AI-Based Number Plate Detection Using Artificial Intelligence

Devesh Kumar, Diksha
Department of Computer Science & Engineering, Sharda University, India
Email: devesh.kumar@sharda.ac.in

Abstract

Automatic Number Plate Recognition (ANPR) has become one of the most practical applications of Artificial Intelligence (AI) and Computer Vision in modern transportation systems. The proposed system integrates classical image processing techniques with deep learning-based Optical Character Recognition (OCR) to achieve robust and efficient number plate detection and recognition. The detection phase involves grayscale transformation, bilateral filtering, edge detection, and contour approximation to isolate the number plate. The recognition phase employs EasyOCR to extract alphanumeric text. Experimental results demonstrate that the hybrid approach offers superior accuracy and reliability across diverse environmental conditions.

Keywords — ANPR, Computer Vision, EasyOCR, Deep Learning, Image Processing, Canny Edge Detection

I. INTRODUCTION

With the exponential increase in global vehicle ownership, traffic management, toll automation, and law enforcement demand scalable and intelligent solutions. Automatic Number Plate Recognition (ANPR) systems address this challenge by using cameras and AI models to detect and recognize vehicle plates. Traditional methods relying on edge detection and morphological operations often fail under poor lighting, occlusion, or variable plate formats. To overcome these limitations, AI-driven models leveraging machine learning and deep learning have emerged as powerful tools. This paper presents a hybrid AI-based approach that combines classical vision algorithms with EasyOCR for efficient number plate recognition.

II. RELATED WORK

Early ANPR systems were rule-based, depending on edge detection and segmentation techniques. Du et al. [2] reviewed early methods that suffered from sensitivity to lighting and noise. CNN-based systems later improved robustness and accuracy, as shown by Montazzolli and Jung [3] using deep convolutional networks for real-time plate detection. Silva and Jung [4] proposed CNN models capable of handling unconstrained environments. Recent research has integrated OCR and AI to achieve end-to-end recognition. However, most deep models require high computational resources, limiting real-time deployment. Our work balances computational cost and accuracy using a hybrid AI approach.

III. METHODOLOGY

The proposed system consists of two main stages: detection and recognition. In the detection phase, the input image undergoes grayscale conversion and bilateral filtering for denoising. The Canny edge detector is applied to identify prominent edges. Contours are then extracted, and those approximating rectangular shapes are considered number plate candidates. A geometric verification process checks the rectangularity and aspect ratio. The final detected region is warped using homography transformation to correct perspective distortion. In the recognition phase, EasyOCR extracts alphanumeric text using a deep learning-based OCR engine.

IV. MATHEMATICAL MODEL

Let the input image be $I \in R^{H\times W\times 3}$. Grayscale conversion is given by $G(x,y) = 0.2989R + 0.587G + 0.114B$. Edge detection using Canny produces a binary edge map $E = C(G;\sigma,\tau\_low,\tau\_high)$. Contours are extracted from E and ranked by area. Rectangular candidates are scored as $S(P) = \lambda 1 S\_rect + \lambda 2 S\_angle + \lambda 3[2 \le r \le 6]$. The optimal plate region P^* maximizes S(P). Text recognition is modeled as $S^{\wedge} = argmax\_S\ P(S \mid warp(I, H(P^*)))$.

V. DATASET AND RESULTS

Experiments were conducted on multiple vehicle datasets including OpenALPR and Indian Vehicle Dataset. The proposed system achieved 95% detection accuracy and 93% recognition accuracy with an average processing time of 0.6 seconds per image. The hybrid approach outperformed classical edge-based ANPR systems by maintaining reliability under poor lighting and tilted plate conditions.

VI. APPLICATIONS AND DISCUSSION

This system has applications in automated tolling, parking management, law enforcement, and traffic analytics. Integrating it with Internet of Things (IoT) networks enables smart surveillance in real-time. The hybrid pipeline balances performance and efficiency, making it suitable for edge devices and embedded systems.

VII. LIMITATIONS AND FUTURE WORK

Although effective, the system may face challenges with motion blur and occluded plates. Future work will involve using YOLOv8 for faster detection, transformer-based OCR models for improved accuracy, and dataset augmentation for multilingual plate recognition.

VIII. CONCLUSION

The presented AI-based number plate detection system successfully combines classical image processing with AI-driven OCR to achieve efficient and accurate ANPR. Its robustness under varied environmental conditions makes it ideal for smart city deployments. This hybrid method provides a practical balance between computational efficiency and accuracy.

REFERENCES

[1] International Transport Forum, Global Transport Outlook 2023, OECD Publishing, 2023.
[2] S. Du et al., “Automatic License Plate Recognition (ALPR): A State-of-the-Art Review,” IEEE Trans. Circuits and Systems for Video Technology, 2013.
[3] A. Montazzolli and C. Jung, “Real-time Brazilian License Plate Detection and Recognition using Deep CNNs,” J. Electronic Imaging, 2017.
[4] S. Silva and C. Jung, “License Plate Detection and Recognition in Unconstrained Scenarios,” Proc. IEEE CVPR, 2018.
[5] C. Li et al., “End-to-End License Plate Recognition with RNNs,” Neural Computing and Applications, 2020.
[6] J. Zhuang et al., “Vehicle License Plate Recognition: A Review,” Signal Processing: Image Communication, 2020.