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Smart Surveillance For No-Helmet Violations And License Plate Identification

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Abstract - *Helmet non-compliance among two-wheeler riders remains a major cause of severe injuries and fatalities in road accidents. Manual monitoring and challan generation by traffic authorities is time-consuming, inconsistent, and prone to human error, especially in high-traffic areas. To address this issue, this paper presents an AI-Based Helmet Violation Detection and E-Challan Generation System using deep learning and computer vision techniques. The proposed system allows users to upload an image of a two-wheeler rider through a web interface. A YOLO-based object detection model is used to verify the presence of a rider and detect helmet usage. If a helmet violation is identified, the system automatically detects the vehicle number plate using a dedicated YOLO model and extracts the registration number through OCR using EasyOCR. Based on the extracted details, the system generates an electronic challan with a fixed fine amount of ₹235. All challan records, evidence images, timestamps, and generated PDFs are stored in a database for future reference. The system provides a user-friendly interface for result visualization, challan download, and challan history tracking. The proposed solution improves enforcement efficiency, reduces manual workload, and supports scalable integration into smart traffic surveillance systems.*

Key words : Helmet Detection, E-Challan Generation, YOLO, Number Plate Recognition, EasyOCR, Computer Vision, Deep Learning, Django, Traffic Rule Enforcement.

1. INTRODUCTION

Two-wheeler vehicles are one of the most widely used modes of transportation due to their affordability and convenience. However, the rise in two-wheeler usage has also led to an increase in road accidents, many of which result in severe head injuries and fatalities. Wearing a helmet is one of the most effective safety measures for reducing the impact of accidents. Despite strict traffic regulations, helmet non-compliance is still commonly observed, especially in densely populated urban areas. Manual monitoring by traffic police is often limited by manpower, traffic volume, and environmental conditions, which reduces the efficiency of enforcement.

With the advancement of Artificial Intelligence (AI) and Computer Vision, automated systems have become more effective for traffic surveillance and safety rule enforcement. Deep learning-based object detection algorithms such as YOLO (You Only Look Once) provide real-time detection with high accuracy and can be deployed in practical applications such as helmet detection and number plate recognition. Integrating such technologies into a digital enforcement system can significantly reduce manual effort and improve transparency in challan generation.

This project proposes an AI-Based Helmet Violation Detection and E-Challan Generation System that automates the process of detecting helmet violations and generating electronic challans. The system accepts an uploaded image of a two-wheeler rider, detects whether the rider is wearing a helmet, and if not, identifies the vehicle's number plate and extracts the registration number using OCR. A challan is then generated with a predefined fine amount and stored in a database along with evidence and timestamp. The system also provides downloadable PDF challans and challan history for monitoring and record maintenance.

1.1 Motivation

Helmet usage plays a vital role in reducing head injuries, yet many riders ignore safety regulations. The motivation behind this work is to create an automated and reliable enforcement system that encourages helmet compliance and enhances road safety.

1.2 Problem Statement

Existing traffic enforcement methods rely heavily on manual monitoring, which is inefficient and prone to errors. There is a need for an automated system that can detect helmet violations and generate challans accurately with supporting evidence.

1.3 Objectives

The main objectives of the proposed system are to detect the presence of a rider, verify helmet usage, recognize the vehicle number plate, generate an e-challan with fine details, and store all challan records in a database for future reference.

1.4 Scope of the Work

The scope of this project includes helmet detection, number plate detection, OCR-based vehicle number extraction, automatic challan generation, PDF generation, and challan history tracking through a Django-based web application. The system can be further extended for real-time CCTV-based monitoring and integration into smart city traffic management systems.

2. PROPOSED SYSTEM

The proposed system is an AI-Based Helmet Violation Detection and E-Challan Generation System designed to automate the process of detecting helmet violations and generating electronic challans with evidence. The system takes a two-wheeler rider image as input through a web interface, verifies helmet compliance using deep learning, and automatically generates a challan when a violation is detected. The complete workflow integrates object detection, OCR, database storage, and PDF generation in a single platform.

2.1 System Overview

The system begins by allowing the user to upload a two-wheeler rider image through a Django-based web application. After upload, the image is processed using a YOLO-based deep learning model to detect the presence of a rider and identify helmet usage. The system is designed with proper decision logic to avoid false challans. If no person is detected, the system directly returns the result as "No Person Detected". If a rider is detected and a helmet is present, the result is shown as "No Violation". If a rider is detected without a helmet, the system proceeds to number plate detection and challan generation.

