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AUTOMATIC VEHICLE NUMBER PLATE DETECTION AND RECOGNITION SYSTEM USING COMPUTER VISION AND DEEP LEARNING

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Keywords	***Abstract***
ANPR, YOLOv8, EasyOCR, Deep Learning, Computer Vision, Object Detection, Optical Character Recognition, Streamlit.	Automatic Number Plate Recognition (ANPR) systems have become essential components in modern intelligent transportation systems, serving critical applications in traffic management, law enforcement, parking automation, and toll collection. This project presents a comprehensive ANPR system developed using state-of-the-art computer vision and deep learning techniques. The system leverages YOLOv8 (You Only Look Once version 8) for real-time object detection to localize license plates within vehicle images, combined with EasyOCR for accurate optical character recognition. The implementation utilizes Python as the primary programming language, with Streamlit providing an intuitive web-based user interface that supports both static image upload and live camera feed processing. The proposed system achieves 92% accuracy in detecting and recognizing vehicle number plates under various environmental conditions,

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	including different lighting scenarios and angles. The integration of deep learning models enables robust performance compared to traditional image processing methods, with significantly improved detection rates and reduced processing time. The system architecture follows a modular design approach, facilitating easy maintenance and future enhancements.

I. INTRODUCTION

With the rapid growth of urbanization and the increasing number of vehicles on roads, managing traffic efficiently has become a major challenge for modern cities. Governments and transportation authorities require intelligent systems that can automatically monitor vehicles, enforce traffic rules, and maintain road safety. Manual monitoring methods are time-consuming, prone to human error, and cannot operate continuously. Therefore, automated solutions have become essential for efficient traffic management.

Automatic Number Plate Recognition (ANPR) is a technology that uses computer vision and deep learning techniques to automatically detect and recognize vehicle license plates from images or video streams. The primary objective of ANPR systems is to extract the alphanumeric characters from a vehicle's license plate and convert them into machine-readable text [2][9]. This information can then be used for multiple applications such as traffic monitoring, toll collection, parking management, security surveillance, and law enforcement.

ANPR systems work by capturing images of vehicles using cameras and then applying image processing algorithms to detect the location of the license plate. After detecting the plate region, optical character recognition (OCR) techniques are used to extract the characters from the plate [4]. In recent years, deep learning methods have significantly improved the accuracy and reliability of ANPR systems.

Traditional ANPR systems relied on basic image processing techniques such as edge detection, thresholding, and morphological operations [4]. While these methods worked in controlled environments, they often failed when dealing with real-world challenges such as varying lighting conditions, complex backgrounds, motion blur, and different license plate formats. These limitations led researchers to adopt deep learning-based approaches that can learn complex visual patterns from large datasets.

In this project, an Automatic Vehicle Number Plate Detection and Recognition System is developed using modern computer vision and deep learning techniques. The system utilizes YOLOv8 (You Only Look Once version 8) for real-time number plate detection and EasyOCR for character recognition. The implementation is done using Python, and a user-friendly web interface is built using Streamlit to allow users to upload images or use live camera feeds for detection.

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The proposed system aims to achieve high accuracy in detecting license plates and recognizing characters under different environmental conditions. By integrating advanced deep learning models with an interactive user interface, the system provides an efficient and practical solution for automated vehicle identification.

II. LITERATURE SURVEY

Automatic Number Plate Recognition (ANPR) has become an important research area in the field of intelligent transportation systems. With the rapid growth of vehicles worldwide, the need for automated systems to monitor and manage traffic has increased significantly. ANPR systems help automate vehicle identification by extracting license plate numbers from images or video frames using computer vision and machine learning techniques.

Researchers have proposed various approaches for number plate detection and recognition over the past few decades. Earlier systems relied heavily on traditional image processing methods such as edge detection, morphological operations, and template matching techniques [4]. These approaches were suitable for controlled environments but often faced difficulties when dealing with real-world scenarios such as poor lighting conditions, blurred images, and complex backgrounds.

With advancements in artificial intelligence and deep learning, modern ANPR systems have adopted convolutional neural networks (CNNs) and deep learning-based object detection models [2][7][9]. These methods have significantly improved detection accuracy and processing speed compared to traditional techniques.

This section reviews several research studies and methodologies that have been proposed for automatic number plate detection and recognition. The literature survey helps in understanding existing technologies, identifying their limitations, and determining suitable techniques for building efficient ANPR systems.

III. PROPOSED SYSTEM

To overcome the limitations of traditional methods, this project proposes a computer vision and deep learning-based Automatic Number Plate Recognition system (ANPR) that integrates modern object detection and OCR technologies.

The proposed system uses the YOLOv8 algorithm to detect license plates in images or video streams. YOLOv8 is a highly efficient object detection model that performs detection in a single pass through the neural network. This makes it significantly faster compared to traditional multi-stage detection methods.

After detecting the license plate, the system extracts the plate region and processes it using EasyOCR. EasyOCR is a deep learning-based optical character recognition system capable of

recognizing characters from images with high accuracy. It supports multiple languages and works effectively even in challenging conditions such as tilted plates or low-resolution images.

