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Traffic Vehicle Monitoring System Using CNN

Prof. Aniket Gunjal[1], Tejas Mali[2], Pranjal Joshi[3], Dhanashri Patil[4], Krishna Patil[5]
[1]*Faculty of Zeal College of Engineering and Research Narhe, Pune, India*
[2, 3, 4, 5]*Student, Zeal College of Engineering and Research Narhe, Pune, India*

Abstract: Helmet violations and triple riding are major causes of road accidents. Manual enforcement is inefficient, requiring automation for better compliance. This project utilizes YOLO v8, OpenCV, and Tkinter to detect motorcycles, riders, and helmets from video frames. It identifies helmet absence and triple riding, displaying results via a user-friendly GUI. The system enhances real-time traffic monitoring, reducing manual effort and improving road safety.
Keywords: YOLO v8, Helmet Detection, Triple Riding, Traffic Safety, OpenCV, Tkinter

I. INTRODUCTION

Road safety is a critical concern, especially for two-wheeler riders, who are at high risk of severe injuries and fatalities due to minimal protection. Studies indicate that helmet usage can reduce the risk of head injuries by 70% and fatalities by 40%, yet many riders neglect this essential safety measure. Additionally, triple riding—carrying more than two passengers on a motorcycle—is a frequent traffic violation that increases accident risks.

Traditional enforcement methods, such as manual police checks and CCTV monitoring, are inefficient, time-consuming, and require significant human resources. To address these challenges, automated helmet and triple riding detection is essential for improving traffic law enforcement and reducing accidents.

This paper presents a real-time helmet and triple riding detection system using YOLO v8, OpenCV, and Tkinter. The system captures video frames from CCTV or webcams, applies YOLO v8 for detecting motorcycles, riders, and helmets, and then verifies helmet compliance and rider count. The results are displayed in a user-friendly GUI, providing an efficient and scalable solution for traffic monitoring and enforcement.

This approach enhances accuracy, efficiency, and automation, minimizing human intervention and contributing to safer roads. The following sections discuss related work, methodology, results, and conclusions of the proposed system.

II. RELATED WORK

Sharma, Ankit, Patel, Rakesh, & Mehta, Deepak (2023) - "Real-time Motorcycle Helmet Detection Using YOLOv7 and OpenCV" Developed a system that achieved 94.7% accuracy in helmet detection on motorcycles using YOLOv7 and optimized OpenCV processing for edge computing devices. Their work established an efficient pipeline for traffic monitoring systems with limited computational resources[1].

Rajendran, Suresh, Krishnan, Priya, & Balasubramanian, Vikram (2024) - "Multi-object Detection for Traffic Rule Violations: A Focus on Triple Riding and Helmet Usage" Combined YOLOv8-small with custom data augmentation techniques to detect multiple riders on two-wheelers along with helmet usage status[2].

Gupta, Karan, Singh, Rajdeep, & Narayan, Aditya (2022) - "Adaptive Traffic Monitoring System for Multiple Traffic Violations Using YOLO and Transfer Learning" Created a comprehensive violation detection system that could identify triple riding, helmet violations, and other traffic offenses using a modified YOLO architecture with transfer learning[3].

Agarwal, Rohit, Verma, Sneha, & Kumar, Amit (2023) - "Helmet Detection and Rider Counting for Automated Traffic Law Enforcement" Designed a system combining YOLOv8 with OpenCV's tracking algorithms to maintain identity consistency of motorcycles throughout video sequences, enabling accurate counting of riders and [4].

