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International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Bike Riders Detection Without Helmet and Triple Seat

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ABSTRACT:

Road safety violations such as riding without helmets and carrying more than two passengers on a two-wheeler (triple seat) are major causes of accidents, especially in densely populated regions. This project proposes a smart surveillance system that automatically detects such violations using machine learning techniques integrated with a Raspberry Pi. The system employs real-time video input from a camera module connected to the Raspberry Pi, which processes the footage using a trained deep learning model to identify two key violations: absence of helmets and presence of more than two riders on a bike. Convolutional Neural Networks (CNNs) are used for accurate object detection and classification. Once a violation is detected, the system captures the image, tags the violation, and stores or transmits the data for further action. This solution is cost-effective, portable, and can be deployed in urban traffic environments to assist authorities in monitoring and improving road safety. The integration of machine learning with embedded systems offers a promising approach to automated traffic rule enforcement.

Keywords: Machine Learning, Computer Vision

Introduction:

In recent years, road safety has become a critical concern due to the increasing number of accidents caused by traffic rule violations. Among the most common violations observed on Indian roads and in many developing countries are riding two-wheelers without helmets and carrying more than two people on a bike, commonly referred to as triple riding. These practices not only endanger the lives of the riders but also put other road users at risk. Traditionally, traffic violations are monitored manually by traffic police, which is time-consuming, inefficient, and prone to human error. To address this issue, there is a growing need for automated systems that can detect such violations in real-time. With advancements in artificial intelligence, machine learning, and embedded systems, it is now possible to build cost-effective and intelligent surveillance solutions.

This project aims to design and implement a smart detection system using Raspberry Pi and machine learning algorithms to automatically identify two major violations: riding without a helmet and triple seat riding. A camera module captures live video, which is processed using a trained deep learning model capable of detecting the number of people on a bike and whether the riders are wearing helmets. The compact and affordable nature of the Raspberry Pi makes it ideal for real-time deployment in various traffic monitoring scenarios

By automating the detection of these violations, the proposed system helps in reducing the burden on traffic authorities, improving enforcement efficiency, and ultimately promoting safer driving behavior among two-wheeler riders.

Literature Survey

The growing concern for road safety, especially regarding motorcycle usage, has led to the development of innovative monitoring systems aimed at enforcing compliance with safety regulations. Key areas of focus in recent research include helmet usage detection, passenger limit monitoring, and the integration of real-time automated systems.

Automated helmet detection systems have attracted considerable research attention due to their potential to improve road safety. Studies such as Pramono et al. (2020) demonstrate the application of Convolutional Neural Networks (CNNs) for real-time and accurate helmet detection. These systems significantly aid in distinguishing between helmeted and non-helmeted riders, thereby enhancing safety enforcement on roads.

In parallel, the monitoring of passengers on motorcycles is recognized as vital for ensuring adherence to passenger limits. Algorithms like YOLO (You Only Look Once) have shown high efficiency in detecting and counting passengers, as reported by Zhou et al. (2019). Khan et al. (2022) further emphasized the importance of integrating machine learning with real-time monitoring to improve the accuracy and reliability of such systems.

The integration of automated systems using technologies like Raspberry Pi and camera modules has also demonstrated positive outcomes. Singh et al. (2021) reported a significant improvement in the detection of helmet and passenger violations, compared to traditional monitoring methods. Kumar et al. (2020) highlighted the importance of intelligent traffic management systems capable of real-time monitoring and reporting.

Real-time notification systems are equally important. Ahmed et al. (2018) found that systems that immediately alert authorities upon detecting violations enhance response efficiency and enforcement effectiveness. Furthermore, mobile applications have been recognized by Ranjan et al. (2021) as vital tools in facilitating user-friendly interfaces for reporting violations and improving communication between riders and enforcement agencies.

However, challenges remain in the deployment of these monitoring systems. Factors like helmet design variations, environmental conditions, and privacy concerns can affect system accuracy and acceptance. Gupta et al. (2022) stressed the need for adaptable algorithms and robust security frameworks to ensure data protection and regulatory compliance.

In addition to technological solutions, legislative measures and public awareness campaigns play a crucial role. Research by Sharma et al. (2021) demonstrated that strict enforcement of traffic laws, combined with educational initiatives, can lead to a measurable decrease in traffic violations and accidents. This underscores the necessity of a comprehensive approach that includes both technological and educational interventions.

System Development

The system works by using a camera connected to a Raspberry Pi, which is placed in a location like a traffic signal or roadside where bikes pass frequently. The camera continuously captures live video or images of the vehicles on the road. These images are processed in real-time by the Raspberry Pi, which runs a machine learning model trained to detect motorcycles, the number of people riding the motorcycle, and whether or not they are wearing helmets.

