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Automatic Traffic Rule Violation Detection and Fine Collection System Using AI

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Abstract: *Traffic rule enforcement is a critical component of road safety management; however, traditional systems rely heavily on manual monitoring, delayed challan issuance, and voluntary fine payment, leading to inefficiency and revenue loss. This project presents an AI-powered Automatic Traffic Rule Violation Detection and Fine Collection System that integrates real-time computer vision, license plate recognition, and automated banking transactions. The system utilizes YOLOv5 for detecting traffic violations such as no helmet usage, triple riding, signal violations, overspeeding, and missing license plates from live video streams and images. Optical Character Recognition (OCR) is employed to extract vehicle registration numbers, which are mapped to pre-linked bank accounts. Upon successful identification, fines are calculated based on violation type and automatically deducted through a REST-based banking API.A desktop-based detection GUI and a modern web dashboard provide real-time monitoring, transaction history, and reporting capabilities. The proposed system eliminates manual intervention, ensures higher fine collection rates, and enhances transparency, making it suitable for smart city traffic management applications.*

Keywords: Traffic Violation Detection, YOLOv5, Computer Vision, License Plate Recognition, OCR, Automatic Fine Deduction, Flask API, Smart City, Road Safety

I. INTRODUCTION

Background

Rapid urbanization and the exponential growth of vehicles have significantly increased traffic violations in metropolitan areas. Conventional traffic enforcement systems depend on traffic personnel, CCTV monitoring, and post-event challan generation, which are often inefficient and prone to delays. As a result, many violations go unnoticed or fines remain unpaid, reducing the effectiveness of traffic laws. Recent advances in artificial intelligence and deep learning, particularly in real-time object detection, have enabled automated analysis of traffic footage. Simultaneously, digital banking and API-driven financial systems provide the infrastructure needed for instant monetary transactions.

Problem Statement

Existing traffic enforcement mechanisms suffer from several limitations:

- Heavy dependency on manual monitoring and intervention
- Delayed challan issuance and low fine recovery rates
- Lack of real-time violation response
- Inefficient tracking and audit mechanisms

There is a need for a fully automated system that can detect traffic violations, identify offenders, and ensure immediate fine collection without human involvement.

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Objectives:

The main objectives of the proposed system are:

- To detect traffic rule violations in real time using AI-based object detection
- To extract and recognize vehicle license plates accurately
- To calculate fines dynamically based on detected violations
- To automatically deduct fines from linked bank accounts
- To provide real-time monitoring, reporting, and audit trails

II. LITERATURE SURVEY

Traffic Violation Detection: Previous research highlights the effectiveness of deep learning models such as YOLO and SSD for vehicle and rider detection in traffic surveillance systems. YOLO-based architectures are particularly suitable for real-time applications due to their high speed and accuracy.

License Plate Recognition: Automatic License Plate Recognition (ALPR) systems using OCR and deep learning have been widely adopted for vehicle identification. These systems are capable of handling regional variations in number plate formats and environmental conditions.

Automated Enforcement Systems: Several studies emphasize that automated enforcement systems significantly improve compliance and reduce traffic violations. However, most existing systems stop at challan generation and do not integrate automated fine collection.

Digital Payment Integration: API-based banking systems enable secure, auditable, and instant financial transactions. Integrating such systems with enforcement mechanisms can eliminate payment delays and manual processing.

III. METHODOLOGY

System Design and Architecture:

The system follows a modular architecture consisting of:

- Violation Detection Module
- License Plate Recognition Module
- Automatic Fine Deduction Module
- GUI & Web Dashboard Module

Violation Detection Module

Traffic videos or images are processed frame-by-frame using YOLOv5. The model is trained to detect helmets, riders, license plates, and traffic violations. Frame sampling ensures optimal performance without excessive computation.

License Plate Recognition Module

Detected license plate regions are passed to an OCR engine to extract vehicle numbers. The extracted plate number acts as a unique identifier for retrieving bank account details.

Automatic Fine Deduction Module

A Flask-based REST API simulates a banking system. Once a violation is confirmed:

- The system validates account existence
- Checks available balance
- Deducts the fine amount
- Logs the transaction with timestamps

User Interface Module

Tkinter GUI displays detection results, violation images, and fine status

Web Dashboard allows account management, transaction viewing, and reporting

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System Implementation

The system is implemented using Python, with YOLOv5 and PyTorch handling AI inference. OpenCV manages video processing, while Flask provides REST endpoints for banking operations. Pandas is used for CSV and Excel report generation.

