AI-Powered Vehicle Number Plate Recognition and Theft Plate Detection

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Abstract*— Law enforcement, security, and traffic management have all experienced significant challenges as a result of the increasing number of vehicles on the road. To solve these issues, this research proposes an AI-powered Vehicle Number Plate Identification and Theft Detection System that makes use of EasyOCR for exact character identification and YOLOv8 for real-time license plate detection. The system's integration with a Streamlit interface, which allows for both live webcam monitoring and image uploads, makes it adaptable to a variety of operating environments. Automatic cross-verification occurs between identified license plates and a database of reported stolen vehicles. When a match is found, the system sends out fast notifications, assisting law enforcement in preventing auto theft and misuse. Monitoring and alarm systems are protected from duplicate detections. The system's architecture accommodates variations in angles, lighting, and plate morphologies, resulting in consistent performance across a variety of settings. The system's user-friendly interface and fast processing speed allow for efficient traffic monitoring and surveillance at checkpoints, parking lots, and toll plazas. Its use of open-source technology ensures affordability, scalability, and adaptability for future enhancements such as mobile deployment and cloud integration. Overall, this concept provides a practical, intelligent, and automated solution to improve vehicle security and traffic control in cities.

Keywords: Vehicle Number Plate Recognition, YOLOv8, EasyOCR, Computer Vision, Real-Time Detection, Streamlit, Traffic Monitoring, Smart City, Deep Learning.

I. INTRODUCTION

Vehicle identification with license plates is critical for law enforcement, parking management, toll collection, and traffic surveillance. Traditional manual inspection methods are time-consuming, prone to human error, and unscalable in real-time scenarios. Advancements in computer vision and artificial intelligence (AI) have made automated vehicle number plate recognition (VNPR) systems a practical and effective solution. Recent developments in deep learning have enabled VNPR systems with rapid and highly accurate detection capabilities. These systems employ algorithms capable of processing images and live video streams in real time to localize and identify license plates. Figure 1 illustrates the overall methodology of the proposed VNPR system, highlighting the structured flow of data acquisition, preprocessing, detection, recognition, and verification. The integration of the YOLOv8 deep learning model for license plate detection and EasyOCR for character recognition establishes a robust platform for automated vehicle monitoring. To enhance public safety, recognized plates are cross-referenced with stolen or blacklisted vehicle databases, allowing the system to generate instant alerts for suspicious entries. As represented in Figure 2, the modular system architecture ensures scalability, reliability, and seamless operation across diverse environments. A Streamlit-based interface is incorporated to provide real-time usability, enabling functionalities such as live monitoring via webcam, image uploads, duplicate detection prevention, and visualization of detection results. The performance of the system is demonstrated in Figure 3, which presents sample outputs including valid, counterfeit, and theft-related number plate classifications.

II. LITERATURE SURVEY

Research usually entails looking at current solutions, determining their shortcomings, and suggesting better approaches. Real-time license plate recognition and cross-verification against databases of reported stolen or suspicious vehicles are features of a powerful Vehicle Number Plate Recognition (VNPR) system. The system improves operational efficiency and public safety by combining deep learning models with optical character recognition (OCR) to achieve higher accuracy, faster processing, and greater reliability. This field has seen contributions from a number of researchers, but the current study focuses on the use of AI-based algorithms for vehicle plate detection, specifically with reference to Indian license plates.

[1] A. Roy and D. P. Ghoshal (2011). *Number Plate Recognition for Use in Different Countries Using an Improved Segmentation*. This research introduces a segmentation-based method for number plate recognition adaptable to multiple countries. The system improves detection accuracy by enhancing the object area while reducing irrelevant regions, forming the foundation for future ANPR developments.

[2] Ahmed, A. A., & Ahmed, S. (2021). *A Real-Time Car Towing Management System Using ML-Powered Automatic Number Plate Recognition*. This research develops a practical ANPR system for real-time car towing management. The system uses

machine learning to detect license plates accurately, and experimental results show effective deployment for law enforcement applications.

[3] Ahma, G., Ahma, G., & Reqica, M. (2024). *AI-Powered Algorithms in Car Plate Detection: A Case Study on Kosovo Plate Recognition*. This research investigates AI-powered methods for vehicle license plate detection with a focus on Kosovo plates. The proposed system leverages deep learning to improve recognition accuracy in region-specific contexts. Experimental results demonstrate enhanced detection reliability compared to conventional methods.