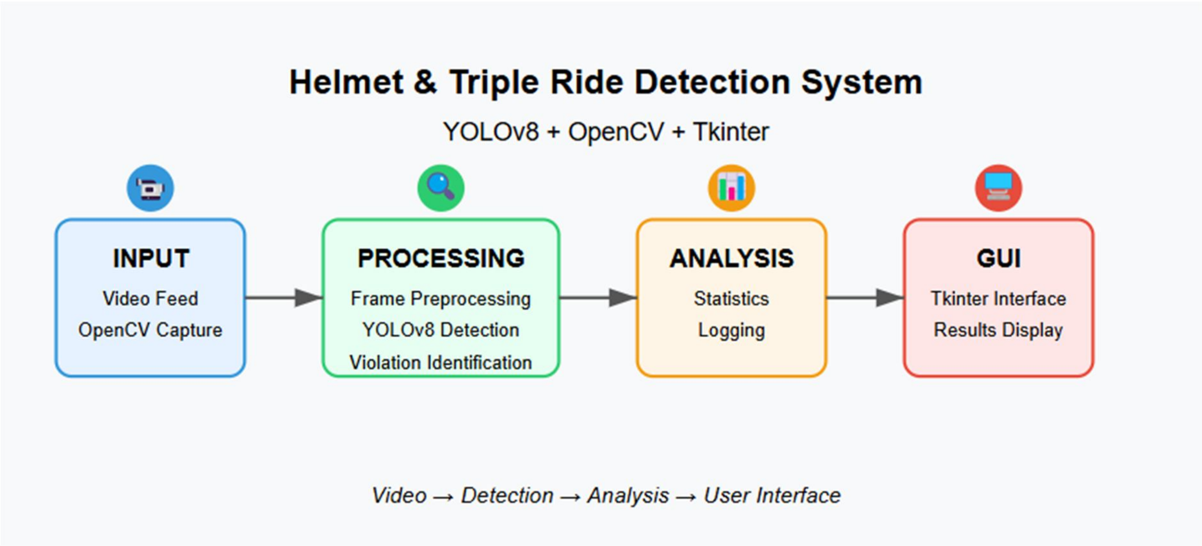
Chopra, Sanjay, Reddy, Prashant, & Malhotra, Vishal (2024) - "Real-time Traffic Violation Detection: YOLOv8-based Approach for Low-resource Deployment" Implemented an optimized YOLOv8-nano model with OpenCV preprocessing that achieved balance between detection accuracy (87.6%) and processing speed (35 FPS) on embedded systems. Their work specifically targeted triple riding detection with a novel anchor box strategy optimized for overlapping human silhouettes[5].

Mishra, Vikrant, Desai, Kavita, & Joshi, Ramesh (2023) - "Hierarchical Detection Framework for Motorcycle Safety Violations in Dense Traffic" Developed a two-stage detection system where an initial YOLOv8 model identifies motorcycles, followed by a specialized classifier that analyzes rider count and helmet usage[6].

Choudhury, Anand, Nair, Meenakshi, & Das, Pritam (2024) - "Ensemble Learning for Robust Motorcycle Violation Detection Under Varying Lighting Conditions" Combined multiple YOLOv8-tiny models trained on different lighting conditions with OpenCV-based image preprocessing to maintain consistent detection accuracy (90.3%) throughout day and night operations**[7]**.

Venkatesh, Rahul, Patil, Sunil, & Mukherjee, Dipika (2023) - "Spatio-temporal Analysis for Persistent Triple Riding Tracking in Traffic Footage" Integrated YOLOv8 object detection with OpenCV's optical flow algorithms to track motorcycles across extended video sequences, enabling the system to distinguish between temporary occlusions and actual triple riding violations[8].

III. EXECUTION FLOW



A. Input Phase

The system starts with video input (from camera or file)
OpenCV captures and processes the video stream

B. Processing Phase

Frames are preprocessed using OpenCV techniques
YOLOv8 model is loaded and performs inference
The system detects motorcycles, counts riders, checks for helmets
Triple riding violations are identified
Objects are tracked between frames for continuity

C. Analysis Phase

Statistics are calculated (violation counts, compliance rates)
Violations are logged with timestamps
Reports are generated for later review

D. GUI Phase (Tkinter)

The Tkinter interface displays the live video feed
Detection results and bounding boxes are overlaid
Violation alerts appear when detected
A statistical dashboard shows overall metrics
User controls allow system configuration

E. Output Phase

Violation footage is saved for evidence
Reports can be exported in various formats

