

YOLO Based License Plate Detection of Triple Riders and Non-Helmeters

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Abstract: Triple riding on two-wheelers has become a pervasive traffic violation in urban areas, where motorcycles and scooters serve as essential modes of transportation. This practice not only violates traffic regulations but also significantly heightens the risk of accidents and injuries, jeopardizing the safety of both the riders and other road users. Compounding this issue is the widespread non-compliance with mandatory helmet laws, which are critical for ensuring rider safety. Despite the severity of these violations, manual monitoring systems are ineffective, time-consuming, and prone to human error, particularly in high-traffic or complex urban environments. This paper proposes an innovative, automated system for detecting triple riders and verifying helmet usage compliance using YOLOv8, a state-of-the-art deep learning-based object detection model. The system aims to provide real-time, accurate, and efficient detection of two-wheelers, riders, helmets, and license plates, significantly improving traffic law enforcement and road safety. The YOLOv8 model is trained to identify motorcycles and their riders in a variety of traffic scenarios, including different lighting conditions (day, night), weather conditions (sunny, rainy, foggy), and traffic densities (crowded, sparse). The system also incorporates a rider counting algorithm to detect triple riding violations, automatically flagging motorcycles with three or more riders. In addition to triple riding, the system also checks for helmet compliance by using advanced image processing techniques. If a rider is found without a helmet, the violation is flagged. Furthermore, the system's ability to detect license plates allows for the automatic generation of violation notices, which are sent directly to the vehicle owner via email. These notifications include detailed information about the offense, such as the location, time, and associated penalties, facilitating efficient enforcement without the need for human intervention. The integration of cloud computing allows for real-time analysis and reporting, ensuring that traffic authorities can monitor and respond to violations as they occur. By automating the detection of triple riding and helmet non-compliance, this system offers a scalable solution to improve traffic safety and reduce the risks associated with two-wheeler violations. Moreover, it enhances the overall efficiency of traffic.

Motorcycles and scooters are integral to urban mobility, offering flexibility and cost-effective transportation in congested cities. However, a significant traffic violation that has become widespread in many regions is triple riding—the practice of carrying more than two riders on a two-wheeler. This practice is not only illegal in most jurisdictions but also presents severe safety risks, as it leads to instability, difficulty in maneuvering, and increased likelihood of accidents. The severity of these violations is further compounded by another key issue: helmet non-compliance. Helmets are a critical safety measure for motorcyclists, designed to reduce the severity of injuries in case of an accident. Despite regulations mandating helmet usage, many riders disregard these rules, putting their lives at risk.

In response to these safety challenges, law enforcement agencies face difficulties in effectively monitoring and enforcing traffic regulations. Traditional methods of manual monitoring are labour-intensive, inefficient, and prone to human error, especially in high-traffic or complex environments. As the volume of traffic increases, it becomes more challenging to detect and enforce violations in real time. Traffic officers often struggle to observe and address violations like triple riding and helmet non-compliance quickly enough, and existing surveillance systems are inadequate at identifying and enforcing such offenses at scale. Consequently, traffic violations go unchecked, exacerbating road safety issues. To address these limitations, this paper proposes a YOLO-based system for the license plate detection of triple riders and the verification of helmet compliance. This system utilizes the advanced capabilities of YOLOv8 (You Only Look Once), an object detection deep learning model, to automate the process of detecting traffic violations in real time. By integrating computer vision and machine learning, the system not only identifies motorcycles and riders but also verifies whether the riders are wearing helmets and