GPU acceleration via CUDA enables real-time detection, with CPU fallback for compatibility. All detection results and transaction logs are stored for audit and analysis.

IV. RESULT

The system successfully detected traffic violations from both images and videos in real time. Automatic fine deduction was completed within seconds after violation detection.

Performance Metrics:

- Real-time frame processing with YOLOv5
- Accurate license plate recognition under normal lighting
- Instant fine deduction with transaction logging

The system demonstrated high reliability and minimal latency, making it suitable for real-world deployment.

System Overview

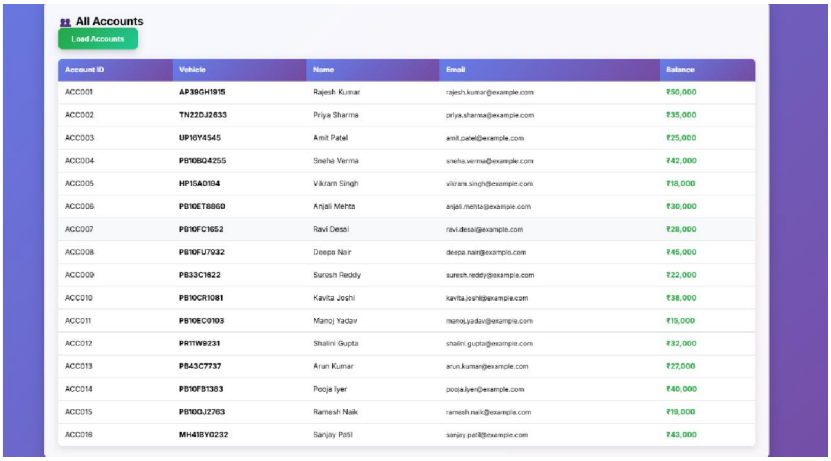

Fig. 1. Accounts Dashboard - 1

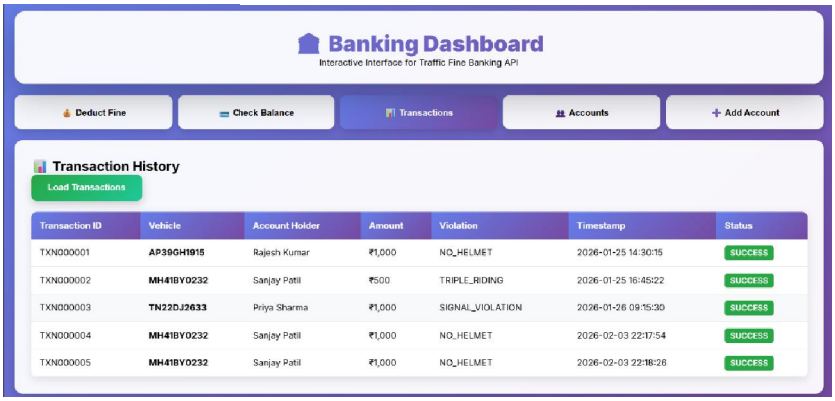

Fig. 2. Accounts Dashboard - 2

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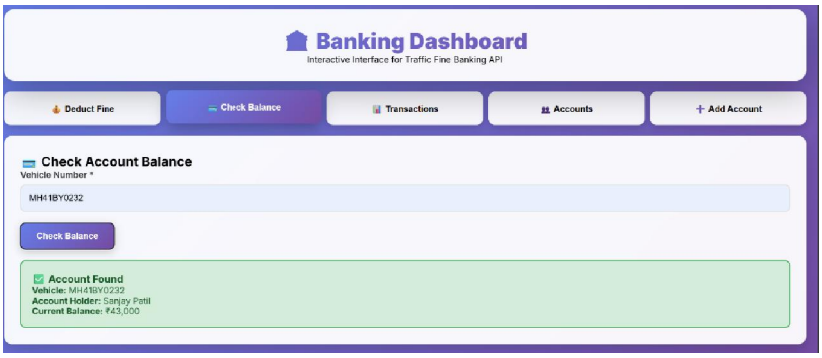

