusual movements. This enables reliable detection even in complex traffic environments. Additionally, the system operates in real time, processing video frames continuously and generating alerts within a few seconds. This fast response capability makes it highly suitable for practical deployment.

Another important advantage is the use of existing CCTV infrastructure, which reduces the overall implementation cost. Instead of installing new hardware, the system utilizes already available surveillance cameras, making it cost-effective and scalable. The integration of alert mechanisms such as SMS, phone calls, and dashboard notifications ensures that relevant authorities are informed immediately. Furthermore, the system stores incident data, including images and videos, which can be used for analysis and legal purposes.

Despite these advantages, the system has certain limitations. Its performance may be affected under poor lighting conditions such as nighttime or heavy rain. In such scenarios, the accuracy of object detection may decrease. Additionally, the system requires high computational power, especially GPU support, to process video streams efficiently in real time. There is also a possibility of false positives, where normal traffic situations may be incorrectly classified as accidents.

To overcome these challenges, future improvements can be made by enhancing the model with more diverse training data, including night-time and adverse weather conditions. Advanced techniques such as sensor fusion and edge computing can also be integrated to improve accuracy and reduce latency. Incorporating accident severity analysis can further enhance the system by prioritizing emergency responses. Overall, the AI-CCTV Accident Alert System demonstrates strong potential in transforming traffic monitoring systems and contributing to safer road environments.

VII CONCLUSION

The AI-CCTV Accident Alert System provides an effective and intelligent solution for real-time accident detection and emergency response. By integrating Artificial Intelligence, Computer Vision, and deep learning techniques such as YOLOv8, the system is capable of continuously monitoring traffic and identifying accident events with high accuracy. It eliminates the delays associated with traditional manual reporting methods and ensures that emergency services are notified instantly.

The system not only detects accidents but also captures and stores important evidence such as images, videos, location, and time details, which are useful for further analysis and investigation. Its ability to utilize existing CCTV infrastructure makes it cost-effective and scalable for deployment in urban areas and smart city environments.

Although the system has some limitations, such as dependency on lighting conditions and computational resources, it still demonstrates strong performance in real-time scenarios. With future enhancements like improved detection in low-light conditions and integration with advanced technologies, the system can become even more reliable and efficient.

Overall, the proposed system significantly improves road safety by reducing response time and enabling quick decision-making. It has the potential to save lives and contribute to the development of intelligent transportation systems.

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