International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 10 | Oct - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

Vehicle Number Plate Detection and Recognition

Ankit Kaushal
Computer Science and Engineering
Chandigarh University
Punjab, India
22BCS50134@cuchd.in

Narinder Yadav
Computer Science and Engineering
Chandigarh University
Punjab, India
narinder.e16474@cumail.in

Nikhil Kumar
Computer Science and Engineering
Chandigarh University
Punjab, India
22BCS50137@cuchd.in

Sachin Yadav
Computer Science and Engineering
Chandigarh University
Punjab, India
22BCS50130@cuchd.in

Ishdeep Singla
Computer Science and Engineering
Chandigarh University
Punjab, India
ishdeep.singla@gmail.com

Dipanshu Garg
Computer Science and Engineering
Chandigarh University
Punjab, India
22BCS50128@cuchd.in

Abstract-

Real-time traffic monitoring systems face a host of challenges, especially the conventional methods using expensive labour-intensive and time-consuming manual operations . These traditional techniques generally involve human operators and hence are bound by scalability and efficiency. However, with advances in surveillance technology and computer vision, new prospects became possible . Through the incorporated video feeds coming from security cameras and traffic monitoring systems, detection of traffic flow, counting, and analyzing the behavioural patterns of the numbered plates can be realized in modern approaches.

Another striking project in the vision is the project of traffic camera analysis, which suggests an entire system for real- time analysis of cameras regarding the detection of traffic. As the system will automate all processes, it is envisioned to give both practical and educative insights into the issue of traffic: vehicle detection and number plate recognition. The system does this by combining enhanced methods of image processing with object detection and tracking, enabling the system to closely observe the flow of traffic. All data analyzed via this system is real-time, meaning that each count-and recognition of a car-is valid. The implementation will use the Python language, and hence it has very potent libraries for image processing as well as machine learning. The presented work will thus equally look at the technical challenge about traffic monitoring in real-time by further discussing the issues in terms of scalability related to practical applications in infrastructural smart cities.

Keywords: Real-Time Traffic Monitoring, Automatic Number Plate Recognition, EasyOCR, OpenCV.

I. INTRODUCTION

A. Problem Definition:

Car number plate recognition and detection have become very critical in several fields, such as parking systems, toll collecting, law enforcement, and traffic management [1][5]. In applications where accuracy may be ensured and eased into possibility, detection and recognition of license plates directly from images or video streams become a vital technological innovation. Serious recent development has occurred in this area, not least because of the significant advances occurring with machine learning and computer vision techniques [4][6.

Further, the exponential growth that the field of license plate recognition has received as a result of the advancement in technology, the cost and accessibility of hardware components required to implement these systems have grown [7]. This has made it easier for anyone to create license plate recognition systems since all the components required, such as high-resolution cameras, moderately affordable storage, and powerful CPUs, are readily available. In other words, technology is more accessible today, and its possible uses multiply, encouraging global creativity among academics and programmers [10]. With smart city initiatives and the digital transformation of the transportation infrastructure currently enjoying more focus than ever before, the demand for intelligent solutions that will easily blend in with existing networks and platforms is correspondingly higher [11][12].

B. Problem Overview:

This project will develop, with the help of Python, an efficient and reliable system for recognizing and detecting automobile number plates [9]. The system shall employ various algorithms and techniques in computer vision that will automatically locate and extract the regions in an image or video frame linked to license plates [1][2]. Subsequently, it will be able to identify alphanumeric characters on the license plates [3].
Different topics included in license plate detection and recognition create a wide array of challenges, such as factors of lighting, the orientation of the vehicle, or even the type of

license plates [4][5]. This study puts together different image processing, pattern recognition, and machine learning techniques that handle these issues and thus turn out trustworthy answers. The importance of this project is due to the different applications it may have. First of all, law enforcement benefits from correct license plate recognition and vehicle identification. The project further develops the research and development of computer vision and machine learning [11][12].

The research paper encompasses the details of the project regarding the problem statement, objectives, methodology, implementation details, and experimental results. It also discusses the existing solutions and techniques in the field, while highlighting novel contributions and further advances made through this project [14][15].

In summary, the number plate detection and recognition Python project really highlights how many tasks associated with transportation and security systems can be improved and automated through the use of computer vision and machine learning technology [16]. The technology enhances efficiency, convenience, and security in so many applications where a correct identification or accurate detection of license plates is involved.

II. LITERATURE SURVEY-

A. Existing System:

The rapid expansion of modern urban and public road networks in recent decades has highlighted the need for efficient road traffic monitoring and management systems [1][2]. As more people use cars, societal issues such as accidents, traffic congestion, and other challenges become increasingly prominent.

