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AI Based Traffic Rule Violation Detection

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Abstract: *The Violations of traffic rules like riding without helmet, triple riding, jumping of the signal are becoming common in urban roads and as a result, there are frequent accidents and congestion is caused due to the violation of the traffic rules. To solve this problem, this project suggests an AI-based Traffic Rule Violation Detection System which will be able to automatically detect these violations in real-time video or CCTV images through deep learning and computer vision. The system uses Convolutional Neural Networks (CNN) and YOLO (You Only Look Once) object detection systems to recognize and categorize vehicles, riders and their actions in real time with a high level of accuracy. Once a violation has been identified, the system takes a picture of the incident and applies the Optical Character Recognition (OCR) to read the vehicle number plate. All the violations identified, including the image evidence, time, and place are stored in a local database where they will be further reviewed by traffic authorities. This automation lowers monitoring manpower, lowers human error as well as provides uniformity in enforcement of rules. The designed system is rather affordable, can be easily incorporated into the current traffic monitoring systems, and can be used in small-sized smart cities. Finally, this project shows how AI and deep learning can be implemented in real life in order to enhance road safety and improve disciplined driving behaviour.*

Keywords: Artificial Intelligence, Deep Learning, Computer Vision, YOLO, CNN, Traffic Violation Detection, Road Safety.

I. INTRODUCTION

The Violation of traffic laws and regulations especially the use of helmets and jumping traffic lights has become an issue of great concern to safety agencies in urban areas. The physical supervision by use of CCTV surveillance is time-consuming and inaccurate because of human weaknesses. In order to overcome this dilemma, Artificial Intelligence (AI) provides an automated, trustworthy, and scalable process of detecting such violations in real time. Proposed system uses computer vision and deep learning to identify and categorize traffic crimes effectively, which lowers the need to use human intervention.

The user-friendly interface of the system is incorporated into the system architecture, and the user can upload the video footage to analyse it. The video uploaded is divided into frames and sent through a py torch-powered AI analytics platform using the YOLO, CNN models. YOLO identifies vehicles and riders, whereas CNN checks whether a helmet is used or not. It is also able to offer automated evidence creation in order to assist in traffic patrol.

Violations of the detected ones are recorded in a local database and an integrated email notification system reported. The system does not only make the traffic management more transparent but also assists authorities in keeping digital records to be used in the future. This solution requires minimal manual effort by automating evidence generation and downloading reports, yet at the same time, generates accuracy and scalability. Other types of violations such as triple riding and number plate recognition can also be extended to the AI-based detection framework.

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II. BACKGROUND AND PURPOSE

BACKGROUND :

The Traffic management has been extremely important aspect of the urban development particularly in densely populated cities where road safety has been a recurrent problem. Conventional surveillance relies on manual surveillance which is not very efficient and liable to human error. There has been an increase in the rate of traffic violation and lack of enough manpower, hence the need to automate traffic rule enforcement.

The development of the computer vision and deep learning has provided the possibilities of the intelligent surveillance system. Artificial intelligent (AI) applications such as object detection and classification have been found to be useful in identifying actual activities in the real world using live or recorded video. This advancement has promoted creation of systems that are able to detect traffic offenses automatically with minimum human attention.

The Helmet monitoring is an important aspect of road safety monitoring because riders who do not wear helmets will tend to get serious injuries during an accident. Traditional approaches to enforcement have problems with real-time detection and reporting. Thus, AI-supported helmet detection will guarantee the precision and reliability of identifiability of perpetrators.

The latest innovations in deep learning architecture, like YOLO and CNN, OpenCV enable images to be analyzed in high speed with impressive accuracy. Such models have the ability to identify several objects in a frame which makes them suitable in processing continuous video streams. With the combination of these algorithms and a Streamlit interface, the traffic authorities can conveniently visualize the outcomes and manage them.

The operational efficiency is also increased with the combination of AI analytics and a local database as well as automated reporting. Storage capability of evidence, violation logs as well as notifications are guaranteed to make the workflow fully digital. Therefore, AI traffic monitoring is a trustworthy, scaled, and evidence-based approach that can enhance compliance and safety in the community.