[4] Muneer, V. K., & Azil, A. (2024). *Study of An AI-Powered Vehicle Monitoring System: An Ensembled Approach for Intelligent Surveillance*. This study presents an ensemble-based AI vehicle monitoring framework integrating number plate recognition for intelligent surveillance. The approach provides comprehensive real-time traffic monitoring and improved detection performance over single-model systems.

[5] Shaheema, S. B., NS, B., Jose, P., Albert, I. E., Anorelin, A., & Tony, E. I. (2024). *AI-Powered Traffic Surveillance: License Plate Recognition with Non-Helmet Detection Using YOLOv8*. This study proposes a multi-task YOLOv8-based traffic surveillance system that combines license plate recognition with non-helmet detection. Experiments demonstrate improved enforcement capability and real-time performance in traffic monitoring scenarios.

III. Proposed Methodology

To ensure accuracy and efficiency, the creation of an AI-powered real-time theft plate detection and vehicle number plate recognition (VNPR) system is a logical, systematic process. For seamless operation, the technique incorporates optical character recognition (OCR), deep learning models, and a Streamlit-based interface. To enhance image quality and increase the effectiveness of detection and identification modules, data is first collected and preprocessed. EasyOCR captures alphanumeric characters for subsequent processing, but YOLOv8 accurately recognizes license plates. To give real-time alerts, detected data is cross-checked against a database of stolen or blacklisted autos. Figure 1 shows how duplicate inputs are minimized and the final findings are shown utilizing sophisticated analytics and visualization tools.

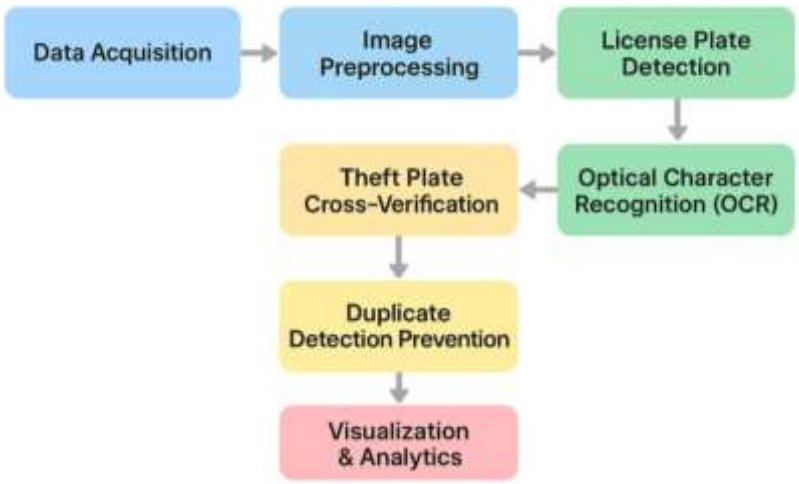

Figure 1: Methodology of AI-Powered Vehicle Number Plate Recognition and Theft Plate Detection

Data Acquisition: Data acquisition is the first and most critical step in developing the Vehicle Number Plate Recognition (VNPR) and Theft Plate Detection system. The quality and diversity of input data have a direct impact on the detection and recognition techniques' precision and dependability. Several data sources are used to ensure that the system functions efficiently in a variety of real-world scenarios.

Image Preprocessing: Image preprocessing is a critical stage in the process of recognizing vehicle number plates. It improves the performance of the EasyOCR recognition module and the YOLOv8 detection model by lowering noise and increasing input data quality. Low lighting, motion blur, noise, and varying resolutions are some of the challenges that real-world images captured from live video feeds or other sources may encounter. Preprocessing ensures that the data is standardized and optimized before it is sent to the detection and recognition phases.

License Plate Detection: The most critical step in the Vehicle Number Plate Recognition (VNPR) pipeline is license plate detection. Before proceeding to character recognition, this stage seeks to precisely locate and extract the region of interest (ROI) from the input image or video frame containing the license plate. How effectively this stage works has a direct impact on the performance of the subsequent Optical Character Recognition (OCR) module and, eventually, the entire system.

Optical Character Recognition (OCR): Optical character recognition (OCR) is a critical component of the vehicle number plate recognition (VNPR) and theft plate detection systems. Following the accurate identification and isolation of the license plate using the YOLOv8 model, the visual representation of characters is translated into machine-readable text. The system can authenticate, store, and analyze vehicle information for real-time monitoring and theft detection. EasyOCR, a deep learning-based text recognition toolkit known for its excellent accuracy and ability to handle complex and noisy images, is utilized in this project to do OCR. This section discusses the OCR procedure, the obstacles encountered, and the approaches utilized to improve recognition performance.

