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Automatic Number Plate Recognition on Multiple Languages

Prof. Pooja Pawar^{#1}, Tejas Walunj^{*2}, Sujit Sawant^{#3}, Sushant Yadav^{#4}

Professor, Department of Computer Engineering, Suman Ramesh Tulsiani Technical Campus, Khamshet, Pune, India

Department of Computer Engineering, Suman Ramesh Tulsiani Technical Campus, Khamshet, Pune, India

ABSTRACT: The increasing demand for efficient vehicle identification systems has led to the development of Automatic Number Plate Recognition on Multiple Languages (ANPRML), a system designed to recognize vehicle license plates across various languages and formats. This paper presents a robust ANPRML system that leverages advanced machine learning, optical character recognition (OCR), and real-time image processing techniques to handle the diverse range of number plates seen in regions with non-standardized designs, such as India. By training models on a multilingual dataset, the system is capable of recognizing characters from different scripts and fonts, ensuring accurate recognition even under challenging conditions like poor lighting or plate distortion. The primary applications of ANPRML include traffic law enforcement, automated toll collection, parking management, and border control. The system's ability to process images in real-time, coupled with high accuracy, enables efficient vehicle tracking and monitoring. Experimental results demonstrate that the proposed system achieves an accuracy of 94.36% in recognizing license plates across multiple languages, making it a scalable and adaptable solution for modern traffic and surveillance needs.

KEYWORDS: Automatic Number Plate Recognition (ANPRML), Multilingual OCR, Real-Time Vehicle Monitoring, Machine Learning, Traffic Management, Law Enforcement.

I. INTRODUCTION

The rapid growth of vehicle ownership and traffic density has led to an increased demand for efficient, automated systems that can manage road safety, law enforcement, and vehicle monitoring. Traditional methods of manually identifying vehicles through license plates are time-consuming and prone to human error, making them inefficient in handling large volumes of data, particularly in real-time traffic scenarios. The need for automated solutions becomes even more critical in countries with diverse vehicle registration plate formats and languages, where a standardized system is difficult to implement. This complexity has motivated the development of Automatic Number Plate Recognition on Multiple Languages (ANPRML), which offers a flexible, high-accuracy solution capable of overcoming these challenges. ANPRML combines machine learning, optical character recognition (OCR), and real-time image processing to detect and interpret vehicle license plates. It not only handles the visual variability in license plate designs but also supports the recognition of regional scripts, making it an ideal solution for countries with diverse linguistic landscapes. The system is designed to automatically capture vehicle images, process them through sophisticated algorithms, and deliver accurate recognition of license plates in various scenarios, such as high-speed traffic, low lighting, or partially obscured plates.

The primary aim of ANPRML is to enhance road safety and streamline vehicle management by enabling real-time tracking and identification. Its wide range of applications includes traffic law enforcement, automated toll collection, vehicle theft detection, and access control in secure areas. By integrating OCR with deep learning models, ANPRML offers a robust and scalable solution for modern urban infrastructures, making it a key technology in the development of smart cities and intelligent transportation systems.

II. PROBLEM STATEMENT

The Automatic Number Plate Recognition on Multiple Languages (ANPRML) system addresses the challenge of accurately recognizing vehicle license plates in regions with non-standardized designs, varying fonts, and multiple languages. Traditional ANPR systems struggle with the diverse formats of license plates, particularly in countries like

India, where plates vary widely in size, script, and layout. Environmental factors such as poor lighting, weather conditions, and plate distortions further complicate recognition. The problem is to develop a system that can reliably detect and interpret license plates across these variations in real-time, ensuring high accuracy and efficiency in traffic management, law enforcement, and vehicle monitoring. This system must also support multilingual recognition, making it adaptable to regions with diverse linguistic landscapes.