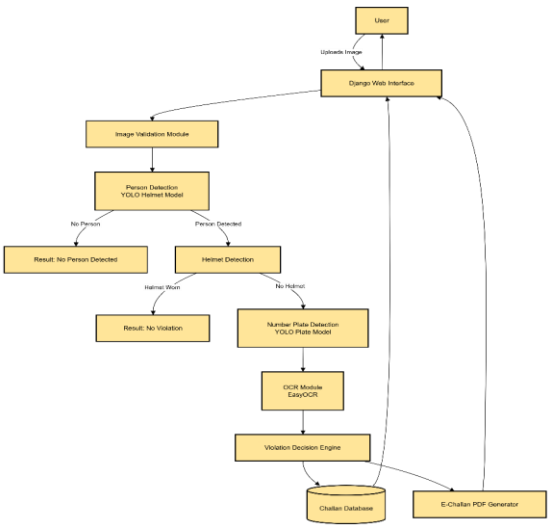

Fig- 1: System Architecture of AI-Based Helmet Violation Detection and E-Challan Generation System

2.2 Helmet Violation Detection

Helmet detection is performed using a trained YOLO object detection model (Helmate_detector.pt). The model analyses the uploaded image and identifies two key classes: person and helmet. The system ensures helmet verification is performed only after confirming that a rider is present in the image. If a rider is detected and the helmet is missing, the system classifies it as a valid helmet violation. This module is the core component of the proposed system and plays a crucial role in improving road safety through automated compliance checking.

2.3 Number Plate Detection and OCR

When a helmet violation is detected, the system activates the number plate detection pipeline. A second YOLO model (license_plate_detector.pt) is used to locate the number plate region from the same image. Once the number plate area is detected, it is cropped and passed to the OCR engine (EasyOCR) for extracting the vehicle registration number. If the extracted text is empty or unclear, the system returns the vehicle number as "Number Plate Not Clear", ensuring that incorrect challans are not generated due to OCR errors.

2.4 Challan Generation and Data Storage

After extracting the vehicle number, the system automatically generates an electronic challan with a predefined fine amount of ₹**235**. A professionally formatted PDF challan is generated using the ReportLab library, containing challan details such as challan ID, vehicle number, violation type, fine amount, timestamp, and evidence image. All challan records, including uploaded images, processed images, PDF files, and violation status, are stored in a centralized database. The system also provides a challan history page where users can view all previous challans and download PDF receipts.

3. METHODOLOGY

The implementation of the proposed AI-Based Helmet Violation Detection and E-Challan Generation System is carried out using a modular approach. The system integrates deep learning models for object detection, OCR for number plate recognition, and Django for web deployment. The complete workflow includes image acquisition, helmet violation detection, number plate recognition, challan generation, and database storage.

3.1 Image Upload and Preprocessing

The system is implemented as a Django web application that provides a user interface for uploading images. When an image is uploaded, Django stores it in the media directory and the file path is passed to the processing module. OpenCV is used to read the image and verify its validity. If the image

cannot be read, the system returns the status as "Invalid Image". The uploaded image is treated as the input evidence and is saved for future reference in the challan database.

3.2 Helmet and Person Detection Using YOLO

After successful upload, the system performs detection using the YOLO-based helmet detection model (Helmate_detector.pt). The model is executed using the Ultralytics YOLO framework. The detection process focuses on identifying two major classes: person and helmet. The system first checks whether a person is detected in the image. If no person is found, the output is directly labeled as "No Person Detected". If a person is detected, the system verifies helmet presence. If the helmet is detected, the status is marked as "No Violation". If a helmet is not detected, the system identifies it as a helmet violation and proceeds to the next stage.

3.3 Number Plate Detection and OCR Extraction

For helmet violation cases, the system applies a second YOLO model (license_plate_detector.pt) to detect the number plate. Once the number plate bounding region is obtained, OpenCV is used to crop the detected plate area. The cropped plate image is then passed to the EasyOCR engine for extracting the alphanumeric registration number. The extracted text is normalized by removing extra spaces and converting it into uppercase format. If OCR fails due to blur, low resolution, or occlusion, the system assigns the vehicle number as "Number Plate Not Clear" to avoid incorrect challan generation.

3.4 Challan Generation, PDF Creation, and Database Storage

After confirming a valid helmet violation and extracting the vehicle number, the system generates an e-challan with a fixed fine amount of ₹235. A PDF challan is generated using the ReportLab library. The PDF includes challan details such as challan ID, vehicle number, violation type, fine amount, timestamp (localized to IST), and the uploaded image as evidence. All challan records are stored in a database using Django ORM, including the uploaded image, processed image, extracted vehicle number, challan status, fine amount, and generated PDF path. The system also provides a challan history page where all stored challans can be viewed and downloaded for record maintenance.

4. RESULTS AND PERFORMANCE ANALYSIS

The proposed AI-Based Helmet Violation Detection and E-Challan Generation System was evaluated using multiple two-wheeler rider images to validate the accuracy of helmet detection, number plate extraction, challan generation, and database storage. The system was tested under different scenarios such as rider with helmet, rider without helmet, and images without any rider. The obtained results confirm that the system effectively automates the process of helmet violation identification and e-challan generation with evidence.

