



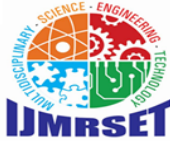
# International Journal of Multidisciplinary Research in Science, Engineering and Technology

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## International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

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# Intelligent Traffic Surveillance System for Automatic Number Plate Recognition

V. M. Niaz Ahamed, Rohini A, Moniga K

Department of Computer Application, B.S. Abdur Rahman Crescent Institute of Science & Technology, Chennai,  
Tamil Nadu, India

Department of Computer Application, B.S. Abdur Rahman Crescent Institute of Science & Technology, Chennai,  
Tamil Nadu, India

Department of Computer Application, B.S. Abdur Rahman Crescent Institute of Science & Technology, Chennai,  
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**ABSTRACT:** Automatic Number Plate Recognition (ANPR) is an intelligent system used to detect and recognize vehicle registration numbers from images and video streams. It plays an important role in traffic monitoring, law enforcement, toll collection, and parking management. In this work, a deep learning-based approach is proposed using YOLOv8 for number plate detection and EasyOCR for text recognition. The system first identifies the number plate region from input images or video frames and then extracts the alphanumeric characters. The proposed model provides accurate and real-time performance under different lighting and environmental conditions, making it suitable for traffic surveillance applications.

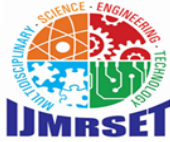
**KEYWORDS:** Automatic Number Plate Recognition (ANPR), YOLOv8, EasyOCR, Object Detection, Optical Character Recognition (OCR), Deep Learning, Computer Vision, Vehicle Identification

### I. INTRODUCTION

In the below fig.1 represent, the rapid growth in the number of vehicles has created significant challenges in traffic management and vehicle monitoring. In many cities, manual verification of vehicle number plates is still commonly practiced, which is time-consuming and prone to human errors. In busy traffic environments, it becomes difficult for authorities to track vehicles efficiently. In order to overcome these limitations, Automatic Number Plate Recognition (ANPR) systems have been introduced as an effective technological solution.

ANPR systems use computer vision and deep learning techniques to automatically detect and recognize vehicle registration numbers from images or video streams. The overall process consists of two important stages: number plate detection and character recognition. In the detection stage, the number plate region is identified from the vehicle image; in the recognition stage, the characters are extracted and converted to readable text. In this work, YOLOv8, a real-time object detection algorithm, is used to accurately detect the number plate region from vehicles.

EasyOCR is applied to extract the alphanumeric characters from the detected plate region. The system captures frames from video streams or images and processes them efficiently under varying lighting conditions, vehicle angles, and complex backgrounds. This ANPR system can be deployed in traffic surveillance, toll booths, parking management, and security checkpoints. The main objective is to develop an accurate, efficient, and real-time number plate recognition system for intelligent transportation applications.



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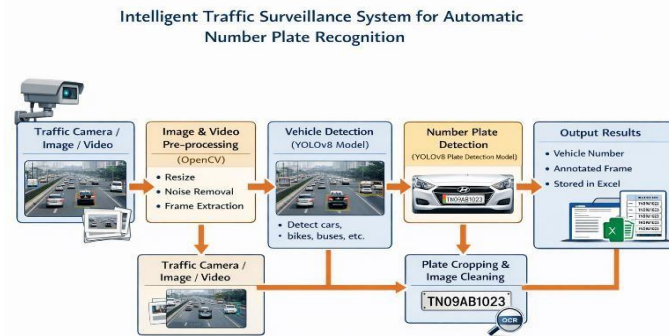


Fig. X. Conceptual diagram of the Intelligent Traffic Surveillance System for Automatic Number Plate Recognition (ANPR).

Fig. 1. Conceptual diagram of the Intelligent Traffic Surveillance System for Automatic Number Plate Recognition (ANPR).

### II. RELATED WORK

In the below table 1 represent, Many researchers have developed vehicle detection and tracking systems using computer vision and machine learning techniques. These systems support traffic monitoring and intelligent transportation applications.

Yusuf et al. [1] proposed a vehicle detection and tracking method using image preprocessing, template matching, and particle filter algorithms for UAV imagery. Their system improved detection accuracy and handled challenges such as occlusion and background noise.

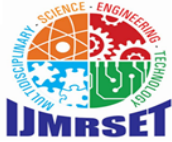
Siddiqui et al. [2] developed an IoT-based automated monitoring system using machine learning for railway track fault detection and localization via acoustic analysis. Although focused on railways, it demonstrated the importance of real-time processing and accurate classification.