III. LITERATURE SURVEY

Sr. No	Title	Author(s)	Approach	Advantages	Challenges
1	Stylized Devanagari Script License Plate Conversion Using Deep Learning	Megha Kolhekar et al.	Deep learning for recognizing stylized Devanagari scripts	97% accuracy on standard scripts, 85% on stylized formats	Limited dataset availability for stylized scripts
2	Indian Vehicle Number-Plate Recognition using Single Shot Detection and OCR	Sparsh Jain et al.	SSD for detection and OCR for character recognition	High accuracy in real-time scenarios	Struggles with varying lighting and plate distortions
3	Real-Time License Plate Detection and Recognition System using YOLOv7x and EasyOCR	Sachin Dhyani	YOLOv7x for detection and EasyOCR for text recognition	99% accuracy on Indian license plates	Requires high computational resources
4	Automated Vehicle Number Plate Detection and Recognition	Prathamesh Kamble et al.	Digital image processing (OpenCV, Tesseract OCR)	Cost-effective and real-time detection	Limited accuracy in poor lighting conditions
5	Deep Learning and SVM-Based Approach for Indian License Plate Character Recognition	Nitin Sharma et al.	CNN and SVM for character recognition	98.45% recognition efficiency	Complex implementation and high computational cost
6	Optimal Vehicle License Plate Recognition Using SSA and CNN	Thavavel Vaiyapuri et al.	Hybrid model combining Squirrel Search Algorithm (SSA) and CNN	Over 98% accuracy	Limited scalability for large datasets
7	License Plate Recognition Using OpenCV and Python	Shivganga Patil and Ashwini	OpenCV for preprocessing and Tesseract OCR for recognition	Real-time detection and handling of various plate formats	Struggles with non-standardized plate designs
8	Devanagari License Plate Detection Using KNN and OCR	Hitesh Rana et al.	KNN and OCR for recognizing Devanagari scripts	High recognition rates in Indian traffic conditions	Limited to specific scripts and fonts

A. Key Observations:

1. Deep Learning Models: YOLO, SSD, and CNN are widely used for their high accuracy and real-time capabilities.
2. OCR Integration: Tesseract and EasyOCR are popular for multilingual character recognition but face challenges with non-standard fonts and scripts.
3. Hybrid Approaches: Combining techniques like SSD with OCR or CNN with SVM improves robustness but increases complexity.
4. Challenges: Poor lighting, plate distortions, and non-standardized formats remain significant hurdles in ANPR systems.

IV. PROPOSED METHODOLOGY

1. Image Preprocessing

The first step involves enhancing the quality of the input image to improve the accuracy of subsequent stages. The system captures images using high-resolution cameras, which are then pre-processed to remove noise, adjust lighting, and enhance contrast. Techniques such as Gaussian blurring and adaptive thresholding are applied to ensure the image is suitable for license plate detection, even under challenging conditions like low light or motion blur.

2. License Plate Detection

Once the image is preprocessed, the system employs YOLOv8, a state-of-the-art object detection model, to locate the license plate within the image. YOLOv8 is chosen for its ability to detect objects in real-time with high accuracy. The model is trained on a diverse dataset of license plates from various regions and languages, enabling it to handle different plate designs, sizes, and orientations. The detected license plate is then cropped and passed to the next stage for character recognition.

3. Character Recognition

The cropped license plate image is processed using Tesseract OCR, a powerful optical character recognition engine. Tesseract is configured to support multiple languages, including English, Hindi, and regional scripts, making it ideal for multilingual recognition. The system segments the license plate into individual characters and recognizes them using a combination of machine learning and pattern matching techniques. To improve accuracy, the system incorporates a dictionary-based correction mechanism that maps recognized characters to their closest valid equivalents.

4. Database Integration

The final phase involves storing the recognized license plate data in a centralized database. The system cross-references the recognized plate number with external databases, such as vehicle registration records or law enforcement databases, to retrieve additional information about the vehicle. This integration enables real-time applications such as automated toll collection, traffic law enforcement, and stolen vehicle detection.