When an image is captured, the machine learning model analyzes it to identify the presence of a motorcycle and counts how many people are sitting on it. At the same time, it checks whether the people on the bike are wearing helmets by detecting a helmet object on their heads. If a person is riding the bike without wearing a helmet, the system considers it a “no helmet” violation. Similarly, if there are more than two people on a motorcycle, the system identifies it as a “triple seat” violation.

Once a violation is detected, the Raspberry Pi stores the image as evidence and records important details like the date, time, and type of violation. This data can be saved locally in a small database or sent to a central server or traffic control system over Wi-Fi or a GSM module. Optionally, the system can be extended to recognize vehicle number plates and send automatic alerts or generate challans (fines). All of this happens automatically, without needing a human to watch the video or manually check for violations.

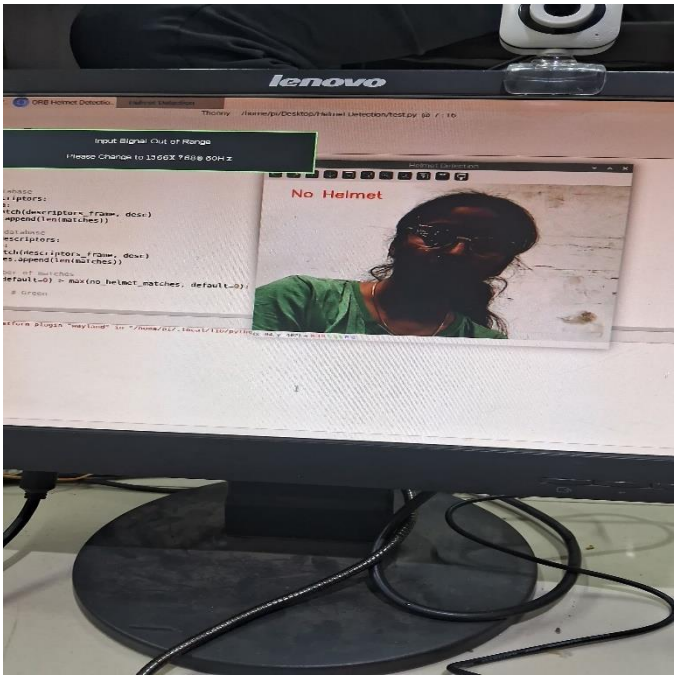

Fig.1 Without Helmet

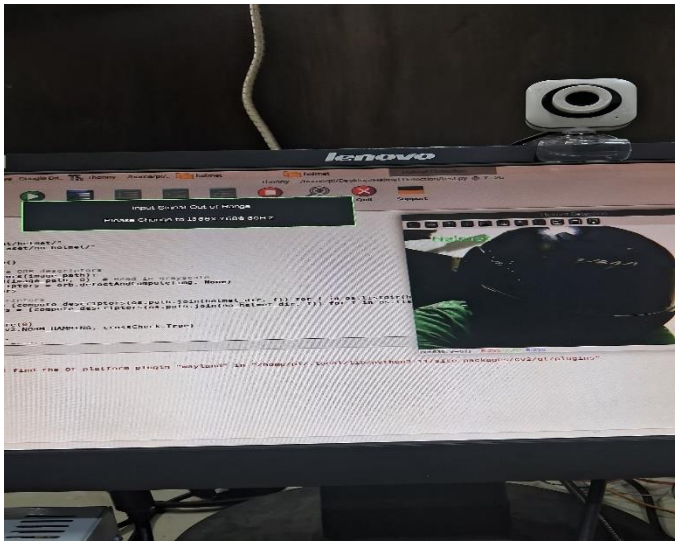

Fig.2 With Helmet

Conclusion

Ensuring the safety of motorcycle riders is a growing concern, especially with the increasing number of violations such as riding without helmets and carrying more than two passengers. This study emphasizes the potential of automated detection systems to monitor and identify such violations accurately. By utilizing advanced technologies like machine learning and computer vision—particularly object detection models—these systems can reliably detect riders without helmets and instances of triple riding in real-time.

The deployment of such systems not only improves enforcement efficiency but also supports the broader goal of promoting safe riding behavior. Real-time alerts and mobile-based reporting tools further strengthen communication between monitoring systems and traffic authorities, enabling timely intervention. Despite existing challenges such as environmental conditions and detection accuracy in complex scenarios, these limitations can be addressed through algorithm optimization and robust system design.

Ultimately, the integration of intelligent monitoring technologies with strict law enforcement and awareness initiatives can lead to a meaningful reduction in traffic violations. A combined strategy involving technology, regulation, and education is key to fostering a safer road environment for all users.

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