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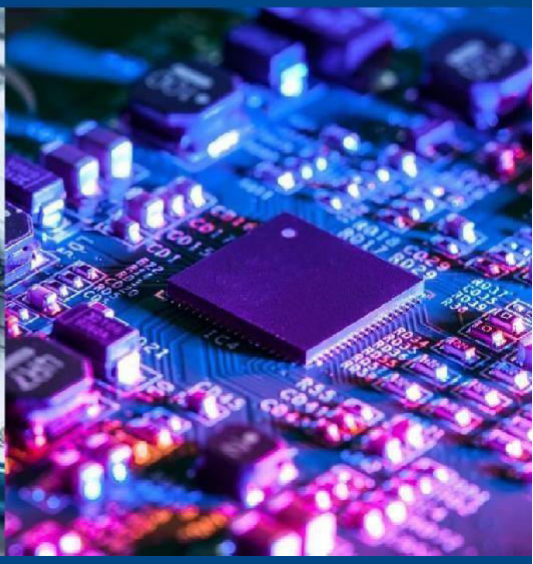

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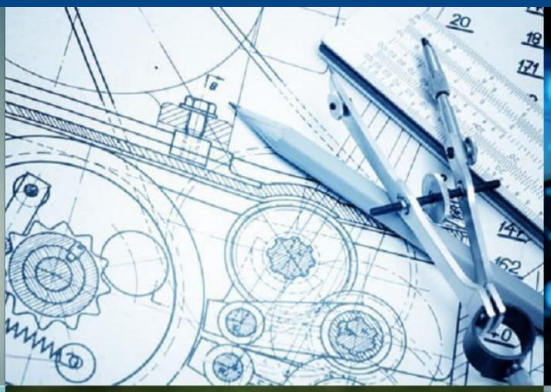

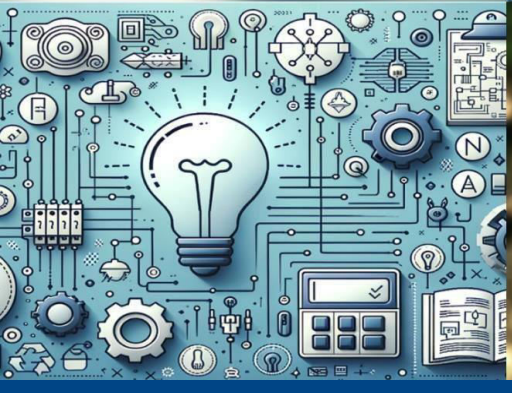

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HSRP AND NON-HSRP VEHICLE NUMBER PLATE DETECTION AND ALERT SYSTEM

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ABSTRACT: HSRP and Non-HSRP Vehicle Number Plate Detection and Alert System is the "HSRP and Non-HSRP Vehicle Number Plate Detection and Alert System" is designed to address the pressing need for automated enforcement of High Security Registration Plate (HSRP) regulations in India. HSRP plates, mandated by the government, feature tamper-proof construction and laser-etched codes to improve vehicle authenticity, security, and traceability. Despite these mandates, many vehicles continue to operate with non-HSRP plates, which poses challenges to law enforcement, road safety, and compliance monitoring. This system integrates computer vision, machine learning, and automated communication technologies into a unified workflow. YOLOv5 is employed for accurate license plate detection under varied environmental conditions, while Histogram of Oriented Gradients (HOG) features and a Support Vector Machine (SVM) classifier are used to distinguish between HSRP and non-HSRP plates. For non-HSRP plates, EasyOCR performs alphanumeric extraction after preprocessing steps such as grayscale conversion and noise reduction. A key enhancement over previous approaches is the use of a MySQL database to store vehicle owner details, replacing CSV-based storage. This ensures scalability, faster queries, and seamless integration with real-world databases. When a non-HSRP plate is identified, the system retrieves owner information from MySQL and sends an automated email alert via SMTP, notifying the owner to comply with regulations. A Flask-based web interface enables users to upload images and view detection results, extracted plate numbers, owner details, and email status in real time.

I. INTRODUCTION

HSRPs are standardized vehicle plates mandated in India to incorporate security features that deter duplication, resist tampering, and support precise identification of registered vehicles. These plates incorporate tamper-proof materials, laser-etched identification codes, and non-removable snap locks, making them difficult to duplicate or alter. Despite the legal mandate, many vehicles still operate with non-HSRP plates due to negligence or lack of awareness, posing challenges to traffic enforcement and public safety. Manual verification of plates is time-consuming, error-prone, and inefficient for large-scale monitoring. Traditional surveillance systems often lack the capability to differentiate between HSRP and non-HSRP plates or to automate follow-up actions.