4.1 Helmet Violation Detection Output

The system successfully detects whether a rider is wearing a helmet by using a YOLO-based helmet detection model. When a rider is detected without a helmet, the system classifies the case as a valid violation and displays the status as "No Helmet Detected". Along with the violation status, the system also displays the detected vehicle number, challan ID, and fine amount. The result page provides a clear visualization of the uploaded evidence image and includes options for downloading the generated challan PDF. The output result interface for helmet violation detection is shown in Fig. 2.

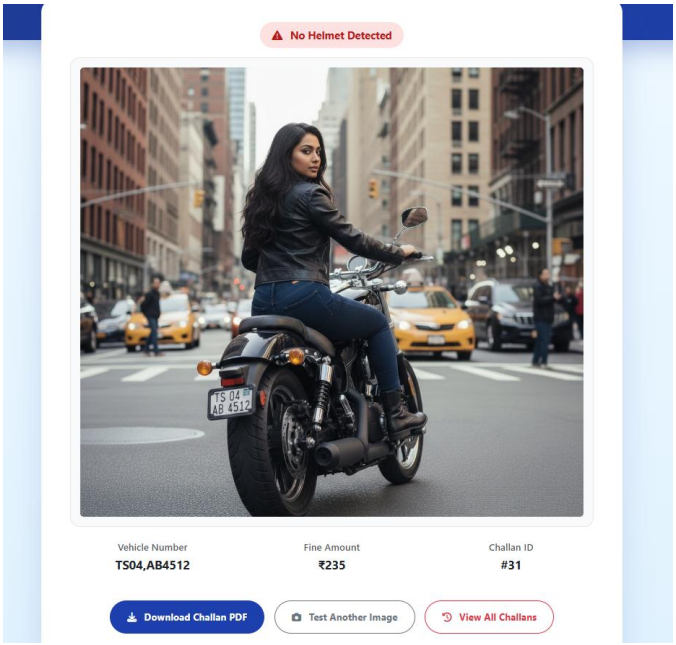

Fig- 2: Result Page Showing Helmet Violation Detection and Generated Challan Details

4.2 E-Challan Generation and PDF Report

After confirming a helmet violation, the system generates an electronic challan with a fixed fine amount of 235. The challan is automatically converted into a professional PDF using the Report Lab library. The generated challan includes essential details such as challan ID, vehicle number, violation type, fine amount, localized timestamp, and evidence image. The PDF generation ensures transparency and acts as an official record for enforcement. The successful generation of challan details and the downloadable challan PDF confirm the reliability of the system.

Fig- 3: Challan History Page Showing Stored Challan Records with PDF Download Option

4.3 Challan History and Database Record Validation

All challans generated by the system are stored in a centralized database using Django ORM. The system provides a challan history page that displays all previous challans in a structured format. Each record includes the challan ID, extracted vehicle number, fine amount, timestamp, and a download button for the corresponding challan PDF. This module validates that the database storage and retrieval processes are functioning correctly. The challan history output is shown in Fig. 3, which demonstrates that the system maintains systematic digital records and supports future analysis such as repeat offender identification.

5. CONCLUSION

This paper presented an AI-Based Helmet Violation Detection and E-Challan Generation System that automates the process of identifying helmet violations and issuing electronic challans. The system integrates YOLO-based deep learning models for rider and helmet detection, followed by number plate detection and OCR-based vehicle number extraction using EasyOCR . When a valid violation is detected, the system automatically generates an e-challan with a fixed fine amount of ₹235, stores the complete record in a database, and produces a professionally formatted PDF challan with evidence and localized timestamp. Experimental results confirm that the system accurately differentiates between no-person cases, compliant riders, and helmet violators while maintaining proper challan history and download functionality. The proposed solution reduces manual enforcement effort, improves accuracy, ensures transparency through evidence storage, and provides a scalable framework that can be extended to real-time surveillance and smart traffic monitoring applications.

6. FUTURE ENHANCEMENT

The Although the proposed system successfully automates helmet violation detection and e-challan generation, several improvements can be incorporated to enhance its performance and real-world applicability. In the future, the system can be extended to support real-time CCTV and video stream processing; enabling automatic monitoring without manual image uploads. Additional traffic violations such as triple riding, mobile phone usage while riding, signal jumping, and speeding can also be detected by integrating more trained deep learning models. The OCR module can be improved by using advanced recognition techniques and supporting multiple regional number plate formats for better accuracy under low-light or blurred conditions. Furthermore, the system can be integrated with SMS/email notification services and online payment gateways to notify vehicle owners and allow digital fine payment. Integration with official transport authority databases can also enable automatic owner verification and repeat offender analysis, making the system suitable for smart city traffic enforcement applications.

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