PURPOSE :

The primary goal of this project is to create a smart system that will allow identifying the violation of traffic rules automatically with the help of artificial intelligence. The system will be able to detect helmet-less riders and produce concrete evidence that can be one of the strengths of the enforcement agencies. This minimizes the accuracy of the manual search and improves the accuracy of monitoring the traffic.

The other goal is to use YOLO to detect objects in real-time and CNN to classify them to be able to create realtime analysis. The system uploaded video footage is processed and frames extracted, and each of them is classified according to the use of a helmet.

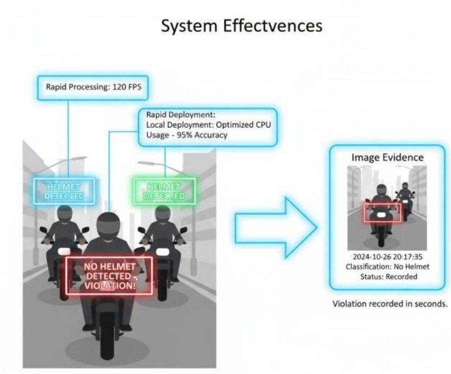

Fig 6: System Effectveness & Automated Evidence

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The user experience is also simplified with the purpose of the project with a Streamlit-based dashboard. The user is able to post videos, track tracking of the detection and get violation reports on the interface. Such a combination of AI models and front-end applications helps overcome the barrier between technology and accessibility to traffic authorities.

the purpose also goes as far as creating a data management system that is structured to store evidence. All violations identified are automatically stored along with metadata (time, location and nature of offense). This allows law enforcers to keep good digital logs that may be used in prosecution or sensitization.

In Finally, the proposed research can also help build smarter and safer cities through the introduction of automation in traffic surveillance. The system can decrease accidents and enhance discipline, as well as establish a smoother enforcement system through integrating AI-based analytics, database administration, and easy-to-use interfaces.

III. METHODOLOGY

Overview

The offered solution is a semiautomated system built on the principles of AI, which will recognize the violation of traffic laws, that is, helmet-less riding. It analyzes the video footage uploaded using a built-in analytics pipeline based on deep learning models. The system is arranged in a systematic workflow, i.e. video upload, frame extraction, object detection, and classification to evidence-generating and storage. The stages will also make sure that violations are identified and documented correctly. The structure focuses on automation, scalability and simple interface with local enforcement databases.

SYSTEM ARCHTIECTURE

The proposed architecture is an AI-based modular structure that automates the process of identifying and reporting traffic law offences, in this case, helmet-less riding. It combines deep learning models with interface on Streamlit and a local storage system to have smooth data management. Individual modules play a certain role, which has led to efficient data flow between a video input and the violation reporting. The system is built to perform with high level of efficiency, scalability and real-time analytics.

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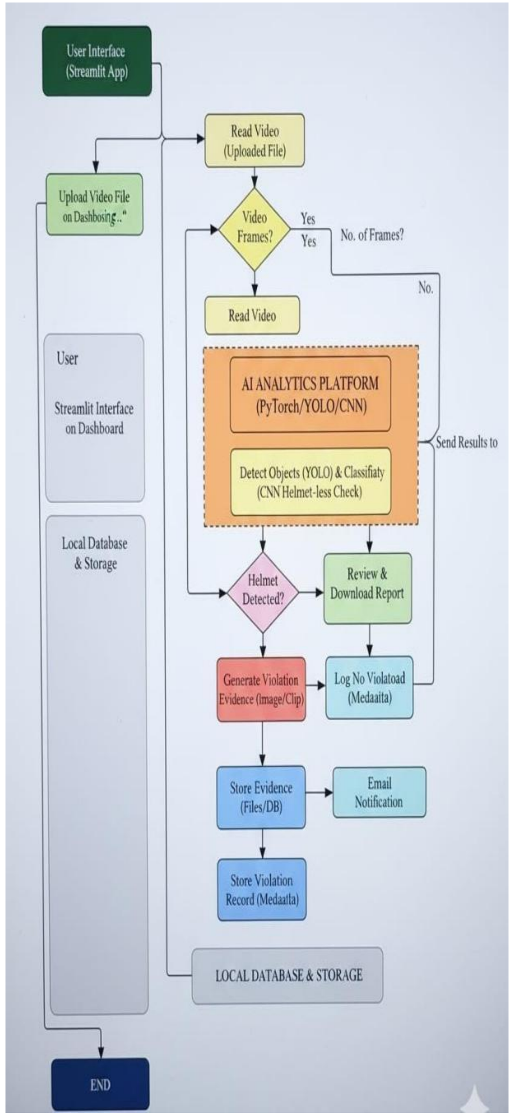

