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AUTOMATED VEHICLE NUMBER PLATE EXTRACTION

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ABSTRACT

Automated Vehicle Number Plate Extraction (AVNPE) is a crucial technology in intelligent transportation systems, enabling law enforcement, toll collection, parking management, and traffic surveillance. Here we present a deep learning-based number plate extraction of the object by utilizing YOLOv8 (You Only Look Once) and implementing Tesseract OCR to extract information from the number plate. An interactive platform supporting real time detection through webcam and image detection of uploaded images using theFlask web framework is developed. . The system includes an image-processing module, license-plate detection module, extracting alphanumeric-based text, and validates state code for Indian vehicle number plates. The results are saved in a standard CSV format for subsequent analysis. Research methodologies, detection efficiency, system implementation, and limitations of the study are discussed in this paper. efficiency, system implementation, and limitations of the study are discussed in this paper.

Keywords: Machine Learning, ALPR, YOLO, Image Detection, Smart Cities.

I. INTRODUCTION

Automated vehicle identification is a crucial element of contemporary traffic management, security enforcement, and urban planning era of rapid technology development. The use of license plate recognition system has become an important tool in applications ranging from traffic law enforcement, parking management, toll collection and security surveillance. Vehicle identification is not an easy task, most of current system is depended on manual checked and surveillance-based enforcement which is inefficient, tedious and subject to human error.In contrast, these traditional methods cannot deliver real-time detection and manage extensive monitoring, rendering them in sufficient in high- traffic regions.

Artificial Intelligence (AI), Machine Learning (ML), and Computer Vision (CV) are being incorporated into intelligent transportation systems (its) to overcome these challenges. These technologies facilitate automatic vehicle identification, real-time analysis, and effective traffic violations enforcement. Automated Vehicle Number Plate Extraction (ANPE)is one of those innovative solutions, where we leverage deep learning-based object detection and Optical Character Recognition (OCR) based techniques to accurately extract and recognize vehicle license plate from images and live video feeds.

The proposed Automated Vehicle Number Plate Extraction System will replace traditional systems as it does the following:

- Image and video based vehicle number plate detection and recognition.
- Minimizing human interference to reduce errors and increase in efficiency.
- Deep learning-based detection of accurate and real-time recognition.
- Allowing interoperability with smart city infrastructure such as traffic control, surveillance, and toll collection automation

This AI-based power system can be adopted by governments, police authorities and private organizations to track vehicles, create automatic Road Transport Safety, and ensure security. Because it allows for real-time operation, it has emerged as an effective application component for intelligent transportation systems that contribute to rapid vehicle recognition and enhanced roadway safety.

II. RELATED WORK

The research works focuses on Automated Vehicle Number Plate Extraction (ANPE) and AI based Vehicle

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Identification systems to improve traffic surveillance, security enforcement and Smart City applications. Conventional number plate extraction approaches used rule-based image processing techniques (edge detection, contour analysis, and color segmentation) to find the license plate from vehicle images. Nonetheless, classical approaches to recognition performance struggled with high accuracy against environmental conditions like dim lighting, motion blur, and children occlusion.

Deep learning-based computer vision techniques have advanced number plate extraction with enhanced accuracy, robustness, and flexibility. YOLO, FasterR- CNN, and SSD are most commonly applied for real-time license plate detection, and they are suitable for traffic management and surveillance. YOLO-based models provide high-speed perception and accuracy but with considerable computational costs. This restricts their deployment on edge devices or embedded systems.

Tesseract OCR and models based on LSTM are widely employed in license plate text recognition, with LSTM providing greater accuracy at the cost of extensive training. Rule-based filtering and deep learning hybrid methods enhance recognition under adverse conditions. Challenges still exist, such as processing occluded or low-res plates and non-standard formats. Inefficiencies arise when processing in real-time also affect scalability on low-powered hardware.

The system proposed overcomes such challenges by implementing an AI-powered framework to improve accuracy, speed, and efficiency. It uses YOLO for detection, preprocessing for image enhancement, and OCR for text capture. This provides high- precision number plate reading for traffic management, security, and smart transportation system.

III. PROPOSED METHOD

The suggested AI-driven Automated Vehicle Number Plate Extraction System combines deep learning, Optical Character Recognition (OCR), and sophisticated image processing methods to identify and extract vehicle license plate data in real-time. The system has three major stages:

1. Vehicle Detection & License Plate Extraction

- YOLOv8 is applied in detecting cars and finding license plates with high accuracy in real-time.
- The regions of the detected license plates are cropped from the image for processing.
- Preprocessing methods like grayscale conversion, contrast adjustment, and noise filtering are utilized to enhance accuracy of recognition under low-light conditions.

