SMART TRAFFIC VIOLATION DETECTION SYSTEM USING YOLOV8

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Abstract: Traffic violations are increasing due to rapid urbanization and an increase in the number of vehicles per capita creating accidents and congestion on the road. Most of the traditional methods for traffic violation detection are error-prone and manual involvement doesn't achieve effective results. The proposed system uses YOLOv8 for the real-time detection of riders, helmets and motorcycles and also OCR for automatic license plate recognition. Spatial correlation theory has been applied to detect most common issues like helmet and triple riding violations. The proposed system achieved a precision of 89.91% for helmet detection and 76.63% for triple riding detection demonstrates effectiveness in real-world traffic situations.

Keywords: Traffic Violation Detection, YOLOv8, ALPR, Computer Vision, Artificial Intelligence.

1. INTRODUCTION

The rapid growth of urbanization and the increasing number of vehicles on roads have significantly contributed to traffic congestion and road accidents across the world. One of the major reasons for these accidents is the violation of traffic rules, including signal jumping, speeding, illegal lane changes, driving without helmets, seatbelt violations, and unauthorized parking. Traditional traffic monitoring systems primarily rely on manual observation or conventional surveillance methods, which are often inefficient, time-consuming, and prone to human error. These limitations create the need for an intelligent and automated traffic monitoring system capable of detecting traffic violations accurately and in real time. Recent advancements in Artificial Intelligence (AI), Deep Learning (DL), and Computer Vision have revolutionized the field of intelligent transportation systems. Object detection algorithms, particularly the You Only Look Once (YOLO) family of models, have demonstrated remarkable performance in detecting and tracking multiple objects simultaneously with high speed and accuracy. Among these models, **YOLOv8**, the latest version developed by Ultralytics, offers improved detection accuracy, faster inference speed, better feature extraction capabilities, and efficient real-time performance. These advantages make YOLOv8 an ideal choice for smart traffic surveillance applications. The proposed **Smart Traffic Violation Detection System using YOLOv8** aims to automate the identification of various traffic rule violations by processing live video streams or recorded surveillance footage. The system employs the YOLOv8 deep learning model to detect vehicles, motorcycles, pedestrians, traffic signals, helmets, and other road objects in real time. By combining object detection with object tracking and rule-based analysis, the system can identify violations such as red-light jumping, riding without helmets, illegal parking, wrong-side driving, lane violations, and overcrowding on two-wheelers. Once a violation is detected, the system captures the evidence image, records the violation details, and stores them for further verification or automated penalty generation. The integration of intelligent video analytics significantly reduces the dependency on manual monitoring while improving the efficiency and reliability of traffic law enforcement. Real-time detection enables quicker response from traffic authorities and helps maintain smooth traffic flow. Additionally, automated violation detection minimizes human intervention, reduces operational costs, and ensures consistent monitoring throughout the day under various traffic conditions. YOLOv8 incorporates advanced neural network architectures, anchor-free object detection mechanisms, efficient feature pyramid networks, and optimized loss functions that improve localization accuracy and classification performance. These features allow the proposed system to detect multiple vehicles even in crowded traffic environments while maintaining low latency. Furthermore, the system can be integrated with existing CCTV infrastructure, edge computing devices, cloud platforms, and Automatic Number Plate Recognition (ANPR) systems to develop a complete intelligent traffic management solution. The proposed system also supports scalable deployment in smart cities where continuous monitoring of highways, intersections, and urban roads is essential. By generating real-time alerts, maintaining digital records of violations, and providing analytical reports, the system assists traffic departments in improving road safety and enforcing traffic regulations more effectively. The collected data can further be utilized for traffic pattern analysis, congestion prediction, accident prevention, and infrastructure planning. In conclusion, the **Smart Traffic Violation Detection System using YOLOv8** provides an efficient, accurate, and intelligent solution for automated traffic surveillance. By leveraging state-of-the-art deep learning techniques, the system enhances road safety, minimizes human errors, improves enforcement efficiency, and supports the development of modern Intelligent Transportation Systems (ITS). Its ability to detect multiple traffic violations in real time makes it a promising technology for future smart city applications and sustainable traffic management.