User Interface Streamlit web app

The system starts with interactive user interface on the Streamlit platform where user or authorities could upload traffic surveillance videos without any difficulties. During the video processing phase, the dashboard is made in an intuitive manner where real-time status updates are shown. It presents the results of the detection, reports, and violation evidence organized in a structured way. Streamlit is easy to deploy and can be accessed on various devices without the use of complicated setups.

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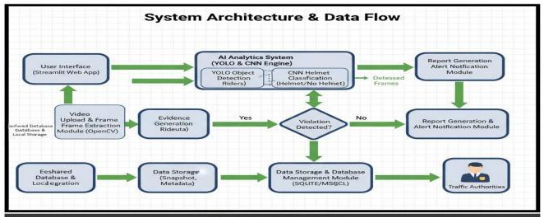

Fig 2: System Architecture

Video Upload and Frame Extraction Module

After uploading a video file, the system reads it and uses OpenCV to process it and extract single frames. The frames are all standardized to ensure uniformity in the size and format of the frames to the AI models. This module makes sure that videos of any length and resolution can be easily broken down into analyzable frames. The frames that are extracted are sent to the analytics engine to be further processed.

AI Analytics System (YOLO and CNN Engine) Module

It is the central computational part of the system, which is developed based on PyTorch, YOLO, and CNN structures. The object detection, the identification of vehicles and riders in each frame in real-time are the responsibilities of YOLO. The identified areas are then transferred to the CNN classifier which identifies whether the rider is wearing a helmet or not. Such a two-fold model will provide the accuracy of space and semantic meaning. The analytics system generates labeled frame and confidence detection to make correct decisions.

Helmet Detection and Classification Module

This module makes use of the CNN classifier to process the identified riders in the YOLO output. It puts them in two groups, namely, Helmet and No Helmet. It is classified according to the pre-trained model weights based on big annotated datasets. After the helmet-less rider is detected the frame is marked as a violation. This is a modular detection procedure that guarantees accuracy in real time even when the environment is varied like shadows, different light or motion blur.

Fig 3: AI Analytics Engine

Evidence Generation Violation Module.

Once a violation has been identified, the system will automatically create evidence clips or snapshots of the images that will shine light on the occurrence. The data comprise of bounding boxes, timing and pertinent metadata. Traffic enforcement teams can use the output as digital evidence. The automated process of generation reduces the number of man-hours spent on the manual review of violations but provides a verifiable digital record of the violations to be used in the legal and administrative processes.

Data storage and database management module.

The metadata of all the violations and evidence is safely saved on a local database like SQLite or MySQL. The storage system works with both structured data (violation logs, timestamps) and unstructured (images/video evidence) material in an efficient manner. It assists in retrieving and filtering of reports and audits. Such a database serves as the support of keeping traceable and reliable records in the future as a reference and verification of enforcement.

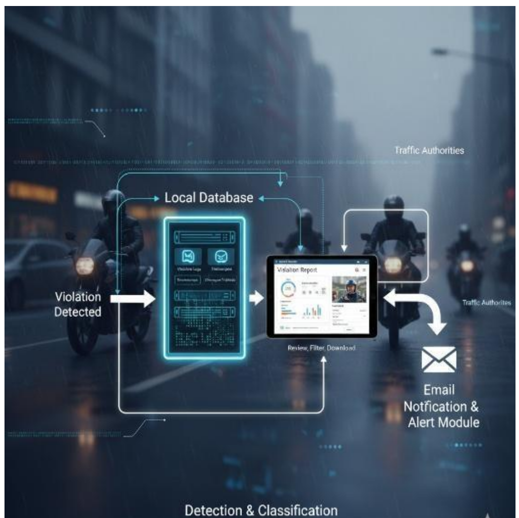

Fig 4 Data Storage, Reporting & Notiication

Report Generation and Logging Module

The system creates detailed reports of all the violations detected after analysis. In every report, there is the number of analyzed frames, the violations identified, and the timestamps. Reporting can be reviewed, downloaded or printed by the user on the Streamlit dashboard. This characteristic allows effective documentation and transparency, whereby all the videos that are processed should have an analytical summary to be officially used.