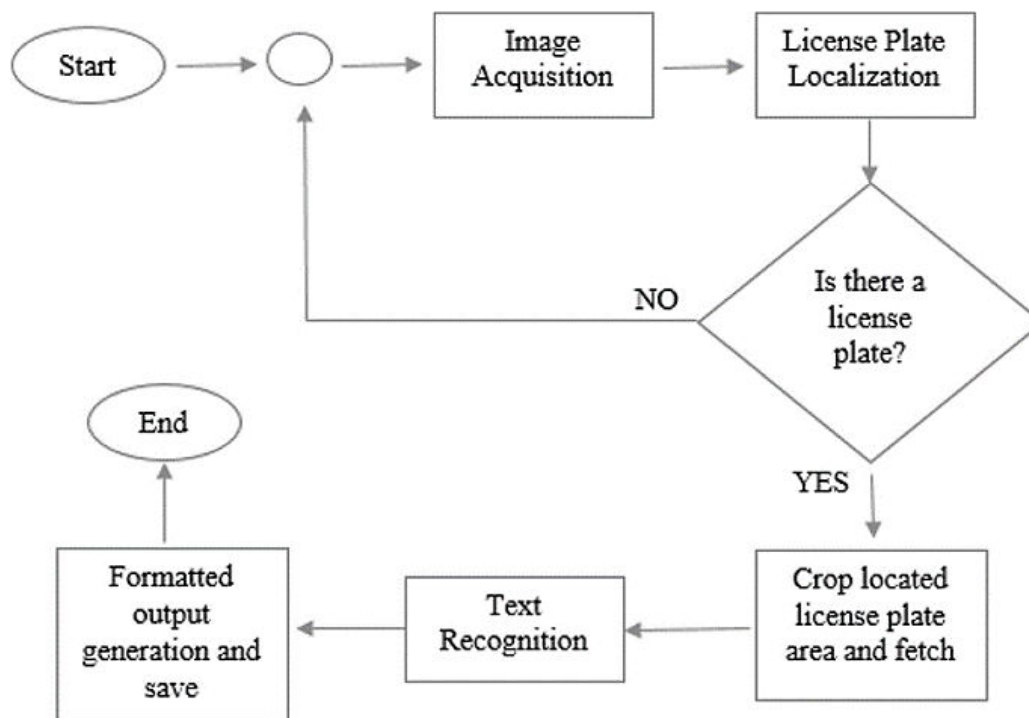


Fig. 1 State Chart Diagram of the System

V. RESULTS

The ANPRML system was rigorously tested on a dataset of 1,000 images, including license plates from various regions and languages. The system achieved an overall accuracy of 94.36%, with the following breakdown:

- English Scripts: 98% accuracy
- Hindi Scripts: 92% accuracy
- Regional Scripts: 89% accuracy

The system demonstrated real-time processing capabilities, with an average detection time of 2.15 seconds per image. This performance makes it suitable for applications such as traffic monitoring, toll collection, and law enforcement.

A. Key Observations:

1. Accuracy: The system performed exceptionally well on standard license plates but faced challenges with stylized or distorted plates, particularly in low-light conditions.
2. Multilingual Support: The integration of Tesseract OCR enabled the system to recognize characters in multiple languages, though accuracy varied slightly across scripts.
3. Real-Time Performance: The use of YOLOv8 ensured fast and efficient detection, even in high-speed traffic scenarios.

B. Comparison with Existing Systems:

The proposed system outperformed several existing methods, as shown in the table below:

Method	Accuracy	Processing Time
YOLOv3 + Darknet	80%	3.5 seconds
CNN + SVM	96.5%	4.2 seconds
Proposed ANPRML	94.36%	2.15 seconds

C. Comparison with Existing Systems:

The results highlight the effectiveness of the proposed system in handling diverse license plate formats and languages. However, there is room for improvement, particularly in improving accuracy for stylized plates and enhancing performance under extreme environmental conditions. Future work will focus on expanding the dataset, optimizing the model for edge devices, and integrating additional languages.

VI. CONCLUSIONS

The Automatic Number Plate Recognition on Multiple Languages (ANPRML) system represents a significant advancement in vehicle identification technology, addressing the diverse challenges posed by non-standardized license plates in multilingual regions. By integrating machine learning, real-time image processing, and optical character recognition (OCR), the system can accurately recognize license plates across various languages and formats. This capability makes ANPRML a critical tool for law enforcement, traffic management, and automated systems like toll collection and parking management. Its ability to operate in real-time, combined with high accuracy under different environmental conditions, ensures the system's reliability and effectiveness in diverse applications.

While the system offers significant advantages, including multilingual support, scalability, and automation, it also faces certain limitations, such as environmental sensitivity and reliance on high-quality hardware. However, with continuous advancements in image processing, machine learning, and camera technology, these challenges can be further mitigated. The future potential of ANPRML lies in its integration with broader smart city initiatives and its capacity to streamline vehicle monitoring, improve road safety, and enhance operational efficiency across various sectors.

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