II. LITERATURE SURVEY

Traffic surveillance and automated traffic violation detection have become significant research areas due to the rapid growth of urban transportation and the increasing need for intelligent traffic management systems. Recent developments in deep learning, computer vision, and object detection models such as YOLO have substantially improved the accuracy and speed of real-time traffic monitoring. [1] Joseph Redmon et al. introduced the You Only Look Once (YOLO) object detection framework, which transformed object detection by treating detection as a single regression problem. Unlike traditional two-stage detectors, YOLO performs object localization and classification simultaneously, enabling real-time performance with high detection speed. Although the original YOLO model had limitations in detecting small and overlapping objects, it laid the foundation for modern real-time traffic surveillance systems. [2] Glenn Jocher et al. presented YOLOv8, an advanced object detection architecture that incorporates an anchor-free detection mechanism, improved feature extraction, optimized training strategies, and better segmentation capabilities. Compared with earlier YOLO versions, YOLOv8 achieves higher detection accuracy while maintaining real-time inference speed, making it highly suitable for intelligent transportation systems, vehicle detection, helmet detection, and traffic monitoring applications. [3] Vedha priya vadhana Rajamani and Ravi Chandra Koirala proposed a real-time traffic monitoring system using YOLOv8 for automated helmet violation detection. Their framework processes live and recorded surveillance videos to identify motorcycles, riders, and helmet usage. The study demonstrated that YOLOv8 significantly improves detection accuracy while reducing computational complexity, making it suitable for deployment in smart city traffic surveillance systems. [4] Pragna G., Pallavi V. S., Raaja Nithila Nethran, and Varsha V. developed a Smart Traffic Violation Detection System Using YOLOv8 integrated with Optical Character Recognition (OCR) for automatic license plate recognition. The system detects helmet violations and triple riding using spatial correlation techniques. Experimental evaluation reported high precision for helmet detection while demonstrating the effectiveness of combining YOLOv8 with OCR for automated traffic law enforcement. [5] Muhammad Tariq Bashir et al. proposed an AI-driven real-time motorcycle traffic violation detection framework integrating YOLOv8 with IoT-based analytics. Their system detects helmetless riders, multiple passengers, and other violations under challenging traffic conditions. The framework utilizes cloud-based monitoring and intelligent analytics, demonstrating that combining edge AI and IoT significantly improves real-time traffic monitoring efficiency and enforcement capabilities. [6] **Armstrong Aboah, Bin Wang, Ulas Bagci, and Yaw Adu-Gyamfi** proposed a real-time multi-class helmet violation detection system using **YOLOv8** combined with a few-shot data sampling technique. The proposed approach reduces the amount of labeled training data required while maintaining high detection accuracy. The model was evaluated in the AI City Challenge and demonstrated robust performance in detecting helmet violations under varying traffic conditions. However, the work primarily focuses on helmet detection and does not address other traffic violations such as signal jumping or illegal parking. [7] **B. M. Nandini et al.** presented a **YOLOv8-based automated traffic violation detection and enforcement system** capable of detecting helmet violations, triple riding, and other road safety violations. The framework integrates real-time object detection with automated evidence generation to improve law enforcement efficiency. The study reported improved detection accuracy compared with previous YOLO versions, but performance decreased under adverse weather and poor illumination conditions. [8] **M. S. Abirami, H. K. Jain, and A. S. Kanwar** developed an automated two-wheeler traffic violation detection framework using **YOLOv8**. The system detects motorcycles, riders, helmets, and number plates and automatically generates electronic tickets after recognizing vehicle registration numbers. The framework significantly reduces manual intervention; however, OCR accuracy decreases when license plates are blurred or partially occluded. [9] **T. Saelee and W. Viyanon** proposed a deep learning-based helmet detection system for motorcycle riders and passengers using YOLO models. The system was designed to improve road safety by automatically identifying riders who are not wearing helmets. Experimental results showed reliable detection accuracy in urban traffic environments, although the system requires high-quality surveillance cameras to maintain consistent performance. [10] **M. Hossen et al.** introduced an automated rider and helmet detection framework based on deep learning for enhancing road safety. Their approach combines vehicle detection with rider analysis to identify helmet compliance in real time. The proposed system demonstrated improved monitoring efficiency but experienced reduced accuracy in heavily congested traffic where multiple riders overlap. [11] **D. Mullagura et al.** proposed an intelligent monitoring system for enforcing helmet regulations on two-wheelers using computer vision techniques. The framework automatically identifies motorcycles, riders, and helmet usage from surveillance videos, thereby reducing dependence on manual traffic monitoring. While the system performs well during daytime conditions, nighttime detection remains challenging due to insufficient lighting. [12] **A. Hegde, A. Agarwal, and M. Moharir** developed an AI-driven traffic surveillance system integrating **YOLOv8** with Optical Character Recognition (OCR) for simultaneous detection of helmet violations, missing rear-view mirrors, and automatic license plate recognition. The system achieved high precision and recall in real-time testing and demonstrated the practicality of combining object detection with OCR for automated traffic enforcement. [13] **S.**