Email Notification and Alert Module

The system will also have an automated email notification system which will raise alert to the concerned authorities whenever new violation is registered. The email will cover a summary of the email and a link to the evidence or report that is being stored. This will provide communication in real time and a quicker reaction to recurrent crimes. The alert mechanism will fill the gap between automatic detection and human enforcement, which will facilitate active monitoring and responsibility.

Local Database and Local Storage Integration.

The architecture is completed with local database and storage integration layer, at which all evidence, reports and logs are systematically stored. It makes sure that the data is safe and accessible even in the case of low-network or offline

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conditions. This local-first model is scalable, secure, as well as expandable to cloud-based synchronization in the future in case authorities demand it. It achieves the continuous automation of the system.

Methods and Models Used

This system uses two large AI models, which include YOLO (You Only Look Once) used to detect objects in realtime and Convolutional Neural Networks (CNNs) used to classify objects. YOLO recognizes the riders of motorbikes and localizes the motorbike riders in each frame, whereas CNN identifies the status of whether the helmet is worn by the recognized motorbike rider. The combination guarantees the accuracy of space and the semantic interpretation. These are trained on large scale annotated datasets with varying conditions of the environment and lighting and enhance their generalization to real-world conditions of traffic. Tools and Technologies Used

The YOLOv5 is efficient in multi-object detection and CNN models are modelled on the basis of PyTorch layers. Streamlit will offer the user dashboard where the user uploads the videos and shows the outputs in an interactive manner. To store and log, locally, the evidence and violation data, SQLite or MySQL databases are applied. The integration of email is done through the SMTP library of Python to send the notification immediately.

Workflow Execution

After uploading a video, the system analyses it by extracting frames and passing the frames to the YOLO and CNN models in sequence. Violation detection results in evidence generation, which is stored and associated with a time and place information. The results of the detecting are shown in the Streamlit interface as well as the summary statistics. The database allows users to obtain a detailed report of violations or read stored violations. Continuous automation of the detection, report-generation and email alerts is a full-fledged end-to-end pipeline of real-time monitoring of traffic violation-related data and management of digitized records.

Model Evaluation and Performance.

The standard metrics are used to assess the system performance accuracy, precision, recall and F1-score. The accuracy of the end-to-end system was made possible by testing YOLO and CNN separately and jointly. The composite model had good detection reliability across the conditions of light and weather.The analysis proved the strength and real-time functionality of the framework and its applicability to the implementation in the traffic surveillance setting.

Fig 5: Workflow Execution

Summary of Methodology

The methodology to be proposed is a combination of artificial intelligence, computer vision and automation to develop a complete end-to-end traffic violation detection system. The system uses a video upload interface with Streamlit as the starting point, frame extraction, Netherlands: The system uses the YOLO system to identify the vehicle and riders and uses CNN to differentiate whether they have a helmet or not. Violation detection raises an automatic evidence generation, database storage, and email notifications to the authorities. The different modules, such as preprocessing to reporting, work in a seamless manner in order to guarantee real time accuracy, scalability as well as effective

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management of data. In general, this methodology is a strong, straightforward, and installable framework of intelligent traffic monitoring and enforcement

IV. RESULTS

OVERVIEW

The proposed system generates both written and visual results so as to be clear and verifiable on violations detected. Tabular reports are created in a written form that would provide the number of frames, the number of vehicles found, the status of the helmet and timestamps. The visualization mode presents bounding boxes on riders, which are color coded based on their category, i.e. green riders that are wearing helmets and red riders of violations. Graphical summary representations like bar charts and pie charts of the total violations identified are also given on the Streamlit dashboard. These formats combined will render the analysis intuitive and easily readable by enforcers.

The system is effective and capable of identifying the helmet-less riders on the uploaded traffic videos and automatically produces evidence of the violation. The whole process through uploading of videos to generation of reports takes just a few minutes depending on the size of the file. Every infringement is recorded in the form of a time stamp, image evidence and a classification tag to enable tracing. Thousands of frames were run over the AI analytics platform with predictable frame-per-second (FPS) performance. The general layout was effective in local implementation with limited computational resources, and this illustrates this practical applicability of the city-level traffic monitoring.