Challenges of the Existing System:

- Due to the speed of vehicles, images captured may sometimes be blurred [5][6].
- It is impractical to manually count vehicles 24 hoursa day, throughout the year [8].
- Remote areas require automatic devices for traffic counting [9][10].
- Strict lane discipline is required for accurate data collection [11].
- Detection of non-motorized vehicles is difficult [13].
- Overhead reading systems may fail to capture data accurately [14][15].

B. Proposed System:

The proposed system aims to improve the recognition and detection of car number plates using Python, taking into account various factors such as accuracy, speed, resilience, algorithm complexity, dataset size and variety, target platform, and application [1][2]. Rather than using template matching methods, we propose creating a block diagram of a number plate recognition system utilizing OpenCV and EasyOCR [3][4]. The following components are considereddуring development:

- License Plate Detection: Utilizing the machine learning-based library OpenCV for detecting licenseplates [5][6].
- Character Segmentation: Techniques such as thresholding, connected component analysis, and contour analysis may be used. Deep learning-based methods like CNNs (Convolutional Neural Networks) and RNNs (Recurrent Neural Networks) have also shown promising results in character segmentation tasks [7][8][9].
- Character Recognition: Deep learning-based EasyOCR will be used for character recognition, leveraging a Raspberry Pi camera to detect and identify license plates [10][11].
- Integration: A pipeline-based approach is considered, where license plate detection, character segmentation, and character recognition algorithms are sequentially applied to input images or videos. Alternatively, end-to-end deep learning models that integrate all three tasks in a single network may be employed [12][13].
- Testing and Evaluation: A large and diverse dataset of images or videos with license plates will be used for testing. Metrics such as processing time, accuracy, precision, recall, and F1-score will be employed to evaluate the system's effectiveness. The performance of the system will also be compared against state-of-the-art methods and previously developed solutions [16][17].

C. Literature Review Summary:

YEAR	AUTHOR	PROJECT	GOAL
2023	Puppala Ramya et al.,	Number Plate Recognition Using Optical Character Recognition and Connected Component Analysis	The aim is to recognize the license plate so that vehicles can easily follow when a traffic ticket or speeding is made.
2023	Anuj S. Tote et al.,	Automatic number plate detection using TensorFlow in an Indian scenario	A study was carried out to determine vehicle numbers using computer vision Techniques.
2023	Liang Chen et al.,	Road vehicle recognition algorithm in safety assistant driving based on artificial intelligence	This article aims to examine the vehicle recognition algorithm in artificial intelligence based safe driver
2023	Juan Alberto Antonio Velázquez et al.,	License Plate Detection and Location for Fast Character Segmentation	The main function of this business is to look for licenses anywhere
2023	Mohammad Sadra	Development of BPR	This study developed a

	Rajabi et al.,	models in smart cities using loop detectors and license plate recognition technologies	Public Roads Bureau model using data collected from loop detectors and license plate recognition systems.
2022	Shreya anekar et al.,	Automated Gate System Using Number Plate Recognition	This research aimed to develop and implement an automatic gate control system.
2022	Rayson Laroca et al.,	On the Cross-dataset Generalization in License Plate Recognition	The author investigated a real- time OD matrix based on the trip per-vehicle.
2022	Muhammad Ayaz et al.,	Automatic Vehicle Number Plate Recognition Approach Using Color Detection Technique	To improve the detection and recognition rate of the AVNPR system and remove faced problems due to issues such as variations in format, lighting conditions, scales, and colors of number plates
2022	Adithya. t.g et.al	AVNP Recognition Idea Development using AI-based	Improve the detection and recognition rate of the AVNPR system
2022	Nahin Hossain et.al	Automatic License Plate Recognition System Using Deep Neural Network	Implement an automatic number plate recognition system using artificial neural networks
2021	Syed Afaq ali shah et al.,	Automatic Number Plate Recognition: A Detailed Survey of Relevant Algorithms	Automatic Number Plate Recognition: A Detailed Survey of Relevant Algorithms
2021	Hamid mirza hossein et.al	How realistic is static traffic assignment? Analyzing automatic number-plate recognition data and image processing of	Traffic analysis using data mining of processed images of real time traffic maps as a location-based data model
		real-time traffic maps for investigation	

III. - PROBLEM STATEMENT/OBJECTIVE:

The research on vehicle number plate detection and recognition addresses the need for an automated system to detect and recognize license plates in images or video feeds [1][2]. This issue is critical in various applications, including law enforcement, parking management, and traffic monitoring [3][4]. One of the most significant challenges in license plate recognition is the diversity of plate designs and the varying conditions under which images are captured. License plates differ in size, language, color, and design, and images can be affected by factors such as lighting, occlusions, and noise [7].