Kumar et al. proposed a **Traffic Rules Violation Detection System using YOLOv8** that detects multiple violations, including wrong-way driving, red-light jumping, over speeding, helmetless riding, and triple riding. The framework also integrates an automated alert mechanism to notify authorities immediately after a violation is detected. The study highlights the effectiveness of AI-based surveillance for improving road safety and reducing manual monitoring efforts.

III. EXISTING SYSTEM

Traditional traffic monitoring systems mostly depend on traffic police officers watching over the roads or basic CCTV cameras. These systems need people to constantly look for traffic violations like not wearing helmets riding with many people on a bike and speeding. This manual process is very time-consuming requires a lot of work and people can easily make mistakes in cities with a lot of traffic. Regular image processing methods also have trouble accurately spotting violations when the lighting is bad the weather is changing or things are blocking the view. As there are more vehicles on the road these old methods just don't work well and can't handle traffic management in real-time.

DISADVANTAGES OF EXISTING SYSTEM

• High Dependence on Manual Monitoring.
• Time-Consuming Process.
• Limited Detection Accuracy

IV. PROPOSED SYSTEM

The proposed Smart Traffic Violation Detection System Using YOLOv8 utilizes Artificial Intelligence, Deep Learning, and Computer Vision techniques to automatically detect traffic violations from live CCTV video streams. The system employs the YOLOv8 object detection model to identify motorcycles, riders, helmets, and other relevant objects in real time. Spatial relationship analysis is used to accurately determine helmet violations and triple riding Violations by associating riders with motor cycles and helmets. Once a violation is detected, the system extracts the vehicle's license plate using Tesseract OCR, allowing authorities to identify the offender automatically. The system records evidence by capturing images and timestamps, making it suitable for automated traffic enforcement and intelligent transportation systems.

ADVANTAGES

- Automatic Traffic Violation Detection.
- Real-Time Monitoring.
- High Detection Accuracy.

SYSTEM ARCHITECTURE

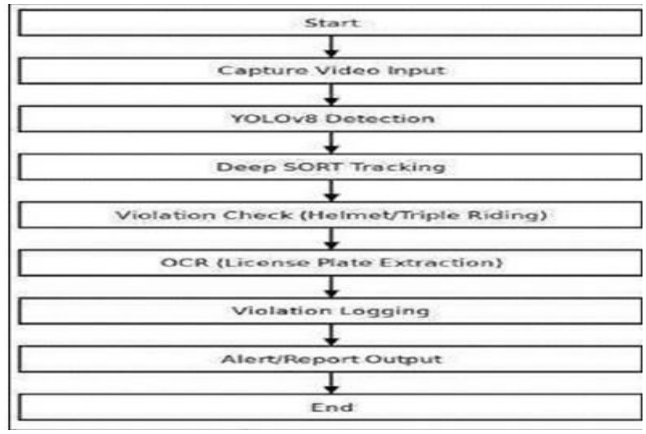

Fig 1: System Architecture

V. UML DIAGRAMS

1. CLASS DIAGRAM

A Class Diagram is a UML diagram. It represents the functions of a Application. The diagram shows the sequence of functions. These functions are performed from the start to the end of a process. It helps to understand how tasks are done. Also it shows how functions move through stages.