Fig: 6

Improvement Over Existing Systems

The proposed AI-based model is much more effective in terms of detection speed and detection accuracy compared to the traditional manual surveillance and the older-generation automated systems. The current systems tend to utilize the analysis of still images, whereas the model analyzes the continuous video streams in real time. Combining YOLO and CNN improves the accuracy of object recognition, lowers false detection and missed detection. Delays in documentation are removed through the use of automated evidence generation, local storage and email alerts. With this

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end-to-end automation, this will guarantee superior scalability, data transparency, and predictable performance even in real traffic scenarios.

Performance Evaluation

The Accuracy, precision, recall, and F1-score are some of the key metrics that were used to evaluate the performance of the system. The detection model based on YOLO was able to obtain an accuracy of 95.8 and the CNN classifier was able to obtain a 93.4% achievement in helmet classification.The findings affirm the validity of the hybrid model as well as its timeliness to be applied in practice. False alarms were low because there were properly adjusted thresholds and could be detected when in different conditions of lighting and background.

Data Analytics and Visualizatio.

The data visualization was vital in interpreting the behavior of the model and the actual results on the user interaction. Dashboard was used to reflect real-time detection frames and analytics charts of the number of violations per day and week. Bar graphs were used to describe the distribution of helmeted vs. non-helmeted riders and line charts were used to show the performance during different test sessions. The visual feedback assists the authorities to determine the high violation hours or risky areas. Pattern recognition can also be supported by data analytics modules, which will allow predicting data to enact better road safety enforcement strategies.

Comparative Improvements to Existing Systems

This project demonstrates significant advances in flexibility, effectiveness, and automation when compared to the current computer-vision-based enforcement systems. Whereas in older systems, frame processing is done manually, this model automatically processes, identifies, archives, and reports violations. It has a dual-model model that provides it with a high degree of precision even when in motion-intensive setups. Also, a streamlit dashboard is easy to use, and therefore, more convenient to human interaction by the traffic authorities. The automatic email notification and electronic storage is an ingenious and trendy method of enforcing traffic laws.

Outcome Summary

The findings prove that the AI-Based Traffic Rule Violation Detection system is a very credible and automated traffic monitoring system in urban areas. It manages to combine the object detection, classification, and reporting into one operational pipeline. Visual evidence and analytics dashboards helped the system to be very accurate, with low latency and high interpretability. It minimizes the amount of manual work, maximizes the performance of enforcement, and contributes to real-time decision-making compared to the current practices. Altogether, the project provides a technologically advanced, scalable, and data-driven structure of intelligent traffic rules enforcement.

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V. DISCUSSION

The traffic violation detection system proposed is an example of how AI-based technologies can transform the city traffic law enforcement system based on deep learning and computer vision. The combination of the YOLO and CNN architecture makes the system successfully recognise cars and classify the use of helmets with a highlevel of accuracy. The modular nature enables smooth video processing, evidence generation, and reporting, which is controlled by an easily understandable Streamlit dashboard. This automation eradicates human bias and fatigue besides assuring real-time accuracy. The paper emphasizes the need of scales and data-driven enforcement tools capable of changing to different settings and circumstances. These types of AI integration are a huge success in the direction of smarter and safer cities.

In addition to the technical performance, the project focuses on the overall societal and administrative effects of AI in the field of public safety. Automation in violation detection not only makes the enforcement faster but also creates transparency and responsibility in the process of law enforcement. Data analytics and visualization will enable the authorities to examine the behavioral tendencies and formulate specific campaigns of awareness. In addition, storing of digital evidence facilitates the legal checking and subsequent audits minimizing disputes and corruption. This discussion goes on to support the fact that the system is not simply a technical innovation but rather a practical governance tool that will work out as a bridge between technology and civic responsibility. Its flexibility to identify other contraventions such as triple riding or signal jumping makes it a base in the coming intelligent traffic systems.