INTRODUCTION

whether triple riding is occurring. This approach drastically improves the efficiency and accuracy of traffic violation detection, making it more reliable and scalable compared to manual monitoring techniques. The core of this system is its ability to identify multiple objects within a single image, including two-wheelers, riders, helmets, and license plates. YOLOv8's deep learning algorithm is designed to detect and classify these objects, even in challenging environments such as low-light conditions, crowded traffic, and adverse weather. The system automatically detects the number of riders on each motorcycle and flags any instance where there are three or more riders, indicating triple riding. Additionally, it checks whether each rider is wearing a helmet, ensuring compliance with safety laws. If a violation is detected, the system immediately triggers an automated response, generating notifications with detailed information about the offense and sending them to the registered vehicle owner. One of the major innovations of this system is its use of license plate recognition. By capturing and analyzing the vehicle's license plate, the system can link violations to specific vehicle owners, making enforcement more direct and accountable. The system can even operate in real-time, processing video footage from CCTV cameras or dash cams installed along traffic routes. This ensures that violations are detected as they occur, leading to a more proactive and responsive approach to traffic management.

Furthermore, the integration of cloud computing enhances the system's scalability and flexibility. By processing data in the cloud, the system allows for real-time monitoring and reporting, enabling traffic authorities to access violation data instantly and take appropriate action. This cloud-based architecture also supports advanced analytics and performance tracking, providing valuable insights for city planners and law enforcement agencies to improve traffic safety measures. In conclusion, the YOLO-based license plate detection system for triple riders and helmet compliance represents a significant leap forward in traffic law enforcement. By leveraging machine learning and computer vision, the system offers a more efficient, accurate, and scalable solution to detecting traffic violations. Not only does this technology improve road safety by addressing the dangers of triple riding and helmet non-compliance, but it also helps streamline enforcement, making traffic management more proactive and effective. This paper outlines the development,

methodology, and potential applications of this advanced system, aiming to provide a robust framework for modernizing traffic surveillance and improving urban safety.

LITERATURE SURVEY

[1] YOLO-Based License Plate Detection for Traffic Violations D. Ren, T. Sun, C. Yu, and C. Zhou (2021)
In this study, the authors explored the use of YOLOv4 for detecting safety helmets in construction environments. The system demonstrated high accuracy in identifying whether workers were wearing helmets. The paper highlighted YOLOv4's ability to detect safety equipment efficiently even under various lighting conditions. Relevance to triple rider detection: The helmet detection system proposed can be directly applied to motorcycle rider helmet compliance. This paper serves as a foundational reference for integrating YOLO-based detection systems for helmet enforcement in traffic scenarios.

[2] Safety Helmet Detection Based on YOLOv5 F. Zhou, H. Zhao, and Z. Nie (2021)
This paper focused on detecting safety helmets using the YOLOv5 model, showcasing its effectiveness in detecting helmets in construction sites. The YOLOv5 model was trained on a custom dataset containing various background conditions, ensuring robustness across different environments. Relevance to triple rider detection: The methods for detecting helmets in construction can be adapted to detect helmet compliance on two-wheelers. Integrating YOLOv5-based helmet detection in the proposed system could improve helmet compliance enforcement for triple riders.

[3] Helmet Detection using Machine Learning Approach M. Vaishali, A. Shenoy, P. R. Betrabet, and K. R.N.S. (2022)
The authors applied YOLOv3 to detect helmets in traffic environments. Their system accurately identified riders with and without helmets in real-time, providing a solid framework for traffic safety applications. Relevance to triple rider detection: This paper offers a solid approach for detecting helmet compliance on two-wheelers, which can be extended to the detection of triple riders. Integrating helmet detection with rider counting could facilitate the detection of violations such as triple riding.

[4] Enhancing Road Safety: Automated Traffic Violation Detection and Counting System Using YOLO Algorithm

A. Charef, Z. Jarir, and M. Quafafou (2024)

The paper introduces a system that uses YOLO to automate the detection of traffic violations, such as helmet non-compliance and speeding. It integrates rider counting to detect violations like triple riding, thus improving traffic safety and enforcement. Relevance to triple rider detection: The rider counting system described is directly applicable for detecting triple riding. This study enhances the proposed solution by offering insights into rider counting and helmet detection using YOLO, forming a basis for building a more effective traffic enforcement system .