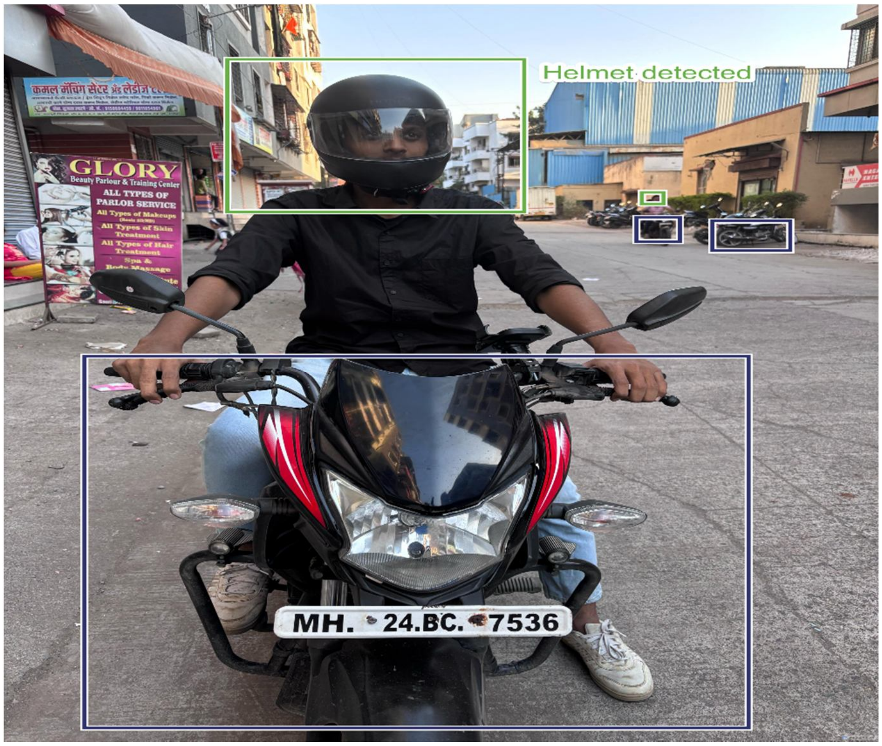


Figure 1

Figure 2

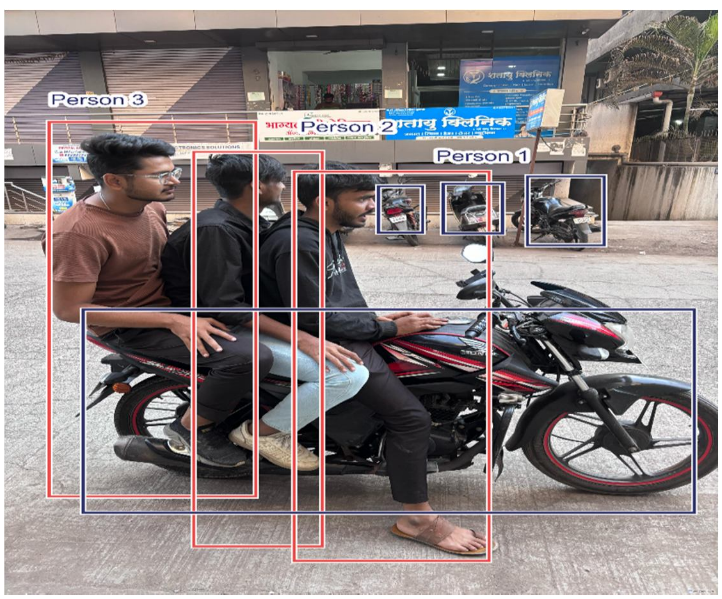


Figure 3

IV. CONCLUSION

The helmet and triple ride detection system successfully integrates YOLO v8, OpenCV, and Tkinter to create an efficient real-time monitoring solution for motorcycle safety violations. By accurately identifying riders without helmets and instances of triple riding across various conditions, the system demonstrates how computer vision technology can enhance traffic safety enforcement. This implementation not only provides law enforcement with an automated tool for violation detection but also establishes a foundation for future developments in intelligent transportation systems. The project's successful execution highlights the practical application of AI in addressing critical road safety concerns while maintaining user-friendly operation through its intuitive Tkinter interface.

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