This project proposes an automated solution that detects license plates using YOLOv5, classifies them as HSRP or non-HSRP via an SVM classifier with HOG features, and extracts plate numbers using EasyOCR. Unlike file-based approaches, this system stores and retrieves owner information from a MySQL database, enabling faster searches and better scalability. For non-HSRP detections, it sends automated compliance alerts via email.

II. LITERATURE SYRVEY

[1] **Zhang et al.** conducted a comprehensive survey on License Plate Recognition (LPR) techniques, outlining the progression from classical image processing to modern deep learning approaches. The study emphasizes challenges such as plate variability, lighting, and motion blur, which directly relate to the environmental conditions faced in this project. The findings support the adoption of hybrid solutions that combine deep learning for detection and traditional features for classification, as used in the proposed system.

[2] **Redmon et al.** developed the YOLO (You Only Look Once) framework, introducing a unified, single-stage approach to object detection that significantly accelerated processing. Its capability to detect even smaller objects within complex scenes makes it suitable for identifying license plates in diverse traffic conditions. In this work, YOLOv5, a refined and enhanced version of YOLO, is applied for precise and efficient plate detection.

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[3] **Sharma and Verma** proposed methods for localizing Indian High Security Registration Plates using a blend of classical image processing and machine learning. Their focus on HSRP-specific features, such as laser etching, provides domain knowledge that informs the SVM+HOG classification stage in this work.
[4] **Kumar et al.** addressed dataset limitations in HSRP recognition by employing synthetic data generation and augmentation. This approach improves model robustness to diverse plate appearances and is recommended as a future enhancement for the proposed system to overcome data scarcity.
[5] **Gupta and Singh** proposed a real-time HSRP recognition method using Edge AI tailored for low-power, resource-limited devices. Their focus on reducing energy demands and detection delays provides useful insights for adapting similar solutions to compact or mobile platforms.

EXISTING SYSTEM

Current vehicle license plate monitoring systems in many regions still rely heavily on manual inspection or basic surveillance setups. In such systems, enforcement officers visually check license plates for compliance with HSRP standards, a process that is slow, labor-intensive, and prone to human error. Traditional automated systems, where implemented, often use classical image processing techniques for plate detection and recognition. These methods depend on fixed thresholding, contour detection, or morphological operations, which work reasonably well in controlled environments but fail when faced with real-world challenges such as inadequate lighting, blurred motion in images, tilted viewing perspectives, partially hidden plates, and differences in plate patterns.

Another limitation of many existing solutions is their inability to classify plates into HSRP and Non-HSRP categories. They generally focus on extracting the alphanumeric content of the plate without analyzing its security features or physical characteristics. Furthermore, integration with enforcement workflows is minimal—owner identification often requires accessing separate government databases manually, and communication with non-compliant vehicle owners is typically delayed due to the absence of automated alert mechanisms.

These constraints make existing systems less effective for large-scale, real-time deployment in smart city environments, traffic monitoring networks, toll plazas, and border checkpoints, where rapid detection, classification, and action are crucial for ensuring road safety and regulatory compliance.

PROPOSED SYSTEM

The proposed system automatically detects vehicle license plates, classifies them as High Security Registration Plates (HSRP) or Non-HSRP, and sends alerts to owners of non-compliant vehicles. The process begins with image acquisition via a web interface or camera feed, followed by preprocessing to improve detection quality. YOLOv5 is used to accurately localize the license plate, which is then cropped and classified using an SVM model trained with HOG features.

For plates categorized as Non-HSRP, the next step applies EasyOCR-based text recognition to retrieve the vehicle registration details. This number is matched against a MySQL database containing vehicle owner details, and upon a match, an automated email notification is sent to the owner. The final results—including the image, classification type, extracted number, and notification status—are presented via a Flask-based web interface. This system offers a scalable and efficient approach for enforcing HSRP compliance in real-world scenarios.

III. SYSTEM ARCHITECTURE

The proposed system is designed as a modular pipeline that integrates detection, classification, OCR, database retrieval, and notification into a unified workflow. The process begins with image acquisition, where the user uploads a vehicle image through a Flask-based web interface. The uploaded image is processed by a YOLOv5 detection model, which accurately identifies and crops the license plate region. This cropped image is then analyzed using an SVM classifier trained on HOG features to determine whether the plate is an HSRP or non-HSRP type. For non-HSRP plates, the system applies EasyOCR after preprocessing steps such as grayscale conversion and noise reduction to extract the alphanumeric plate number. The extracted number is then matched against records stored in a MySQL database, enabling fast retrieval of the corresponding vehicle owner's details. If a match is found, the system sends an automated compliance alert to the owner via SMTP email. Finally, the results—including the plate type, extracted number, owner

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information, and alert status—are displayed to the user through the web interface. This architecture ensures accuracy, scalability, and suitability for real-time enforcement applications.