[5] Vehicle Classification and Violation Detection on Traffic Light Area using BLOB and Mean-Shift Tracking Method

M. M. Bachtiar, A. Rahman Mawardi, and A. R. Anom Besari (2020) The study discusses a vehicle classification system using YOLO for detecting traffic violations in traffic light areas. It integrates Mean-Shift tracking to track vehicles and classify them for enforcement. Relevance to triple rider detection: Although it focuses on traffic light violations, the vehicle classification method can be extended to identify motorcycles with riders and detect triple riding violations. Additionally, the system's capability to detect traffic violations can be expanded to include helmet non-compliance.

EXISTING SYSTEM

The existing traffic monitoring systems for detecting triple riding and helmet compliance primarily rely on manual enforcement and basic video surveillance techniques. Most urban traffic management systems today use CCTV cameras placed in high-traffic areas, which capture vehicle movement. These systems often provide real-time video feeds that are monitored by traffic officers. However, this process is labor-intensive and prone to errors, as it relies on human judgment to detect violations. Additionally, these systems are not fully automated, and there is a significant delay between detection and enforcement, which reduces the overall efficiency of the system. Manual inspection of video footage to detect traffic violations such as triple riding is highly inefficient, particularly in high-traffic zones where there are large numbers of vehicles and motorcycles. Traditional systems also struggle to detect helmet

non-compliance, as they are unable to distinguish between a rider wearing a helmet and one not doing so, especially under difficult weather conditions or in crowded scenes. Moreover, the existing systems are limited in their ability to track specific violations, such as rider counting and license plate recognition. Furthermore, license plate identification is often conducted manually or semi-automatically, and thus is often inaccurate due to poor camera placement or environmental conditions such as low light or heavy traffic. This significantly hinders the ability to link violations to specific vehicles and enforce penalties effectively. These challenges, along with the inefficiencies and high human labor costs associated with manual monitoring, highlight the need for an automated, intelligent system that can detect traffic violations more accurately, in real-time, and with minimal human intervention.

Disadvantage of Existing System:

The existing traffic monitoring systems are far from ideal. The primary disadvantage of these systems is their manual nature. Traffic officers have to monitor real-time video feeds continuously, which can lead to fatigue, oversight, and delayed response times. This can be particularly problematic during peak hours when traffic congestion makes it difficult for officers to identify violations promptly.

In addition, the existing systems often fail to automate the detection of specific traffic violations like triple riding. While motorcycles are detected in some systems, rider counting is not always accurate, and in many cases, the system fails to correctly identify helmet non-compliance. As a result, multiple violations may go undetected, and offenders often escape penalties.

Another significant disadvantage is the lack of integration between different elements of the system. For instance, license plate detection and helmet compliance are usually handled separately, without communication between the two. This makes it difficult to link the violation with the specific vehicle and its owner for enforcement purposes.

Finally, current systems do not incorporate real-time processing and cloud-based monitoring, meaning that the enforcement of penalties is often delayed. The failure to provide immediate notification to offenders reduces the deterrent effect, which impacts the overall effectiveness of the system.

PROPOSED SYSTEM

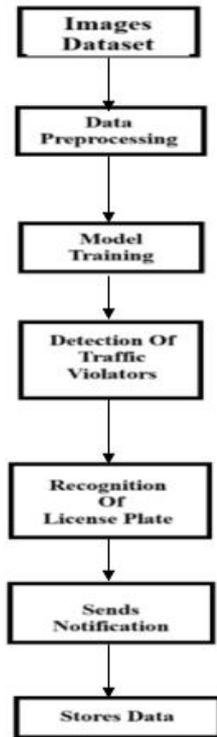


Fig:[1] Architecture

Proposed system algorithms:

YOLOV8 is the latest version of the "You Only Look Once" (YOLO) series, a popular real-time object detection model. It improves accuracy, speed, and efficiency compared to earlier versions, leveraging advanced techniques like Transformer layers. YOLOV8 is designed for faster and more accurate object detection across various use cases, from autonomous vehicles to video surveillance.