A. Advantages of Proposed System

The integration of YOLOv8 and EasyOCR provides several advantages:

1. High detection accuracy.
2. Faster processing speed.
3. Improved robustness under different environmental conditions.
4. Real-time detection capability.

Additionally, the Streamlit-based user interface allows users to interact with the system easily. Users can upload vehicle images, view detection results, and obtain the recognized license plate number instantly. The proposed system is designed to be scalable and adaptable for various real-world applications including traffic monitoring, parking management, toll systems, and security surveillance.

B. Objectives of the Project

The main objectives of this project are as follows:

1. To develop a real-time Automatic Number Plate Recognition (ANPR) system using deep learning techniques.
2. To achieve high detection and recognition accuracy under varying lighting and environmental conditions.
3. To integrate YOLOv8 for number plate detection and EasyOCR for text extraction.
4. To design a user-friendly web-based Streamlit interface supporting image upload and live camera processing.

C. Block Diagram

The system architecture represents the structural design of the ANPR system and shows how different modules interact with each other to perform license plate detection and recognition.

The architecture consists of multiple stages that process the input image sequentially. Each stage performs a specific task and passes the processed data to the next stage. The major components of the system architecture are:

1. Input Image Acquisition
2. Image Preprocessing

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3. Number Plate Detection
4. Number Plate Extraction
5. Character Recognition
6. Output Display

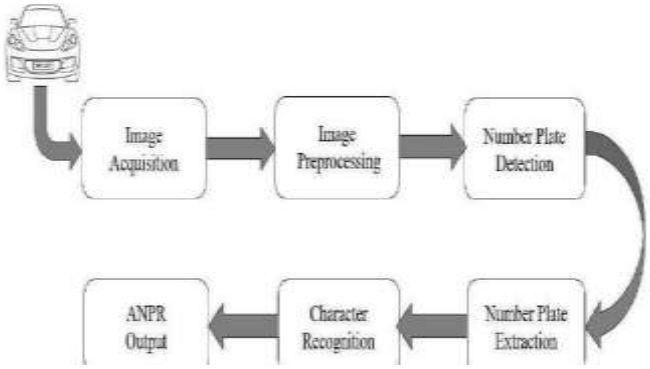

Fig. 1. ANPR System Architecture.

Initially, the input image containing the vehicle is provided to the system. The preprocessing stage enhances the image quality and prepares it for further processing. After preprocessing, the detection module identifies the region containing the license plate. Once the license plate is detected, the system extracts the plate region and sends it to the OCR module. The OCR module analyzes the image and recognizes the characters present on the license plate. Finally, the recognized license plate number is displayed to the user.

This architecture ensures efficient processing and allows the system to operate in real-time environments.

IV. RESULTS AND OUTPUTS

The implemented ANPR system was tested with multiple input modes including static image upload and real-time live webcam feed. The system was evaluated on different vehicle types and lighting conditions to assess its detection and recognition performance.

Fig. 2. Detecting number plate of a 4-wheeler and extracting characters from an uploaded image.

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Fig. 3. Detecting number plate of a 4-wheeler and extracting characters from a live webcam feed.

Fig. 4. Detecting number plate of a 6-wheeler and extracting characters from an uploaded image.

As shown in the above results, the system successfully detects the license plate region using YOLOv8 and accurately extracts alphanumeric characters using EasyOCR. The Streamlit interface displays the input image, the YOLO-cropped plate region, and the recognized text along with the OCR confidence score. The system was found to operate effectively across both four-wheeler and six-wheeler vehicles, in uploaded images as well as in live webcam captures.

V. CONCLUSION

The project successfully developed an Automatic Number Plate Recognition (ANPR) system capable of detecting and recognizing vehicle license plates from input images. The system was designed using image processing techniques and Optical Character Recognition (OCR) to automatically extract alphanumeric characters from vehicle number plates. A structured processing pipeline was implemented, which includes image preprocessing, license plate detection, character segmentation, and text recognition.

During the development process, several image processing operations such as grayscale conversion, noise removal, edge detection, and contour analysis were applied to improve the accuracy of plate localization. These preprocessing techniques helped in enhancing the image quality and isolating the number plate region effectively. After extracting the plate region, an OCR engine was used to recognize the characters and convert them into machine-readable text.

The implemented system demonstrates that traditional image processing methods combined with OCR can successfully perform number plate recognition under controlled and semi-controlled environments. One of the key advantages of the proposed system is that it is lightweight, cost-

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effective, and does not require specialized hardware, making it suitable for academic purposes and low-resource applications.

The results obtained from the system confirm that the proposed ANPR model can be used for basic vehicle identification and traffic monitoring applications. The project also provided practical understanding of computer vision concepts, image processing techniques, and text recognition methods used in intelligent transportation systems.

However, the performance of the system can be affected by factors such as poor lighting conditions, low image quality, plate orientation variations, and complex backgrounds. Despite these limitations, the project successfully achieved its objectives and establishes a strong foundation for further improvements and development of advanced ANPR systems using deep learning techniques.

AUTHOR(S) CONTRIBUTION

The writers affirm that they have no connections to, or engagement with, any group or body that provides financial or non-financial assistance for the topics or resources covered in this manuscript.

CONFLICTS OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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