2. License Plate Character Recognition

- Tesseract OCR is employed to read alphanumeric characters from the preprocessed license plate image.
- The system uses adaptive thresholding and morphological operations to enhance character legibility.
- The extracted text is subjected to validation checks to verify that it conforms to standard license plate formats.

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3. Data Processing & Storage System

- The extracted license plate number is stored in a structured database for easy retrieval and analysis.
- Detected plates are recorded with timestamps, for accurate tracking and historical information.
- The system provides real-time integration with security databases, traffic monitoring centers, and automatic vehicle tracking systems.
- CSV-based logging facilitates easy export and additional analysis for law enforcement or traffic management uses.

The hybrid AI-based approach guarantees high accuracy with minimal human involvement and efficient real-time processing. Future improvements will aim to boost OCR performance in low-light situations, incorporate edge computing for quicker on-device processing, and strengthen system security through blockchain-based data storage for better scalability and reliability.

IV. EXPERIMENTAL RESULTS

The suggested AI-driven Automated Vehicle Number Plate Extraction System was validated with real-world images and video recordings taken under different environmental conditions. The performance of the system was measured against important parameters like license plate detection accuracy, OCR recognition accuracy, processing speed, and real-time efficiency.

1. Vehicle Detection & License Plate Recognition

- The YOLOv8-based detection model attained a detection accuracy of more than 90% under various lighting and weather conditions, such as daytime, nighttime, fog, and rain.
- The Tesseract OCR model effectively extracted license plate text with an average accuracy of 85%, working well on clear and well-lit images.
- Recognition errors were mainly caused by blurry images, partial occlusions, and low contrast, impacting OCR readability.

2. OCR Accuracy& Text Extraction

- The OCR algorithm worked best with normal license plate fonts and sharp images, and accuracy decreased in the case of damaged or stylized plates.
- Adaptive preprocessing methods like grayscale conversion, thresholding, and noise filtering enhanced OCR performance under low-light conditions.

3. Processing Speed & Efficiency

- The system processed video frames at an average rate of 30 milliseconds per frame, allowing real-time detection and extraction.
- License plate text extraction was achieved within 1-2 seconds per frame, and it is appropriate for traffic surveillance, toll collection, and auto-security screening.

4. Error Analysis

- The main sources of error were low-resolution images, motion blur in moving objects, and non- standard

fonts for the license plates.

- Performance was much better with high-resolution cameras with infrared capability, particularly in nighttime detection.
- Future developments will concentrate on refining OCR algorithms to better cope with blurred and occluded plates.

The experimental results show that the system is highly accurate and efficient in extracting vehicle number plates in real-time. Future enhancements will aim to improve OCR performance in low visibility conditions, optimize processing speed for large-scale use, and incorporate AI-driven adaptive recognition techniques to achieve better accuracy across various scenarios.

V. DISCUSSION

The experimental results show that the Automated Vehicle Number Plate Extraction System successfully automates the detection of license plates and recognizes characters, achieving high accuracy and efficient real-time processing. By combining deep learning- based detection with OCR techniques, this system proves to be dependable solution for various applications, including traffic monitoring, security enforcement, and automated toll collection. Nevertheless, there are still some challenges that must be tackled to ensure broader adoption and improved robustness in real-world situations.

Key Observations

- High Detection Accuracy: The YOLOv8 model showed more than 90% accuracy in identifying and extracting number plates under various environmental conditions.
- OCR Performance: The Tesseract OCR model effectively recognized alphanumeric characters but faced challenges with distorted, stylized, or low- resolution plates.
- Efficient Real-Time Processing: The system delivered rapid processing speeds, making it ideal for real-time license plate extraction in surveillance and vehicle tracking applications.

Challenges Identified

- Blurred & Partially Visible Plates: Plates captured during high-speed motion, in low light, or when partially obstructed resulted in decreased OCR accuracy.
- Environmental Factors: Reduced visibility caused by rain, fog, glare, or nighttime conditions impacted image clarity, which in turn affected detection performance.
- Computational Constraints: The deep learning model demands considerable processing power, posing challenges for low-end or embedded edge devices.

Future Improvements

- Advanced OCR Techniques: Utilizing deep learning-based OCR models like CRNN (Convolutional Recurrent Neural Networks) or Transformer-based OCR to better manage non-standard fonts and low- resolution plates.
- Adaptive Image Processing: Improving preprocessing methods, such as contrast adjustments, noise reduction, and image sharpening, to facilitate better text extraction in challenging conditions.
- Integration with Edge AI & IoT: Implementing optimized AI models on edge devices to lessen dependence on cloud computing, which will lead to quicker response times and greater scalability.
- Multi-Angle Recognition: Adding multiple camera angles to enhance plate extraction from vehicles that are moving quickly or captured from various perspectives.