Theft Plate Cross-Verification: After successfully identifying the license plate and extracting the OCR-extracted alphanumeric characters, the next critical step is theft plate cross-verification. This module not only confirms that the recognized license plate number is real, but it also checks that it matches a database of stolen or blacklisted cars. This capability transforms the system from a simple recognition tool to an intelligent surveillance tool that can assist public safety and law enforcement agencies.

Duplicate Detection Prevention: Real-time car tracking systems commonly detect the same license plate multiple times within a short period of time. This typically occurs when a car passes through several consecutive frames in a video stream or remains in the camera's field of view for a few seconds. If each detection is saved as a new entry, the system may create

Duplicate records, leading to:

- **Data redundancy** in logs and databases.
- **False inflation of statistics**, such as the number of unique vehicles detected.
- **Performance overhead**, as unnecessary duplicate alerts or theft checks are triggered.

To address this issue, the suggested VNPR system's Duplicate Detection Prevention (DDP) method ensures that each license plate is only logged once within a specific time range.

Visualization & Analytics: Even when detection and recognition are at the heart of a Vehicle Number Plate Recognition (VNPR) system, effective visualization and analytics ensure that the results are clear, actionable, and useful to end users such as traffic authorities, security guards, and law enforcement organizations. This module improves operational efficiency and decision-making by translating raw detection data into statistical insights and clear visual feedback.

System Architecture: A layered, modular architecture is employed to provide scalability, reliability, and real-time performance for theft detection and vehicle recognition. The framework's three basic levels—input, processing, and output—are designed to manage diverse jobs. The input layer collects data through static image uploads or real-time video streaming. The processing layer is responsible for image preprocessing, theft plate cross-verification, OCR using EasyOCR, license plate detection with YOLOv8, and duplicate detection avoidance. Finally, as seen in Figure 2, the output layer stores media records, theft databases, and detection logs to provide seamless interaction with security and traffic monitoring systems.

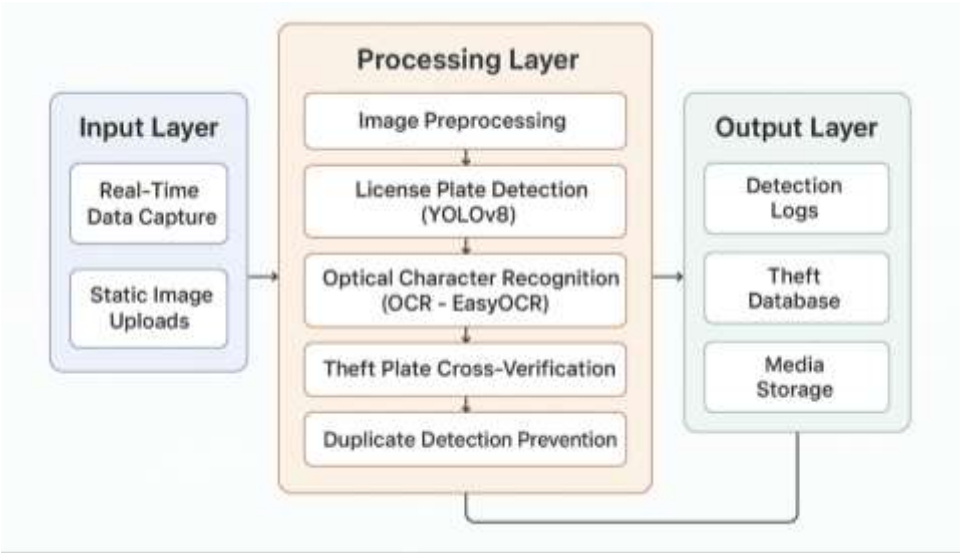

Figure 2: System Architecture of AI-Powered Vehicle Number Plate Recognition and Theft Plate Detection

IV. RESULT

An experimental study was conducted to validate the efficacy of the proposed AI-powered car number plate recognition and theft plate detection system. The system was tested in a number of environments, including static images, real-time video streams, different lighting conditions, and plate types. The results demonstrate how reliable, accurate, and effective the system is. Even in low light, YOLOv8 provided reliable detection, and correction algorithms minimized OCR errors.

Images of number plates were preprocessed to provide equal image sizes and better text visibility. The assignment is completed using Python 3.7 on a Windows PC with a 2.30 GHz Intel i5 processor, 8 GB of RAM, and a 4 GB graphics processing unit (NVIDIA GeForce GTX 1050 Ti with CUDA). Figure 3 shows the camera's results for identifying authentic and invalid license plates.

