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Non-Helmet Rider Detection and Number Plate Extraction using YOLO and OCR

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ABSTRACT: Road safety in India is a major concern, with many fatal two-wheeler accidents caused by helmet noncompliance. Manual CCTV monitoring is inefficient, prompting the need for automation. This project proposes a realtime system using YOLOv2/YOLOv3 for detecting helmet violations and OCR for license plate extraction. It works with standard webcams, making it cost-effective and scalable. The system reduces human effort, enhances enforcement accuracy, and can integrate with smart traffic systems to issue penalties automatically. By automating helmet rule enforcement, this solution improves road safety and supports efficient, real-time monitoring in urban areas, ultimately reducing accidents and saving lives.

KEYWORDS: Road Safety, Motorcycle Accidents, YOLOv2 / YOLOv3, Deep Learning, OCR License Plate Recognition.

I. INTRODUCTION

The rise in motorcycle use in India has increased helmet-related traffic violations, leading to many fatalities. Manual enforcement using CCTV is slow, labour-intensive, and error-prone. This project proposes an automated Non-Helmet Rider Detection System using YOLOv2 and YOLOv3 for real-time detection of motorcycles, riders, and helmets. When a violation is found, OCR extracts the license plate number for automatic identification and enforcement. The system stores data for issuing fines, reducing human effort. Cost-effective and scalable, it integrates with existing traffic systems and can be extended to detect other violations like signal jumping and over speeding, improving overall road safety and enforcement.

II. LITERATURE SURVEY

Shashidhar R. [1] analyzed an automated detection system employing YOLOv2 and OCR to identify helmetless motorcyclists and extract license plate numbers from video footage. The study emphasizes the system's potential to improve traffic law enforcement by minimizing manual monitoring and increasing efficiency. However, it does not delve into how the system would perform in practical, large-scale deployments or how adaptable it is in rural or low-bandwidth environments where infrastructure may be limited.

P. Vinaya Sree [2] proposed a hybrid deep learning framework that uses YOLOv2 for motorcycle and person detection, YOLOv3 for helmet detection, and OCR for license plate number extraction. The research underscores the importance of automating helmet rule enforcement to enhance road safety. Nevertheless, it lacks a thorough discussion of integration complexities, latency in real-time detection, and performance variations across different weather or traffic conditions.

A. Sanjeev Kumar [3] presented a convolutional neural network (CNN)-based solution that targets helmet law violations and leverages OCR to extract number plate data. While the method is sound in terms of algorithmic structure, the paper does not provide implementation specifics, practical testing environments, or results that reflect real-world traffic settings, limiting its applicability for deployment in actual traffic monitoring systems.





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Ramat Enki Anitha [4] employed a YOLO-based model trained on an Indian two-wheeler dataset and achieved an accuracy of 91.3% in detecting helmetless riders. Although the detection performance appears robust, the paper does not address limitations such as OCR inaccuracies caused by motion blur, poor lighting, or non-standard license plates. Furthermore, scalability and processing efficiency under continuous surveillance conditions are not thoroughly explored.

Pathi Sudharshan [5] developed a system combining traditional image processing techniques with YOLO for helmet detection and OCR for license plate extraction. The research highlights the system's ability to reduce manual enforcement burden. However, it falls short in presenting technical evaluations such as false positive rates, detection confidence thresholds, or methods to handle corrupted or partial video inputs, all of which are essential for deployment readiness.

Dr. T. V. S. Sriram [6] created a YOLOv5-based detection mechanism with an innovative data storage strategy, wherein OCR results are systematically recorded in CSV format for further use. The architecture offers modularity and traceability. However, the paper omits critical information regarding system hardware dependencies, processing time per frame, data security protocols, and how the system would ensure compliance with privacy regulations in video surveillance applications.

Vivek Pratap Singh [7] integrated YOLOv2 and YOLOv3 models along with OCR into a unified detection pipeline capable of handling end-to-end traffic law enforcement from video input to violation documentation. While the model's structure is comprehensive and logically sequenced, it lacks a performance assessment under dynamic environmental conditions such as glare, rain, or nighttime operation. Moreover, no benchmarks on processing speed or comparative studies with existing methods are included.

Dishant Padala [8] proposed a real-time surveillance system focused on high-traffic highway areas, using YOLO for object detection and OCR for plate recognition. The framework is ideal for environments where manual monitoring is impractical. Still, it does not tackle challenges like continuous data streaming, bandwidth optimization, or hardware and network infrastructure requirements for deployment over large geographies. Furthermore, the scalability and maintainability of such systems remain unexplored.