Fig. 3. Accounts Dashboard - 3

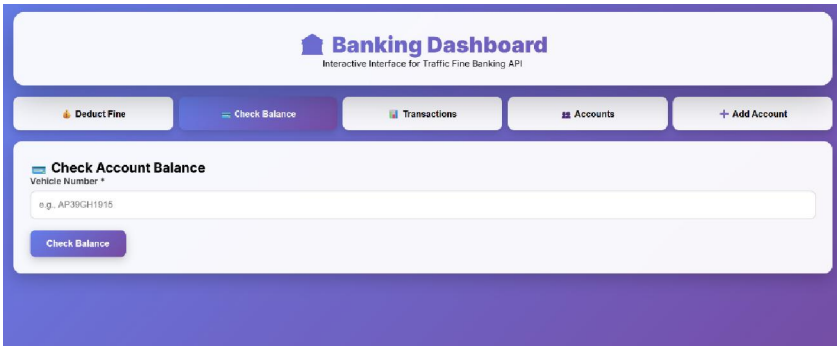

Fig. 4. Accounts Dashboard - 4

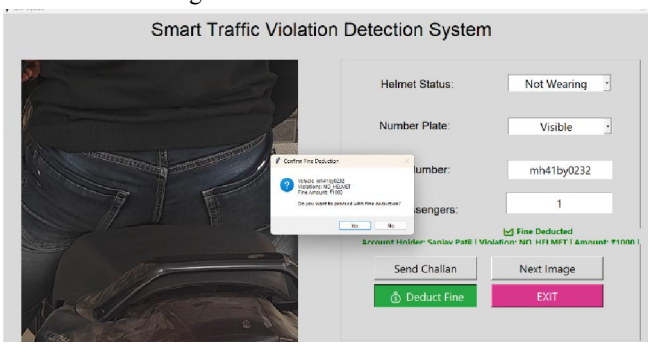

Fig. 5 Amount Deduction Page - 1

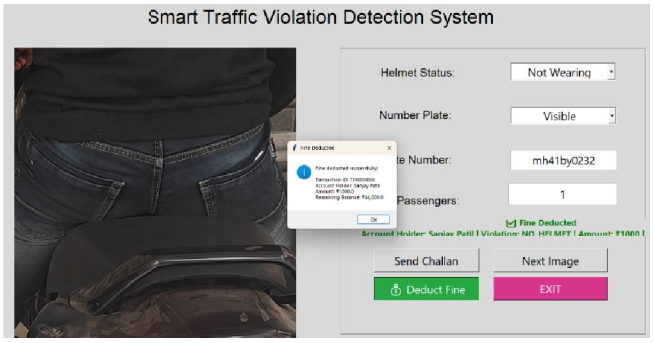

Fig. 6 Amount Deduction Page – 2

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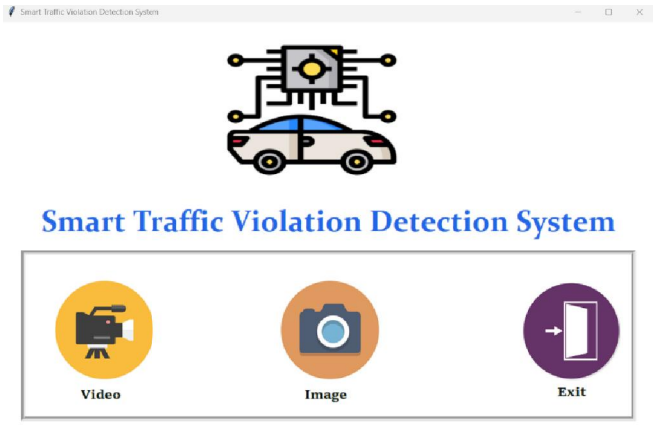

Fig. 7 Main Home Page

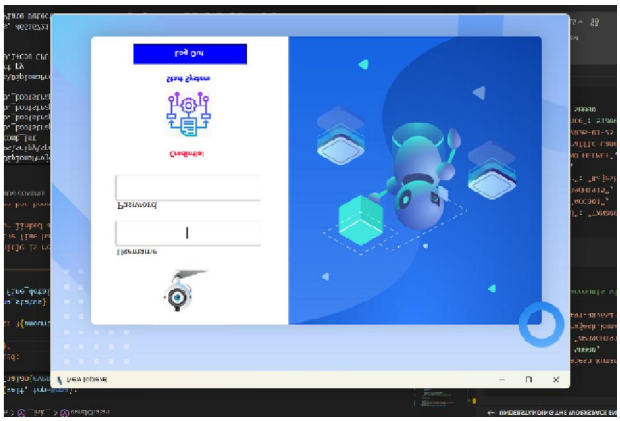

Fig. 3. Login Page

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V. CONCLUSION

The Automatic Traffic Rule Violation Detection and Fine Collection System demonstrates an effective integration of artificial intelligence, computer vision, and digital banking technologies. By automating violation detection and fine deduction, the system eliminates manual intervention, improves enforcement efficiency, and ensures transparency.

Future enhancements include integration with government vehicle databases, cloud deployment, multi-camera scalability, and advanced analytics for traffic pattern analysis.

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