Manohara M. M. PAI [3] surveyed deep learning techniques for vehicle re-identification and tracking, discussing challenges including lighting variation, camera angle changes, and occlusion that also affect number plate detection. Badidi et al. [4] highlighted Edge-AI for real-time video analytics in smart cities, emphasizing the need for fast and lightweight models in surveillance applications.

Table I summarizes the comparative analysis of related works. Most studies focus on vehicle detection and tracking; fewer systems combine number plate detection with text recognition. The proposed system addresses this gap by integrating YOLOv8 for plate detection and EasyOCR for character recognition Litreature Survey

TABLE I. COMPARATIVE ANALYSIS OF RELATED WORKS

Ref No.	Author(s) & Year	Title	Method & Contribution	Limitation
[1]	Muhammad Ovais Yusuf, 2024	Enhancing Vehicle Detection and Tracking in UAV Imagery	Segmentation, Detection, Tracking	UAV-Specific, No OCR



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[2]	Hafeez ur Rehman Siddiqui, 2022	IoT Based Railway Track Faults Detection and Localization	IoT, Machine Learning, Monitoring, Automation	Acoustic-Based, Vision	No
[3]	Manohara M. M. PAI, 2025	Vehicle Recognition and Tracking	CNN, DeepSORT, Analysis, Tracking	Survey Only, No Implementation	
[4]	Karima Moumane, 2023	Edge-AI Enabled Video Analytics in Smart Cities	Video Analytics, Edge-AI, Real-Time, Smart Cities	General Review, ANPR	No

### III. PROPOSED SYSTEM

The proposed system is designed to automatically detect vehicles, identify number plates, and recognize characters from images or video streams. The system is divided into four modules:

#### Module 1: Vehicle Detection

In this module, the system detects vehicles from the input image or video frame using a deep learning-based object detection algorithm. Vehicles such as cars, bikes, buses, and trucks are identified and highlighted with bounding boxes. This step ensures that only vehicle areas are processed in subsequent stages.

#### Module 2: Number Plate Detection

After vehicle detection, the system focuses on identifying the number plate region within the vehicle. YOLOv8 accurately locates the license plate area, which is then cropped for further processing. This improves detection accuracy and reduces unnecessary background noise.

#### Module 3: OCR Module

The cropped number plate image is passed to EasyOCR, which extracts the alphanumeric characters and converts them into digital format for display and storage. This module completes the Automatic Number Plate Recognition process.

#### Module 4: Video & Image Processing Module

This module handles input processing and output display. It captures frames from video streams or reads input images and applies preprocessing techniques — resizing, noise reduction, and contrast enhancement — to improve detection performance. The final annotated output can be stored in a database.

### IV. SYSTEM ARCHITECTURE

In the below fig2 represent, the system architecture encompasses the end-to-end pipeline from input to output.

#### Input Sources

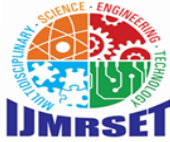
The system accepts sample traffic images or video frames from CCTV cameras as input, containing vehicles moving on roads.

#### Image & Video Processing (OpenCV)

Pre-processing using OpenCV performs resizing, noise removal, frame extraction, and image enhancement to prepare inputs for accurate detection.

#### Detection Engines (YOLOv8)

The processed image is first passed to a YOLOv8 vehicle detection model that draws bounding boxes around detected vehicles. A second YOLOv8 model then detects the license plate region, cropping it for OCR processing.



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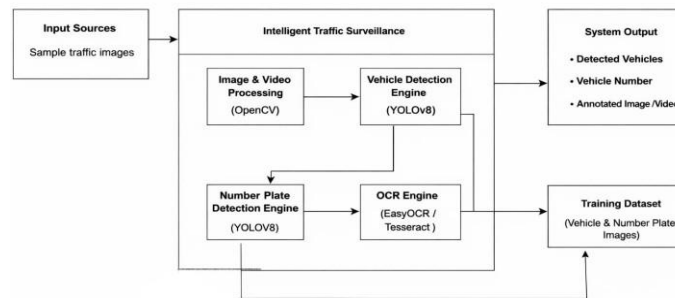
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OCR Engine (EasyOCR)

EasyOCR extracts alphanumeric text from the cropped number plate image and produces the final recognized output (eg.,TN12AM7096). The system also supports Tesseract as an alternative OCR engine



fig. 2. System Architecture of the Proposed ANPR System



### V. IMPLEMENTATION DETAILS

In the below table 2 represent, the system is implemented using Python and YOLOv8n to detect vehicle number plates from images and videos. The dataset is annotated in YOLO format, split into 80% training and 20% validation, and the trained model (best.pt) is used for prediction. Table II lists the implementation parameters.