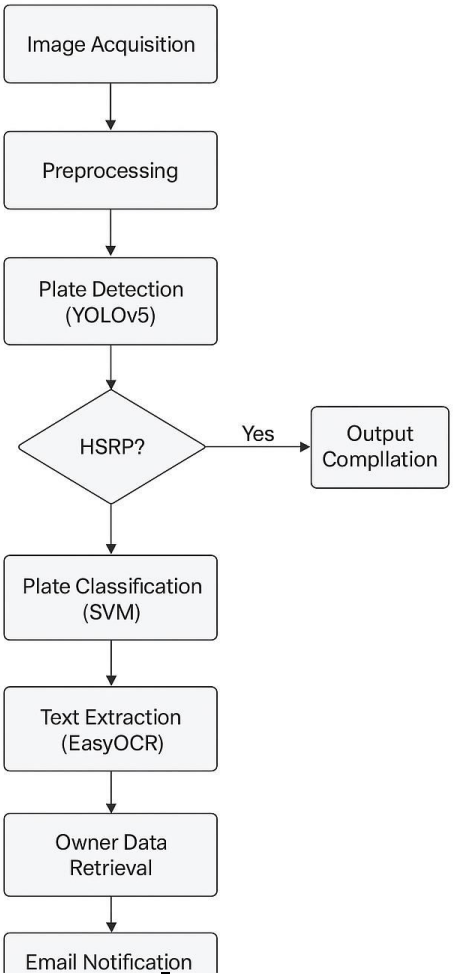

Fig 3.1 System Architecture

IV. METHODOLOGY

The proposed system follows a sequential methodology that combines computer vision, machine learning, and automated communication to detect, classify, and alert non-HSRP vehicle owners. The process begins with image acquisition through a Flask-based web interface, where users upload vehicle images for processing. After upload, the image is processed using a YOLOv5 model that has been specifically trained on a tailored dataset containing license plate images. YOLOv5 localizes the plate region accurately under varied lighting, orientation, and environmental conditions. The detected plate is then classified as HSRP or non-HSRP using a Support Vector Machine (SVM) trained on Histogram of Oriented Gradients (HOG) features. This feature-based classification is effective for distinguishing structural differences such as embossed fonts and laser-etched markings in HSRP plates. If the plate is identified as non-HSRP, EasyOCR is applied to extract the alphanumeric plate number, with preprocessing steps like grayscale conversion and noise reduction improving text recognition accuracy. The extracted plate number is matched against records stored in a MySQL database to retrieve the vehicle owner's name, address, contact, and email details. Upon a successful match, the system automatically sends an email notification to the registered owner via SMTP, advising them to replace their plate with a compliant HSRP. Finally, the results—including the classification outcome, extracted number, owner details, and email status—are displayed to the user through the web interface. This methodology ensures efficient processing, high accuracy, and seamless integration with enforcement operations.

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V. DESIGN AND IMPLEMENTATION

The proposed system is conceived as a modular and scalable application that integrates computer vision, machine learning, optical character recognition (OCR), database management, and automated communication into a unified workflow. The design focuses on efficiency, accuracy, and ease of integration with smart traffic management systems. At the frontend, a **Flask-based web interface** allows users to upload vehicle images, which are then processed through the backend pipeline. Detection is handled by a **YOLOv5** model trained on a custom dataset of annotated license plates, enabling accurate localization under varying lighting, orientation, and environmental conditions. For classification, the system employs a Support Vector Machine (SVM) model trained on Histogram of Oriented Gradients (HOG) descriptors, enabling it to distinguish HSRP from non-HSRP plates based on their structural features and unique font styles.

For non-HSRP plates, the cropped image undergoes preprocessing steps such as grayscale conversion, bilateral filtering, and thresholding before being passed to EasyOCR for alphanumeric extraction. Extracted numbers are matched against a MySQL database, which securely stores vehicle records with fields including license number, owner name, contact information, and email. MySQL is chosen for its scalability, indexing support, and fast query performance, overcoming the limitations of CSV-based storage. The backend, managed through Flask routes, coordinates each step—file upload, YOLOv5 detection, classification, OCR processing, database lookup, and SMTP-based automated email alerts to non-compliant vehicle owners.

The output is presented on the web interface, displaying the uploaded image, classification result, extracted plate number, retrieved owner details, and alert status. This design ensures the system is modular for future upgrades, robust for real-world conditions, and efficient for large-scale enforcement deployments.