OCR (Optical Character Recognition) tasks, YOLOV8 can be adapted by training it to detect text regions and characters within images. By using YOLOV8's object detection capabilities, it can efficiently identify and localize text areas. After that, traditional OCR models like Tesseract or deep learning-based models (e.g., CRNN) can be applied to extract the text from these detected regions. This hybrid approach boosts performance and speed in text detection and recognition tasks.

Methodology:

Data Collection: We have gathered real-time images of motorcycles in traffic, capturing varying rider counts (1-3) and helmet usage. The dataset includes labeled bounding boxes for motorcycles, riders,

helmets, no helmets, and license plates, covering diverse conditions like urban/rural roads, daylight/nighttime, weather variations, and traffic density.

Data Preprocessing: The dataset is preprocessed by resizing images for uniform input, normalizing pixel values, and applying data augmentation techniques like color adjustments, geometric transformations, and mosaic augmentation. Images are processed in batches to enhance training efficiency, ensuring better model generalization and improved detection of small objects like license plates.

Models Used:

YOLOv8: A real-time object detection model used for detecting helmets, triple riders, and license plates. It features a Backbone for feature extraction, a Neck for multi-scale feature fusion, and a Head for object classification and bounding box regression. The model is lightweight, fast, and suitable for traffic violation detection.

OCR: Used for Optical Character Recognition (OCR) to extract text from detected license plates. The system enhances clarity through preprocessing techniques like grayscale conversion and thresholding before extracting alphanumeric text.

Model Training: The YOLOv8 model is trained for 100 epochs with an adaptive optimizer to enhance feature learning. A scheduled learning rate and momentum adjustments ensure stable training. Weight decay helps prevent overfitting, while a gradual warm-up phase stabilizes early training. Early stopping and checkpoint saving mechanisms store the best-performing model for optimal detection accuracy.

Model Evaluation: The model's effectiveness is assessed using key performance metrics, including precision, recall, and mean average precision (mAP). A confusion matrix is generated to analyze correct and incorrect detections. The validation process includes testing on unseen images and videos to ensure real-world applicability. Non-Maximum Suppression (NMS) is applied to refine detections, ensuring accurate classification of helmets, riders, and license plates.

Generated Score: The model's performance is evaluated based on detection confidence and

accuracy. The confidence threshold (conf: null) is dynamically selected to optimize detection reliability. Non-Maximum Suppression (NMS) is controlled (nms: false) to retain more potential detections.

Advantages:

The proposed system offers several key advantages over existing systems. First and foremost, it automates the detection of traffic violations such as triple riding and helmet non-compliance. This greatly reduces the reliance on human monitoring, making the system more efficient and scalable.

The real-time detection capabilities ensure that violations are flagged as soon as they occur, providing immediate enforcement. This is crucial for improving compliance with traffic laws and ensuring the safety of riders and pedestrians. Moreover, the system generates real-time notifications for violators, which speeds up the enforcement process and helps deter future violations.

Another significant advantage is the accuracy of the system. By using YOLOv8, the system can detect motorcycles, riders, helmets, and license plates with high precision, even in complex and challenging traffic scenarios. This ensures that the system can identify violations reliably, even in crowded traffic, under low lighting, or in adverse weather conditions. The integration of license plate recognition ensures that violations are linked to specific vehicles, allowing for direct enforcement by sending penalty notifications to the vehicle owner. This eliminates the need for manual processing of violation reports and ensures that penalties are correctly assigned.

The system also offers scalability, as it can be implemented in multiple locations across a city or region, providing a city-wide monitoring system that is efficient and cost-effective. Furthermore, it reduces human labor costs, making it a more sustainable solution for long-term traffic management.