The primary goal of this project is to develop a system capable of accurately identifying and recognizing license plates across a variety of scenarios [9]. The system must undergo multiple stages of processing, including image preprocessing, plate detection, character segmentation, and recognition. It should handle a wide range of license plate
designs while remaining robust against changes in lighting, occlusions, and noise. Additionally, the system is intended to operate in real-time, delivering fast and consistent results on various devices, including smartphones and surveillance cameras [14][15].
The specific objectives of this project include:

- **Data Gathering:** Assemble a large database of images or videos featuring authorized vehicles. This data will be used to train the system and prepare it for license recognition tasks [1][2].
- **Image Preprocessing:** Preprocess images or videos to remove noise, adjust lighting, and improve overall image quality [3][4].
- **License Identification:** Develop an algorithm capable of identifying the position and size of license plates within an image or video feed [5][6].
- **Character Segmentation:** Segment the characters on the license plate to prepare them for recognition.
- **Character Recognition:** Create a character recognition module that can accurately identify the characters on license plates [11][12].
- **Integration:** Integrate the license plate verification and validation processes into a system that can verify and validate license plates in real-time from images or video feeds [14].
- **Evaluation:** Measure the system's performance by assessing the accuracy, speed, and robustness of the license detection and recognition algorithms [15].

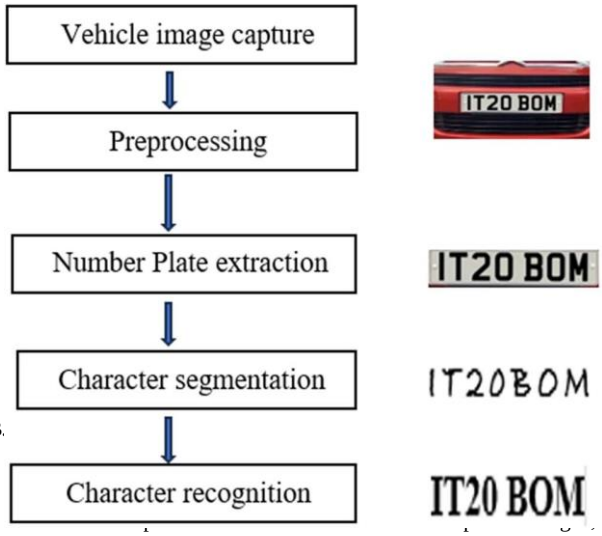
The ultimate goal is to create a system that can be utilized in various applications, including law enforcement, parking lot management, and traffic monitoring, delivering real-time results for license plate recognition and validation.

IV. METHODOLOGY

The following are the various sections that make up the approach for the Python project on vehicle number plate detection and recognition:

A. flow diagram

The ANPR system operates in three stages: first, it locates the car and photographs it from the front or back, then it locates the number plate, and finally it extracts the number plate as an image [1]. The following step is to implement an image segmentation strategy. Neural networks, mathematical morphology, color analysis, and histogram analysis are all examples of segmentation approaches [4][5]. Segmentation is used to identify specific characters. Optical Character Recognition (OCR) is one method for viewing each character in a database that contains numerous alphanumeric characters. The flow diagram below demonstrates how an ANPR system operates and what stepsare followed.



B.

lighting setups, and camera angles.

- We are using Real Time Car Number Plates Extraction for dataset collection means capturing NP images through live streaming. [3][4].

C. Image Pre-processing

- Remove noise and enhance image quality
- Adjust contrast and brightness using techniques such as histogram equalization, color space conversion, and filtering [7].
- We are using the OpenCV library for image pre-processing.
- Detect the position and size of license plates we are going to use the OpenCV machine learning software library [12].

Fig 2. Captured image by the digital camera

Fig 4. Vehicle Number Plate extraction

D. Character Segmentation

- Segment the characters on the license plate and isolate them for recognition
- Use techniques such as thresholding, connected component analysis, and contour analysis

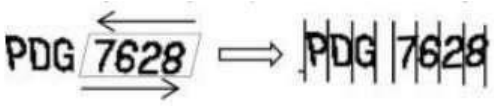


Fig 5. Example of Plate Segmentation.

E. Character Recognition

- Recognize the characters on the license plate we are going to use Easy OCR a Python module for extracting text from the image

Fig 6. Database of templates

F. Integration:

- Integrate the system with other systems and devicesto provide real-time results.

G. Testing and Debugging:

- Test the system on a large and diverse dataset of images or videos that contain license plates. Debug and optimize the algorithms to ensure accuracy, speed, and robustness [5][6].