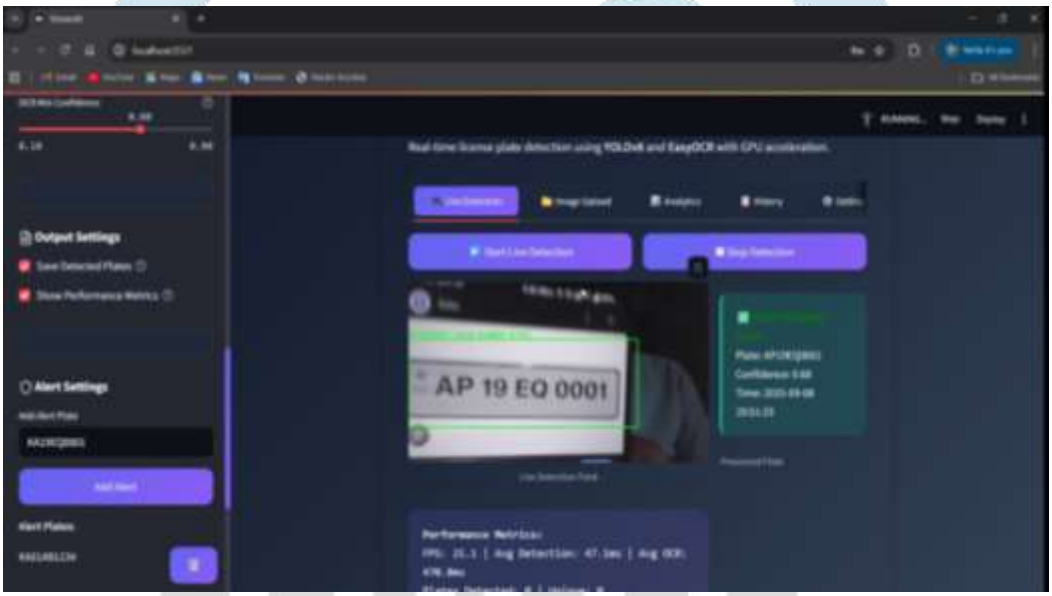

Figure 3: Output Sample of Vehicle Number Plate Recognition and Theft Detection System

OCR Output and Translation: The selected license plate region must be transformed to machine-readable alphanumeric text using the Optical Character Recognition (OCR) stage. Although the EasyOCR-powered OCR module generates raw character outputs, additional translation and correction operations are required to ensure the legality and accuracy of the detected plate number.

Classification Outcomes: Every detected plate in the proposed AI-powered car number plate recognition system is categorized to ensure its legality and applicability. When the discovered characters correctly match the standard Indian automobile registration format, such as TR03MF4477, the plate is verified as legitimate.

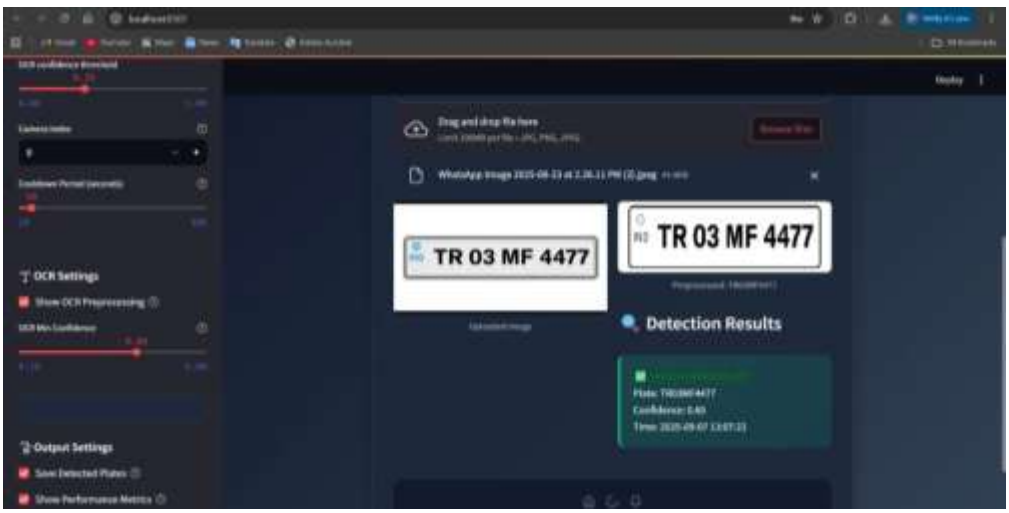

Figure 4: Output Sample of Valid Number Plate Detection

Figure 4 illustrates how the proposed method may detect a real vehicle number plate. Prior to OCR recognition, the uploaded license plate image is preprocessed to increase clarity. The system correctly extracts the alphanumeric sequence TR03MF4477, which follows the typical Indian automobile registration format. The detection result, which validates the plate's legality, is represented by a confidence score of 0.65. This proves that the system correctly detects legitimate license plates and categorizes them for future monitoring and study.