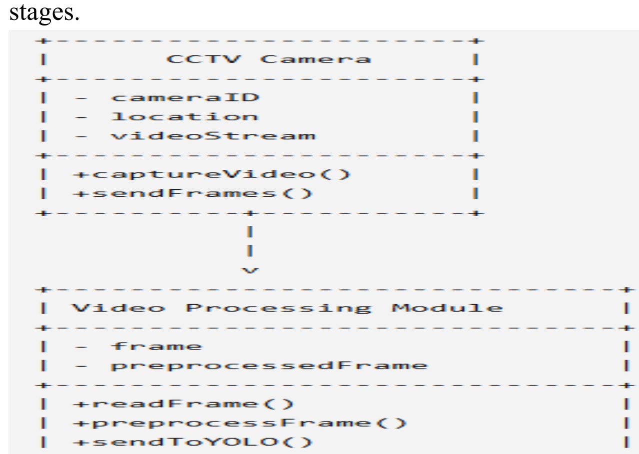

Fig 5.1 shows the Activity diagram

2. USECASE DIAGRAM:

A UML Use Case Diagram is a visual representation that shows how users interact with the Earthquake Prediction System. It helps identify the main functions of the system without showing internal implementation details. The prediction results, accuracy metrics, graphs, and reports are displayed on the dashboard for monitoring and analysis. The UML Use Case Diagram helps visualize these interactions and supports the design, development

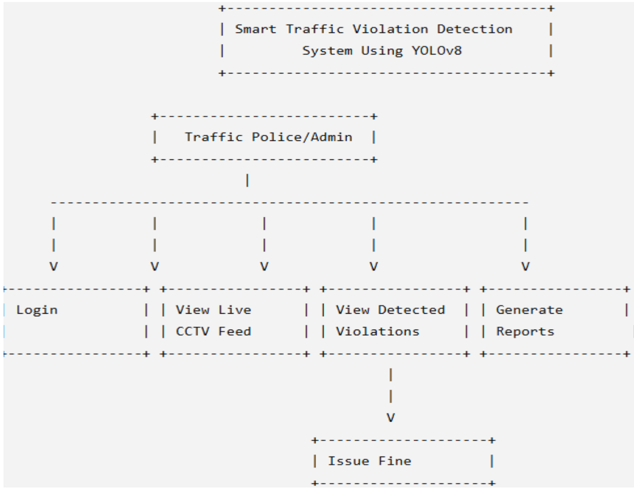

Fig 5.2 Shows the Use case Diagram

3. SEQUENCE DIAGRAM:

Sequence Diagram is a UML diagram. It shows how different objects interact with each other over time. This diagram illustrates how messages are exchanged between the user and system modules to perform a task. The Sequence Diagram shows step-by-step interaction between

