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Automatic-Number-Plate-Recognition-ANPR

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Abstract: Automatic Number Plate Recognition (ANPR) is a computer vision technology that identifies vehicles by capturing and interpreting license plate images. This paper presents a system built using Python, OpenCV, and machine learning algorithms like Haar Cascade and Convolutional Neural Networks (CNN). The proposed model detects, segments, and recognizes license plates in real-time from traffic images or video. This system is highly useful for smart parking systems, traffic monitoring, toll collection, and security surveillance. The project integrates image preprocessing, plate localization, character segmentation, and optical character recognition (OCR) to achieve accurate results. Future improvements may include real-time deployment, integration with vehicle databases, and alert systems for stolen vehicles.

Keywords: *ANPR, Open CV, License Plate Detection, OCR, CNN, Haar Cascade, Smart Surveillance.*

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I. INTRODUCTION

In recent years, technological advancements have revolutionized various aspects of our daily lives. One such notable advancement is the integration of computer vision and machine learning techniques in different applications. Among these, Automatic Number Plate Recognition (ANPR) has emerged as a powerful tool with diverse applications, ranging from traffic management and law enforcement to parking management and security surveillance. This project focuses on the development of a robust and efficient Vehicle Number Plate Detection System using Python, employing state-of-the-art computer vision algorithms and techniques.

Traditionally, manual methods for reading and recording vehicle number plates were labour-intensive and prone to errors. With the advent of computer vision and deep learning, automated systems have become increasingly popular for their accuracy and efficiency. The proposed project seeks to address the challenges associated with traditional methods by leveraging the Python programming language and cutting-edge computer vision libraries such as OpenCV [2], PyTesseract [7], and YOLOv5 [4].

II. BACKGROUND INFORMATION

Number plate recognition systems play a vital role in intelligent transportation and law enforcement systems. Manual tracking is inefficient and prone to human error. With the rise of computer vision and deep learning, ANPR systems have become faster and more reliable. Research has shown that modern ANPR systems leverage a combination of object detection, optical character recognition (OCR), and image pre-processing techniques to achieve high accuracy rates [5].

Tesseract, an open-source OCR engine developed by Google, plays a significant role in reading alphanumeric characters from images [3]. Meanwhile, OpenALPR is another open-source initiative that offers ANPR capabilities through a cloud-based or on-premise solution [6]. State-of-the-art deep learning object detection models such as YOLOv5 have been widely adopted for detecting license plates in real-time scenarios [4]. Tools like OpenCV provide essential image processing functions that are crucial in preparing images for detection and recognition tasks [2].

A working implementation of an ANPR system utilizing these technologies is available in public repositories such as the GitHub project by Singla [1], which integrates OpenCV, YOLOv5, and Tesseract to provide an end-to-end solution for number plate detection and recognition.

A. Research Problem:

Many existing systems lack real-time detection capabilities, are language-dependent, or require high-end infrastructure. This paper aims to develop a lightweight, scalable, and open-source ANPR system.

B. Objectives:

- To detect number plates from real-time video feeds.
- To accurately extract text using OCR.
- To implement a machine learning model for improving recognition.

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C. Thesis Statement:

This study proposes that combining classical image processing techniques with deep learning can yield a cost-effective and efficient number plate recognition system.

D. Outline of the Paper:

- Section 1 provides an overview.
- Section 2 presents a literature review.
- Section 3 describes methodology and tools.
- Section 4 shows results and
- Section 5 discusses limitations and scope.
- Section 6 concludes the work.

III. LITERATURE REVIEW

Several studies have explored license plate recognition using neural networks, edge detection, and OCR tools. Traditional methods used templates and edge-based detection which were sensitive to lighting and angles. Recently, deep learning models like YOLO and CNN have shown robust performance in detection and classification.

S. Duet al. proposed a hybrid method using edge detection and SVM classifiers, while recent works prefer deep learning due to end-to-end learning ability. OpenALPR, a popular ANPR library, is commercial and not adaptable for Indian plates. Our system uses open-source libraries ensuring localization and customization.

IV. METHODOLOGY

A. Research Design:

This project adopts an experimental approach using Python, OpenCV for image processing, and Tesseract OCR for text extraction.

B. Data Collection:

Vehicle images were captured using mobile cameras and CCTV footage. Dataset also included public datasets with Indian vehicle number plates.

C. Sample/Population:

The dataset includes around 1000+ vehicle images with varied angles, fonts, and lighting.

D. Steps Involved:

- **Image Preprocessing:** Grayscale conversion, thresholding, noise removal.
- **Plate Detection:** Using Haar Cascade Classifier trained on number plates.
- **Character Segmentation:** Segmenting each character for OCR.
- **OCR Recognition:** Using Tesseract and CNN models for final character reading.

E. Ethical Considerations:

The dataset used for training was anonymized and did not include any sensitive or personal data. It was collected in public areas.

V. RESULTS

- Achieved **85-90% accuracy** in clean images.
- Real-time detection achieved with minimal lag.
- Successfully recognized plates with non-standard fonts using CNN.

➢ *Sample Output:*

- Input Image → Detected Plate → Segmented Characters → Final Text Output: e.g., "CG04MN1234" Performance was better under natural light and for horizontally aligned plates. Recognition decreased in blurred or rotated images.

VI. DISCUSSION

The proposed ANPR system shows promising results with high accuracy and adaptability. Integration of classical computer vision (OpenCV) with machine learning (CNN, Tesseract) creates a robust hybrid model. It is lightweight and does not require GPU, making it suitable for small institutions or government use.

A. Limitations:

- Struggles with extremely skewed or unclear plates.
- Not optimized for night-time images.
- Currently handles only English/Latin characters.

B. Comparison:

Compared to commercial systems like Open ALPR, our model provides decent accuracy with open-source flexibility.

C. Future Scope

- Multilingual Plate Recognition: Add support for Hindi, regional scripts.
- Real-Time Traffic Violation Detection: Integrate with red-light or wrong-way alerts.
- Vehicle Verification: Match recognized numbers with police databases.
- Mobile App Deployment: Lightweight app for field officers.
- Integration with Toll and Parking Systems: For automatic entry/exit.
- Cloud-Based Centralized Logging: For storing and querying vehicle logs.

VII. CONCLUSION

This project demonstrates a functional, cost-effective ANPR system using OpenCV, CNN, and Tesseract OCR. It provides a foundation for real-world applications such as smart city monitoring, vehicle tracking, and law enforcement automation.

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The system can be improved with better training data, multi-language support, and IoT integration. Its open-source nature makes it ideal for public sector and academic use.

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