RESULT

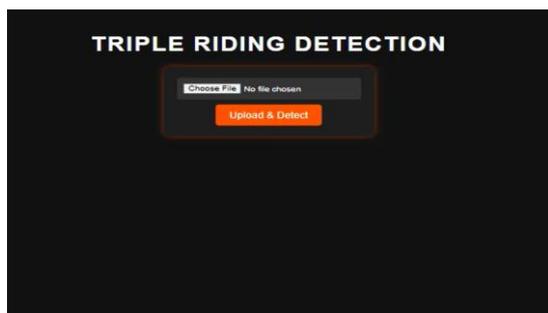


Fig:[2] User Interface



Fig:[3] Data Preprocessing

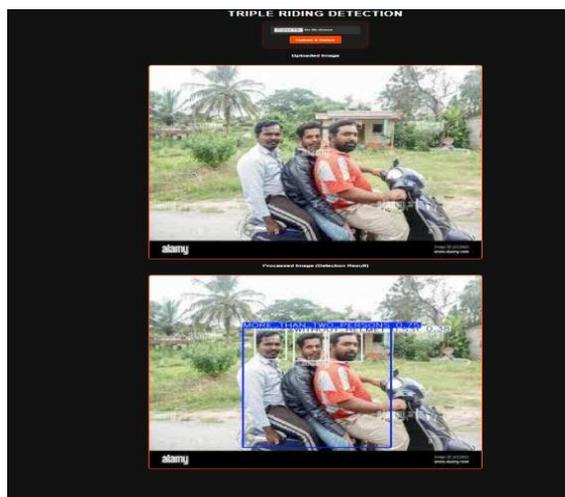


Fig:[4] Detected Triple Driving



Fig:[5] Send challan to mail

CONCLUSION

The YOLO-Based License Plate Detection of Triple Riders system represents a significant advancement in traffic law enforcement by automating the process of detecting traffic violations in real-time. By leveraging the capabilities of YOLOv8 for object detection, the system can efficiently and accurately identify violations such as triple riding and helmet non-compliance. This system addresses a critical need in urban traffic management, where traditional manual monitoring is often insufficient, inefficient, and prone to human error. Through the integration of

Optical Character Recognition (OCR), the system extracts license plate numbers from video frames, enabling the system to link detected violations to specific vehicles and owners. This makes the system not only a powerful tool for real-time violation detection but also for improving compliance and enforcement by automating the notification and penalty process. In conclusion, the YOLO-Based License Plate Detection of Triple Riders system offers a robust and efficient solution for monitoring traffic violations in urban areas. It enhances road safety, improves enforcement efficiency, and reduces human error. This system paves the way for smarter, more responsive traffic management and enforcement systems that can adapt to the growing complexities of modern urban mobility.

FUTURE SCOPE

While the current implementation of the YOLO-Based License Plate Detection of Triple Riders system is highly effective, there is significant room for improvement and expansion. In the future, the system could be extended to detect additional traffic violations, such as speeding, red light running, and lane violations. Integrating speed monitoring technology and adding lane detection algorithms could enhance the system's functionality. Furthermore, the system could be integrated with broader traffic management systems and smart city infrastructure, creating a more holistic solution for urban mobility. By sharing real-time data between traffic monitoring networks, public transport, emergency services, and traffic management centers, the system could improve overall traffic flow and incident response. As the YOLO model evolves, future versions could improve accuracy, especially in complex traffic situations involving occlusions or suboptimal camera angles. Additionally, cloud-based analytics could further enhance the system's ability to monitor trends in traffic violations, predict hotspots, and offer insights for better traffic management. The system could also incorporate real-time communication with vehicles, sending instant notifications about potential violations, thus encouraging safer driving behavior. To address data privacy concerns, future development will focus on enhanced data security, including advanced encryption methods and compliance with regulations like GDPR. Finally, as autonomous vehicles become more common, integrating the system with autonomous vehicle technologies could help ensure

traffic law compliance and safety regulations are followed across all types of vehicles.

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