TABLE II. SYSTEM IMPLEMENTATION PARAMETERS

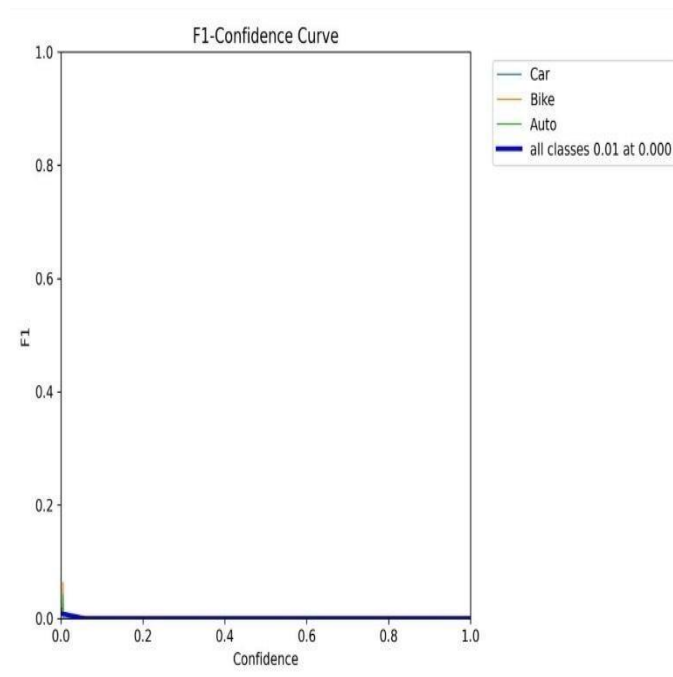
Parameter	Value
Model	YOLOv8n
Image Size	640×640
Epochs	30–50
Batch Size	16
Learning Rate	0.01
Optimizer	Default (SGD/Adam)
Confidence Threshold	0.4
IoU Threshold	0.5



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Fig 4. F1-Confidence Curve



Formula:

$$F1 = 2 \times \frac{Precision \times Recall}{Precision + Recall}$$

### VI. EXPECTED RESULTS

The proposed Automatic Number Plate Recognition (ANPR) system is expected to successfully detect vehicles and recognize Indian number plates from the input video.

#### Vehicle Detection

The system should detect vehicles such as cars, bikes, buses, and trucks from the input video frames. Bounding boxes will be drawn around the detected vehicles.

F1 Score is the balance between Precision and Recall. It shows the overall performance of the detection model.

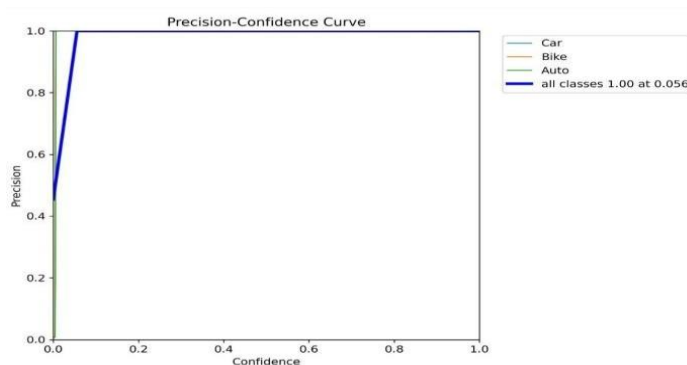


Fig 5. Precision-Confidence Curve



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Formula:

$$Precision = \frac{TP}{TP+FP}$$

Confidence score indicates how sure the model is about its prediction. Higher confidence means the model is more certain about the detected object.

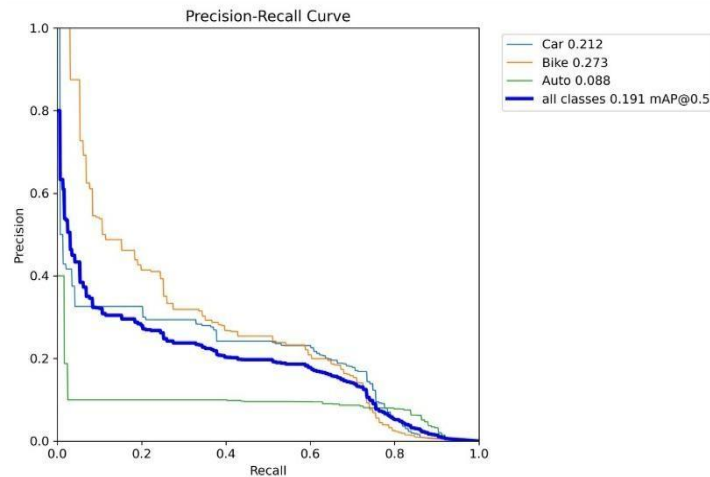


Fig 6. Precision -Recall Curve

Formula:

$$Precision = \frac{TP}{TP+FP}$$

$$Recall = \frac{TP}{TP+FN}$$

Precision measures how many detected vehicles are correct, and Recall measures how many actual vehicles are detected by the model. These metrics help evaluate the detection performance of the system..