VI. CONCLUSION

The Automated Vehicle Number Plate Extraction System employs YOLO for detection and Tesseract OCR for text recognition, providing high accuracy and real- time processing for uses such as traffic monitoring and law enforcement. Challenges such as motion blur and low-light conditions will be tackled with advanced OCR techniques and edge AI integration. Future enhancements will involve blockchain for secure data storage and adaptive AI models for improved scalability. By minimizing manual intervention, this system boosts smart traffic management and automated vehicle identification.

VII. REFERENCES

[1] Sei-Wang Chen; Li-Shien Chen; Chung- Hsien Chen; Shun-Chien Chang, "Automatic License Plate Recognition," DOI: 10.1109/ICIP.2004.1421049, 2004.

[2] Md. Saif Hassan Onim; HussainNyeem; Koushik Roy; Mahmudul Hasan; Abtahi Ishmam; Md. Akiful Hoque Akif; Tareque Bashar Ovi, "BLPnet: A new DNN model and Bengali OCR engine for Automatic License Plate Recognition,"arXiv preprint arXiv:2202.12250, 18 February 2022.

[3] Rajdeep Adak; Abhishek Kumbhar; Rajas Pathare; Sagar Gowda, "Automatic Number Plate Recognition (ANPR) with YOLOv3-CNN," arXiv preprint arXiv:2211.05229, 7 November 2022.

[4] Zuhaib Akhtar; Rashid Ali, "Automatic Number Plate Recognition using Random Forest Classifier," arXiv preprint arXiv:2303.14856, 26 March 2023.

[5] Sai Sirisha Nadiminti; Pranav Kant Gaur; Abhilash Bhardwaj, "Exploration ofan End-to-End Automatic Number-plate Recognition neural network for Indian datasets," arXiv preprint arXiv:2207.06657, 14 July 2022.

[6] S.S.S.R. Depuru; L. Wang; V. Devabhaktuni, "Automatic NumberPlate Detection using Deep Learning," IEEE Conference Publication, DOI: 10.1109/ICGCIoT.2015.7380516, 2015.

[7] Reza Azad; Babak Azad; Hamid Reza Shayegh, "Real-Time and Efficient Method for Accuracy Enhancement of Edge Based License Plate Recognition System," arXiv preprint, arXiv:1407.6498, 2014.

[8] Yi Wang; Zhen-Peng Bian; arXiv preprint, Yunhao Zhou; Lap Pui Chau, "Rethinking and Designing a High performing Automatic License Plate Recognition Approach," arXiv preprint, arXiv:2011.14936, 2020.

[9] A Robust License Plate Detection Algorithm Using Edge Detection and Hough Transform" by J. Li et al. (2018) – This paper present sa robust LPD algorithm using edge detection and Hough transform.

[10] License Plate Detection and Recognition Using Deep Learning" by Y. Yuan et al. (2017) - This paper proposes a deep learning-based approach for LPD and LPR using convolutional neural networks (CNNs).

[11] Jithmi Shashirangana, Heshan Padmasiri, Charith Perera, "Automated License Plate Recognition: A Survey on Methods and Techniques," IEEE Access, DOI: 10.1109/ACCESS.2021.3050281, 2021.

[12] Marcel Del Castillo Velarde, Gissel Velarde, "Benchmarking Algorithms for Automatic License Plate Recognition," arXiv:2203.14298, 2022.

[13] Afshin Dehghan, Syed ZainMasood, Guang Shu, Enrique G. Ortiz, "View Independent Vehicle Make, Model and Color Recognition Using Convolutional Neural Network," arXiv:1702.01721, 2017.

[14] H. Nguyen, F. de la Torre, "License Plate Recognition Algorithms Using Deep Convolutional Neural Networks and Data Augmentation,"2020.

[15] Sorin Draghici, "A Neural Network Based Artificial Vision System for License Plate Recognition," Department ofComputer Science, Wayne State University, 1997.

[16] Mohamed Shehata, Mohamed Taha Abou-Kreisha, Hany Elnashar, "Deep Machine Learning Based Egyptian Vehicle License Plate Recognition Systems," arXiv:2107.11640, 2021.