III. PROPOSED METHODOLOGY AND DISCUSSION

3.1 System Architecture:

The flowchart outlines a system for detecting motorcyclists not wearing helmets and extracting their license plate numbers. The process begins with video input, followed by background subtraction to isolate moving objects. A classifier distinguishes between motorcyclists and non-motorcyclists—non-relevant subjects are discarded.

For detected motorcyclists, head localization is applied to identify helmet use. If a helmet is detected, the subject is discarded; otherwise, the system proceeds to number plate detection/localization. The plate is then segmented into individual characters, which are processed using Optical Character Recognition (OCR) to extract the registration number. The system ensures automated, real-time helmet rule enforcement and rider identification.





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3.2 Process Flow

The project describes a real-time video processing system for helmet detection and license plate recognition. It begins with live video input, extracts frames at intervals, and uses background subtraction to isolate moving motorcyclists. Preprocessing enhances frame quality for better model accuracy. This optimized pipeline improves performance, reduces computational load, and ensures efficient detection in smart city applications. The approach balances speed and accuracy for effective traffic monitoring and law enforcement.



Figure 2: Process Flow Diagram





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3.3 Methodology

The methodology for non-helmet rider detection and number plate extraction involves a structured video analysis pipeline using deep learning and image processing techniques. Initially, live video footage is captured and divided into frames at regular intervals to reduce data load. Background subtraction is applied to isolate moving objects, particularly motorcyclists. A classifier such as YOLO (You Only Look Once) identifies motorcycles and riders, followed by head localization to check for helmet presence. Riders without helmets are flagged for further processing. The system then localizes the number plate on the detected vehicle, segments the characters, and uses Optical Character Recognition (OCR) to extract the license number. This automated process enhances road safety by enabling real-time monitoring and enforcement of helmet compliance through intelligent traffic surveillance.

3.4 Implementation

The Non-Helmet Rider Detection and Number Plate Extraction system is implemented as a robust web-based application integrating real-time video analysis with deep learning and OCR technologies. It combines a responsive frontend for user interaction with a Python-powered backend to process video inputs, detect violations, and extract license plate details. The system is designed to ensure high accuracy, scalability, and ease of use for traffic enforcement agencies.

- Built using React.js for dynamic, modular, and user-friendly frontend interaction.
- Styled with Bootstrap to ensure responsive layouts across various screen sizes.
- HTML/CSS/JavaScript used for foundational UI development and client-side scripting.
- Video Upload Module enables users to upload traffic footage for analysis.
- Real-Time Detection Display highlights non-helmet riders and displays number plate results.
- Dashboard summarizes processed data, presenting violation statistics in a clear format.
- Python backend implements detection logic using YOLOv3 for object recognition.
- OpenCV handles frame extraction and preprocessing for improved detection accuracy
- Tesseract OCR extracts license plate numbers from localized vehicle regions.
- Flask provides RESTful APIs to bridge frontend inputs with backend processing.

3.5 Discussion

The implemented Non-Helmet Rider Detection and Number Plate Extraction system demonstrates an efficient integration of frontend and backend technologies to automate traffic violation monitoring. The use of React.js and Bootstrap ensures a responsive, user-friendly interface, while the video upload module allows easy input for analysis. In the backend, YOLOv3 effectively detects non-helmet riders and vehicle components, with OpenCV supporting video frame extraction and image preprocessing. Tesseract OCR successfully extracts license plate text, enabling identification of violators. Flask facilitates seamless communication between frontend and backend through RESTful APIs. This modular setup, combining powerful detection algorithms with real-time display, provides a scalable and reliable solution for smart surveillance, significantly reducing manual efforts and enhancing road safety enforcement in urban and potentially rural areas.

IV. EXPERIMENTAL RESULTS

Here the project, detects the Rider, wearing helmet or not and Number plate using YOLO (You Only Look Once) and OCR. where the video is divided into different numbers of frames and the detect the rider, helmet and Number plate. OCR helps to Extract the Number plate Accurately.





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Figure 1: output of project



Figure 2: output of Another input

V. CONCLUSION AND FUTURE WORK

The Non-Helmet Rider Detection and Number Plate Extraction system uses YOLO for helmet detection and OCR for reading number plates, reducing manual traffic monitoring. It automates alerts to police and maintains violation records, enabling faster enforcement and fine management. Integration with government databases can streamline violation tracking, offender history, and fine collection across cities. The system collects valuable data on violation locations and times, supporting better road safety planning and policy-making. Future upgrades may include real-time

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GPS tracking, analytics dashboards, and predictive features to prevent violations. Prioritizing accuracy, scalability, and affordability, this technology aims to enhance traffic law enforcement, reduce fatalities, and make roads safer by enabling targeted interventions and improving transparency and accountability in traffic management.

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