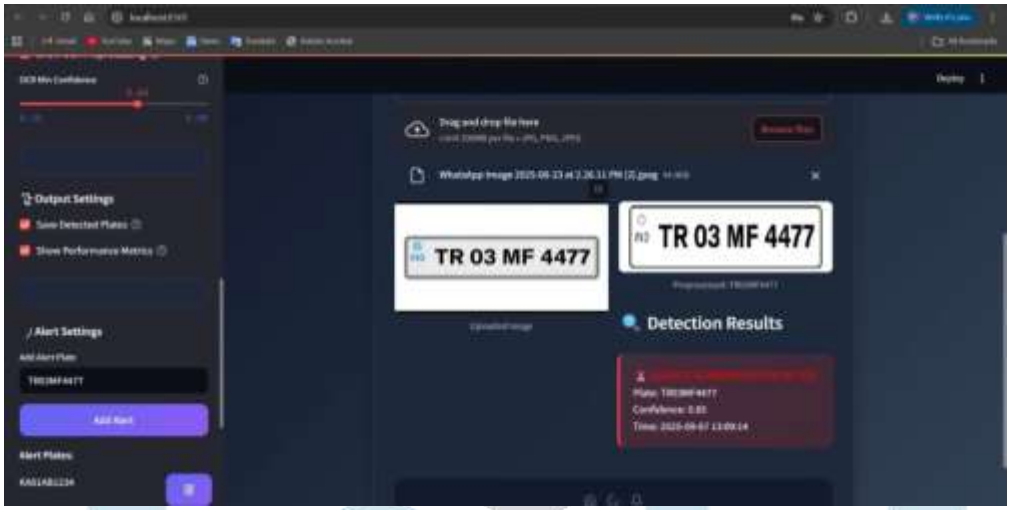

Figure 5: Output Sample of Theft Number Detection.

Figure 5 depicts how the system can detect a suspicious or theft-related license plate. After preprocessing the given plate image, the alphanumeric sequence TR03MF4477 is retrieved using OCR analysis. The computer immediately detects this number plate as suspicious since it relates to an item on the stolen or prohibited vehicle alert list. A red warning box, a date, and a confidence score of 0.65 appear alongside the result. This result validates the system's ability to provide real-time alerts for security and law enforcement applications.

Figure 6: Output Sample of Invalid Number Plate Detection

The identification of an incorrect number plate that deviates from the accepted format for automobile registration is shown in Figure 6. The recovered text does not comply with the established guidelines or the Indian car registration structure following preprocessing and OCR recognition. Consequently, the system marks the plate as invalid and removes it from additional processing. Errors brought on by noise, ambiguous characters, or flawed OCR scans are less common thanks to this categorization. The result shows how the method can eliminate false positives, guaranteeing that only genuine or questionable plates are kept for observation and confirmation.

V. Conclusion

To provide a reliable and effective solution for vehicle identification and theft detection, the proposed Vehicle Number Plate Recognition (VNPR) architecture demonstrates how well YOLOv8-based detection and EasyOCR recognition work together. The system performs effectively even in the presence of challenging environmental conditions such as shifting lighting, motion blur, and angle distortions since it incorporates OCR for precise alphanumeric extraction and deep learning for accurate plate localization. This strategy's theft alarm mechanism, which divides license plates into legal, questionable, and invalid groups, is another feature. This feature allows for the prompt identification of questionable cars, which increases the system's usefulness for surveillance and law enforcement applications. Additionally, the real-time processing capabilities, which is enabled by a Streamlit-based interface, guarantees that the system is both technically sound and feasible for implementation in automated parking facilities, traffic monitoring units, and smart city ecosystems. Overall, the approach strikes an appropriate compromise between speed, precision, and scalability. While the current system performs effectively in controlled and semi-structured environments, it serves as a good foundation for future enhancements such as cloud connectivity for large-scale deployments, mobile/edge implementations, and interface with national vehicle databases. These advancements have the potential to improve its role in smart city infrastructure, crime prevention, and traffic management.

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