Formula:

$$mAP = \frac{AP_1+AP_2+AP_3}{N}$$

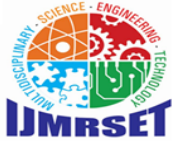
•This graph shows mAP calculates the average detection accuracy for all classes like Car, Bike, and Auto and IoU measures how accurately the predicted bounding box matches the actual object location

### Number Plate Detection

The system should identify the number plate region from the detected vehicle.



Fig. 8. Number Plate Detection Output with Bounding Boxes



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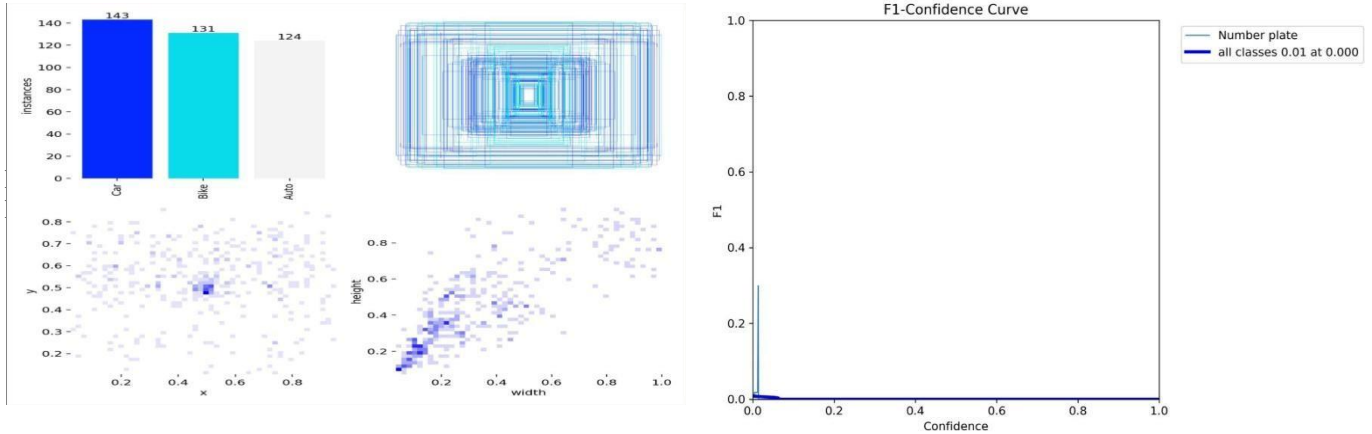


Fig 7. Dataset Annotation & Detection

This graph shows how the model’s precision changes based on different confidence values. Higher confidence levels give more accurate number plate detection..