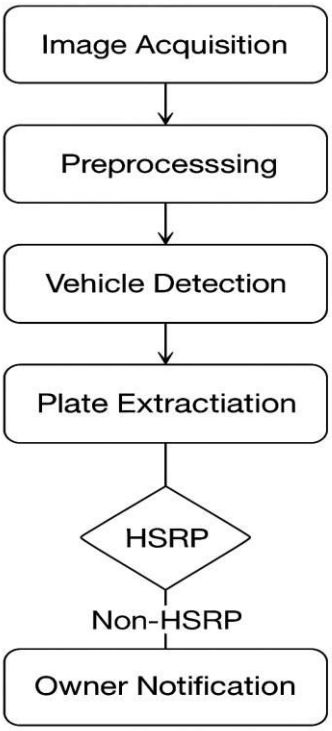

Fig 5.1 Flowchart of working system

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VI. OUTCOME OF RESEARCH

The developed system successfully demonstrated the capability to detect and classify vehicle license plates as HSRP or non-HSRP and to automate the notification process for non-compliant vehicles. The proposed system combines YOLOv5 for accurate license plate localization, SVM with HOG descriptors for classification, and EasyOCR for dependable text recognition, achieving consistent performance under different illumination levels, viewing perspectives, and plate designs. The use of a MySQL database allowed seamless retrieval of owner details in real time, ensuring accurate and up-to-date information. The automated email alert mechanism provided an efficient channel for informing vehicle owners about non-compliance, reducing the need for manual intervention by enforcement agencies. Overall, the research outcome highlights a practical, scalable solution that can be deployed in intelligent traffic management systems, smart surveillance networks, toll gates, and border checkpoints to enhance regulation compliance and improve road safety.

VII. RESULT AND DISCUSSION

The implementation of the HSRP and Non-HSRP Vehicle Number Plate Detection and Alert System demonstrated the effectiveness of combining deep learning, machine learning, OCR, and database technologies in a unified workflow. The system was tested on a diverse set of vehicle images collected under real-world conditions, including varying weather, lighting, camera angles, and plate designs. The results confirmed that the proposed pipeline operates reliably from the moment an image is uploaded to the web interface, through license plate detection and classification, to the final step of owner notification.

YOLOv5, trained on a custom dataset of annotated license plate images, consistently provided accurate localization across different plate sizes, positions, and environmental conditions. This robustness ensured that the subsequent classification process received well-cropped inputs, reducing the chance of false classification. The Support Vector Machine (SVM) model, trained with Histogram of Oriented Gradients (HOG) features, effectively differentiated HSRP plates from non-HSRP plates, even when the visual differences were subtle. This classification step ensured that only relevant (non-HSRP) cases proceeded to the Optical Character Recognition (OCR) stage.

EasyOCR, enhanced with preprocessing methods such as grayscale conversion, bilateral filtering, and thresholding, extracted alphanumeric text from non-HSRP plates with high clarity. The extracted text was then matched against a MySQL database containing registered owner details, enabling accurate and real-time data retrieval. The email notification module, integrated through SMTP, operated seamlessly to send compliance alerts to vehicle owners, ensuring timely awareness of regulatory requirements.

From a practical standpoint, the system reduces manual intervention for traffic enforcement agencies, supports rapid decision-making, and offers a scalable solution that can be integrated into existing infrastructure. Its modular nature makes it adaptable for use in smart traffic systems, surveillance networks, toll gates, parking management, and border control points. The discussion of these results indicates that the approach not only meets the technical requirements for automated HSRP monitoring but also delivers tangible operational benefits, aligning with the goals of intelligent transportation systems and smart city initiatives.

VIII. CONCLUSION

This research presents a complete and functional framework for the automated detection, classification, and monitoring of vehicle number plates, specifically targeting the differentiation between High Security Registration Plates (HSRP) and non-HSRP plates. By integrating YOLOv5 for precise plate localization, SVM with HOG features for classification, EasyOCR for text recognition, and a MySQL database for real-time owner information retrieval, the system provides an end-to-end solution that is both practical and scalable. The inclusion of an automated email alert mechanism further enhances its utility by enabling immediate communication with non-compliant vehicle owners.

The developed system not only reduces manual inspection efforts but also offers a reliable technological pathway toward improving regulatory compliance and road safety. Its modular design makes it adaptable to various operational environments, including smart traffic systems, toll plazas, parking management, and border checkpoints. While the current implementation operates effectively on static images, future work can focus on expanding dataset diversity,

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integrating real-time video processing, optimizing OCR accuracy, and connecting to official vehicle registration APIs for dynamic database updates. These enhancements would enable broader deployment and greater impact in intelligent transportation systems.

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