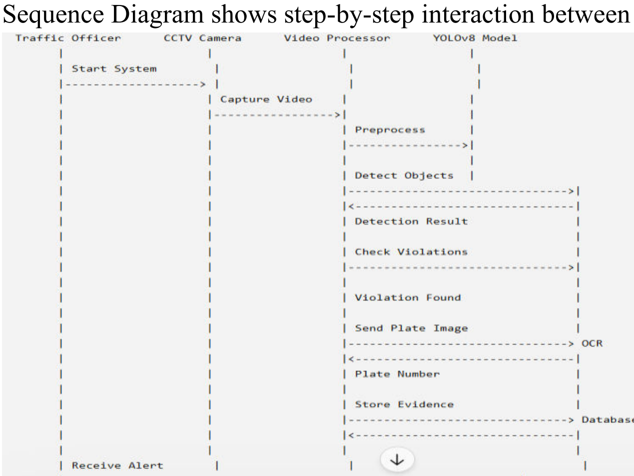

Fig 5.3 Shows the Sequence Diagram

VI. RESULTS

6.1 License Plate Recognition

The license plate recognition system is a part of the plan we have. It helps us figure out which vehicles are involved in traffic violations like not wearing a helmet and having many people on a bike. When the system finds a violation using the object detection module it zooms in on the vehicles license plate number. This is so we can connect the incident to a vehicle. We need to do this to get evidence and make sure traffic enforcement systems work well in the real world. The license plate recognition system is really important, for this. The OCR module is used to read motorbike license plates from the detected image regions. Under normal conditions, where the plate is clearly visible and properly captured by the camera, the system is able to recognize the characters with good accuracy. This makes it suitable for real-time monitoring, as it can quickly convert visual information from CCTV footage into machine-readable text that can be used for further processing and record keeping. However, the performance of the system is affected when the image quality is poor. Factors such as motion blur, low illumination, smudged or dirty plates, and improper camera angles can reduce the accuracy of character recognition. In such cases, the OCR module may fail to correctly interpret the license plate details. Despite these limitations, the system performs reliably in most normal surveillance conditions and contributes effectively to the overall process of traffic violation detection and identification. Figure5 illustrates the license plate recognition process in the proposed system.

Figure 6.1. License Plate Reading

In above screen shows the License Plate Reading.

6.2 Performance Metrics

A restricted test dataset was used to evaluate the system using standard measures like precision, recall, F1-score and mAP@0.5. The evaluative metrics show the YOLOv8s model can identifies violations with high precision, allowing it suitable for real-time traffic monitoring in this situation. The key performance results are explained in below table

Model / Violation Type	Precision (%)	Recall (%)
Helmet Detection Model	89.91	86.37
Triple Riding Detection Model	76.63	57.14

Table 6.1 .Performance Metrics of Traffic Violation Detection Models

In above screen shows the Performance Metrics of Traffic Violation Detection Models

Two YOLOv8 models were developed and trained for 150 epochs includes the helmet detection model and the triple riding detection model. The helmet detection model achievedanaccuracyof89.91%, recall of 86.37%, F1-score of 88.1% andmAP@0.5 of 92.46% showing accurate and effective detection with few false positives or negatives in various situations where riders without helmets may be present. The Triple Riding Detection Model reached an accuracy of 76.63%, recall of 57.14%, F1-score of 65.5% and mAP@0.5 of 57.81% illustrates sufficient accuracy with more complicated detection of multiple riders in random traffic situations. Feature extraction, bounding box regression and processing speed results are verified by YOLOv8. The recall observed in triple-riding detection is decreased due to numerous barriers, overlapping riders and various seating positions in crowded traffic environments. These challenges lead to identify riders in a single frame. As a result, the current technique has an inbuilt limitation provides the way for additional temporal connection and multi-frame tracking mechanisms in future implementations to increase rider counting accuracy.

VII. CONCLUSION

AI and ML technologies have played a significant role in enhancing the speed and accuracy of real- time traffic violation detection systems [17]. This project presents a smart traffic violation detection system using artificial intelligence. A deep learning modelbased on YOLOv8 is used to locate and classify common traffic violations such as helmet and triple riding violations. Optical Character Recognition (OCR) is implemented to recognize license plate numbers from images of traffic violations. The proposed automated method allows detection, reporting and violation tracking with minimal human involvement. This technique uses data preparation, parameter modification and dataset augmentation to achieve optimal model performance. Computer vision algorithms have been demonstrated for effective techniques detecting traffic violations in various types of lighting situations, weather circumstances and camera locations. The resulting system is adaptable, scalable and effective in continuous road and highway monitoring, reducing the requirement for manual observation and the risk of human error. The result shows that the proposed method accurately recognizes helmet and triple riding violations. The experimental results show that the proposed YOLOv8-based system can identify helmet and triple riding violations with high accuracy in real-time traffic situations. The combined spatial analysis and automated license plate identification improves the system's usability for traffic law enforcement. This study provides a specific and adaptable method for smart traffic monitoring systems by handling important challenges such as blocking, scalability and real-time processing. In future, the system improved by accepting numerous camera inputs, modifying performance depends on weather and lighting conditions and using cloud computing for large-scale deployment. AI-based surveillance solutions also perform continuous violation detection and traffic density analysis allowing for scalable and adaptable traffic monitoring systems.

VIII. REFERENCES

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