VI. CONCLUSION

The suggested AI-powered traffic violation detection system demonstrates that deep learning and computer vision are capable of radically changing the way traffic is enforced in the present day by bringing automation, accuracy, and reliability to it. The combination of YOLO and CNN to detect and classify objects in real-time allows the system to identify cars, identify riders with no helmets, and create verifiable evidence with minimum human interference. The modular design of its video upload, frame extraction, analytics, and reporting will provide data flow and operational scalability. The interface based on Streamlit makes it easier to use; authorities can track, analyze, and record violations using an interactive open-source dashboard. In addition to technical performance, the project is solving more civic issues through encouraging digital transparency, lessening human bias, and increasing the efficiency of road safety enforcement. Accountability is enhanced by the provision of automated evidence creation, email notifications, and data visualization, which facilitates policymaking based on data. The system not only improves real-time enforcement of law as it stores digital records and offers comprehensive analytical information, but it is also an efficient basis in the evolution of the smart city traffic control in the future. Finally, the project can be seen as a significant milestone in the direction of intelligent, self-governing traffic ecosystems that can be used to integrate technology, governance, and public security to result in safer and smarter urban environments.

VII. ACKNOWLEDGMENT

This system can be further developed in the future to monitor more types of traffic offences, including signal jumping, triple riding, over speeding and the use of mobile phones whilst on the road. Incorporation of Automatic Number Plate Recognition (ANPR) will also be useful in the accurate identification of offenders. These improvements will allow having a more extensive surveillance system that can support various types of violations at the same time and increase the discipline and obedience of the road.

The Additional developments may be the introduction of cloud-based storage as well as real-time data synchronization to central government traffic databases. This would enable the authorities to be able to access records of violations remotely and trends at a level, whether it be on a city or a state level. Dashboards with live maps may also be included to view the hotspots of common violations and this will aid in the deployment of police resources in a more effective manner.

It is also possible to improve the system by adding edge AI and IoT-based smart cameras to process data on-site and not rely on high-end servers. Besides, reinforcement learning might enhance model flexibility to changing traffic conditions. These developments in the future will turn the proposed structure into a complete, intelligent, and self-protecting traffic monitoring ecosystem of smart cities.

REFERENCES

[1]. S. J. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 4th ed., Pearson, 2020. [1]

[2]. J. Redmon, S. Divvala, R. Girshick, and A. Farhadi, "You Only Look Once: Unified, Real-Time Object Detection," Proc. IEEE Conf. Computer Vision and Pattern Recognition (CVPR), pp. 779–788, 2016. [2]

[3]. Krizhevsky, I. Sutskever, and G. E. Hinton, "ImageNet Classification with Deep Convolutional Neural Networks," Communications of the ACM, vol. 60, no. 6, pp. 84–90, 2017. [3]

[4]. M. Everingham, L. Van Gool, C. K. I. Williams, J. Winn, and A. Zisserman, "The PASCAL Visual Object Classes (VOC) Challenge," International Journal of Computer Vision, vol. 88, no. 2, pp. 303–338, 2010.[4]

[5]. K. He, X. Zhang, S. Ren, and J. Sun, "Deep Residual Learning for Image Recognition," Proc. IEEE Conf. Computer Vision and Pattern Recognition (CVPR), pp. 770–778, 2016. [5]

[6]. S. Sharma and A. Bansal, "Helmet Detection Using Deep Learning and Computer Vision," International Journal of Engineering Research & Technology (IJERT), vol. 10, no. 8, pp. 450–456, 2021 [6].

[7]. R. Singh, P. Kumar, and S. Gupta, "Automated Detection of Traffic Rule Violations Using AI and IoT," IEEE Access, vol. 9, pp. 12045–12055, 2021. [7]

[8]. A Jain and R. Mehta, "Real-Time Motorcycle Helmet Detection Using YOLOv5 and OpenCV," International Conference on Intelligent Computing and Control Systems (ICICCS), pp. 1020–1026, 2022.[8]

[9]. D. Pathak and V. Patel, "AI-Based Road Surveillance System for Traffic Violation Detection," Journal of Intelligent Transportation Systems, vol. 27, no. 4, pp. 540–552, 2023. [9]

[10]. M. Bhattacharya and N. Dey, "Smart Traffic Management Using Machine Learning and IoT," Springer Advances in Intelligent Systems and Computing, vol. 1185, pp. 215–228, 2022.[10]