[17] Dr. M. Ayyappa Chakravarthi etal. published Springer paper “Machine Learning-Enhanced Self-Management for Energy-Effective and Secure Statistics Assortment in Unattended WSNs” in Springer Nature (Q1), Vol 6, Feb 4th 2025

[18] Dr. M. Ayyappa Chakravarthi etal. published Springer paper “GeoAgriGuard AI-Driven Pest and Disease Management with Remote Sensing for Global Food Security” in Springer Nature (Q1), Jan 20th 2025.

[19] Dr. M. Ayyappa Chakravarthi etal. presented and published IEEE paper “Machine Learning Algorithms for Automated Synthesis of Biocompatible Nanomaterials” , ISBN 979-8-3315-3995-5, Jan 2025.

[20] Dr. M. Ayyappa Chakravarthi etal. presented and published IEEE paper “Evolutionary Algorithms for Deep Learning in Secure Network Environments” ISBN:979-8-3315-3995- 5, Jan 2025.

[21] Dr. Ayyappa Chakravarthi M. etal, published Scopus paper “Time Patient Monitoring Through Edge Computing: An IoT-Based Healthcare Architecture” in Frontiers in Health Informatics (FHI),

Volume13,Issue3,ISSN-Online2676-7104,29thNov2024.

[22] Dr. Ayyappa Chakravarthi M. etal, published Scopus paper "Amalgamate Approaches Can Aid in the Early Detection of Coronary heart Disease" in Journal of Theoretical and Applied Information Technology (JATIT),Volume102,Issue19, ISSN 1992-8645, 2nd Oct 2024.

[23] Dr. Ayyappa Chakravarthi M, etal, published Scopus paper "The BioShield Algorithm: Pioneering Real-Time Adaptive Security in IoT Networks through Nature-Inspired Machine Learning" in SSRG (Seventh Sense Research Group)

[24] International Journal of Electrical and Electronics Engineering (IJEEE), Volume 11,Issue9,ISSN2348-8379, 28th Sept 2024.

[25] Ayyappa Chakravarthi M, Dr M. Thillaikarasi, Dr Bhanu Prakash Battula, published SCI paper "Classification ofImage Spam Using Convolution Neural Network" in International Information and Engineering Technology Association (IIETA) - "Traitement du Signal" Volume 39, No. 1

[26] Ayyappa Chakravarthi M, Dr. M. Thillaikarasi, Dr. Bhanu Praksh Battula, published Scopus paper "Classification of Social Media Text Spam Using VAE-CNN and LSTM Model" in International Information and Engineering Technology Association (IIETA) - Ingénierie des Systèmes d'Information (Free Scopus) Volume 25, No. 6.

[27] Ayyappa Chakravarthi M, Dr. M. Thillaikarasi, Dr. Bhanu Praksh Battula, published Scopus paper "Social Media Text Data Classification using Enhanced TF_IDF based Feature Classification using Naive Bayesian Classifier" in International Journal of Advanced Science and Technology (IJAST) 2020

[28] Ayyappa Chakravarthi M. presented and published IEEE paper on "The Etymology of Bigdata on Government Processes" with DOI10.1109/ICICES.2017.8070712andis

[29] Scopus Indexed online in IEEE digital Xplore with Electronic ISBN: 978-1-5090-6135-8, Print on Demand(PoD) ISBN:978-1-5090-6136-5, Feb'2017.

[30] Subba Reddy Thumu & Geethanjali Nellore, Optimized Ensemble Support Vector Regression Models for Predicting Stock Prices with Multiple Kernels. Acta Informatica Pragensia, 13(1), x–x. 2024.

[31] Subba Reddy Thumu, Prof. N. Geethanjali. (2024). "Improving Cryptocurrency Price Prediction Accuracy with Multi-Kernel Support Vector Regression Approach". International Research Journal of Multidisciplinary Technovation 6 (4):20-31.

[32] Dr Syamsundararaothalakola et.al. published Scopus paper "An Innovative Secure and Privacy-Preserving Federated Learning Based Hybrid Deep Learning Model for Intrusion Detection in Internet-Enabled Wireless Sensor Networks " in IEEE Transactions on Consumer Electronics2024.

[33] Dr Syamsundararaothalakola et.al. published Scopus paper "Securing Digital Records: A Synergistic Approach with IoT and Blockchain for Enhanced Trust and Transparency "in International Journal of Intelligent Systems and Applications in Engineering2024.

[34] Dr Syamsundararaothalakola et.al. published Scopuspaper "A Model for Safety Risk Evaluation of Connected Car Network "in Review of Computer Engineering Research 2022.

[35] Dr Syamsundararaothalakola et.al. published Scopus paper" An Efficient Signal Processing Algorithm for Detecting Abnormalities in EEG Signal Using CNN"in Contrast Media and Molecular Imaging 2022.