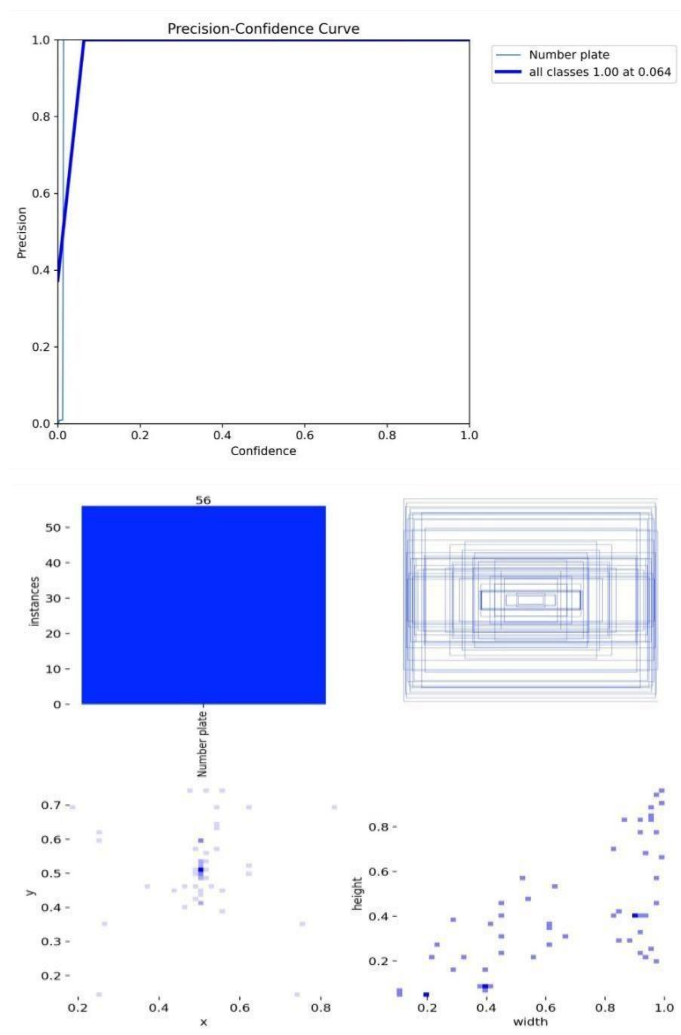


Fig 10. Precision-confidence Curve



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### Range:

$$0 \leq \text{Confidence} \leq 1$$

This figure shows the total number of number plate objects available in the dataset. It indicates that the model is trained using these labeled instances. Confident source how sure the modern is about the detection

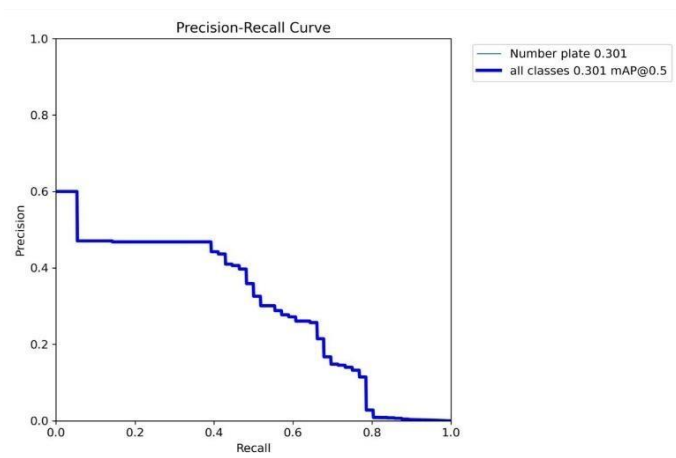


Fig 11. Precision-Recall Curve

Formula:

$$\text{Precision} = \frac{TP}{TP+FP}$$

This curve shows the relationship between precision and recall for the detection model. It helps evaluate the overall performance of number plate detection.

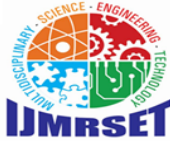
Fig 12. Boundary box detection

This plot shows the position (x, y) and size (width, height) of number plates in the images. It helps to understand how number plates are distributed across the dataset.

$$(x, y, \text{width}, \text{height})$$

### Meaning:

- **x** → Horizontal position of the object
- **y** → Vertical position of the object
- **width** → Width of the object box
- **height** → Height of the object box



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### Number Plate Recognition (OCR)

The cropped number plate image is processed using OCR to extract the character



Fig. 13. OCR Result — Extracted Number Plate Characters



Fig. 14. OCR Character Recognition Output

The Indian number plate format follows a structured pattern:

Part 1 — State Code: TN indicates that the vehicle is registered in Tamil Nadu.

Part 2 — RTO Code: 22 represents the Regional Transport Office (RTO) where the vehicle was registered.

Part 3 — Series Code: DY indicates the registration series assigned by the RTO.

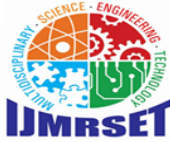
Part 4 — Unique Number: 0304 is the unique number assigned to the vehicle.

Output Video, Images

The system produces an output video showing the detection. All detected vehicle numbers will be stored automatically in an Excel sheet.



Fig. 15. Final Output Frame with Recognized Plates



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### VII. CONCLUSION

The Automatic Number Plate Detection system was successfully implemented using Python and the YOLOv8n model. The dataset was properly collected, annotated in YOLO format, and divided into training and validation sets to ensure effective learning and evaluation. The model was trained with optimized parameters such as image size, epochs, batch size, and confidence threshold to achieve reliable detection performance. After training, the best model weights were used for testing on new images and videos. The system accurately detects number plates and provides bounding boxes with confidence scores, demonstrating efficiency, speed, and practical applicability in real-world scenarios such as traffic monitoring and security systems.

In future work, the system can be enhanced by integrating real-time deployment with CCTV networks and cloud-based databases for large-scale traffic monitoring. Additional improvements may include implementing advanced OCR models for higher recognition accuracy, supporting multiple regional number plate formats, and incorporating vehicle tracking and violation detection to assist smart traffic management systems.

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