H. Deployment:

- Deploy the system on the target platform, such as a desktop, mobile, or web application. Ensure that the system meets the specified requirements and provides accurate and reliable results.

I. Evaluation

- Measure the accuracy, speed, and robustness of the license plate detection and recognition algorithms
- Use a large and diverse dataset of images or videosthat contain license plates

V. Result-

Step-1: Detecting License Plates

```
[22] #imports

     import easyocr
     import cv2 #for images
     import matplotlib.pyplot as plt

[23] img = cv2.imread("/content/2018_Philippine_new_plates.png")

[24] plt.imshow(img)

     <matplotlib.image.AxesImage at 0x7f010fdc58b0>
```

Fig 7. Read in Image

Step-2: Applying OCR to Text (Image).

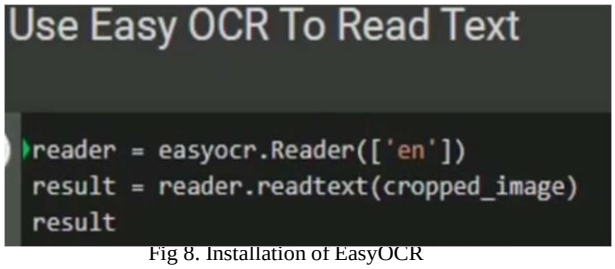


Fig 8. Installation of EasyOCR

Step-3: Apply ROI filtering and OCR

Step-4: OCR filtering

If the number plate image has more letters or words than numbers or variables, we employ OCR filtering to remove any unnecessary words or characters while retaining only the car number or variable [13].

Step-5: Final Output

```
# Print the detected text
for detection in result:
    print(detection[1])

NBC
1234
```

Fig 9. Output

VI. Conclusion-

***A.* Conclusion:**

The Python Vehicle Number Plate Detection and Recognition Project tries to automate linking and detecting license plate figures- a wide application in law enforcement, risk collection, parking operations, and company monitoring. The system incorporates vibrant methodologies and approaches in view to speedily and accurately identify license plate areas, individual letters, and specially sensitive alphanumeric data. Generally speaking, improvements of number plate detection and recognition in Python from automotive may be treated as a great leap forward in robotics and computer vision. It produces a repetitive and reliable result for license plate identification related to efficacy, delicacy, and affordability.

***B.* Future work**.

There is scope for future work and improvements in the system. Some of the important areas on which the future work may focus are as follows:

- Further enhance the accuracy and robustness of the license plate detection algorithm, particularly under poor illumination or complex backgrounds.
- Developing more advanced character recognition techniques that can handle variations in font, color, and style.

- Improving the real-time processing capabilities of the system to handle high-speed video streams or multiple cameras.
- Integrating the system with cloud-based services for storage, analysis, and processing of large amounts ofdata
- Some deep learning-based methodologies, such as object detection and recognition networks, are being explored for better overall accuracy andperformance.

VII. References-

[1] Puppala, R., et al. (2023). License Plate Recognition through Optical Character Recognition and Connected Component Analysis.

[2] Tote, A. S., et al. (2023). Vehicle License Plate Detection Utilizing TensorFlow in the Indian Context..

[3] Chen, L., et al. (2023). AI-Driven Vehicle Recognition for Enhanced Safety in Road Transportation.

[4] Velázquez, J. A. A., et al. (2023). Fast Character Segmentation through Efficient License Plate Detection and Location Techniques.

[5] Rajabi, M. S., et al. (2023). Development of Backward Propagation Models for Smart Cities Using Loop Detectors and License Plate Recognition Systems.

[6] Anekar, S., et al. (2022). Automated Gate Control through Number Plate Recognition Systems.

[7] Laroca, R., et al. (2022). Enhancing Cross-Dataset Generalization in License Plate Recognition Models.

[8] Ayaz, M., et al. (2022). A Color Detection-Based Approach to Automatic Vehicle Number Plate Recognition.

[9] Adithya, T. G., et al. (2022). Conceptualizing AI-Based Vehicle Number Plate Recognition.

[10] Hossain, N., et al. (2022). License Plate Recognition Using Deep Neural Networks.

[11] Shah, S. A. A., et al. (2021). Comprehensive Review of Automatic Number Plate Recognition Algorithms.

[12] Hossein, H. M., et al. (2021). Analyzing Traffic Assignments Using Number Plate Recognition and Real- Time Traffic Image Processing.

[13] Hadavi, S., et al. (2020). Vehicle Movement Analysis through Automatic Number Plate Recognition of Freight and Passenger Traffic.

[15] Amirgaliyev, B., Kairanbay, M., & Kenshimov, C. (2014). Efficient Algorithms and Methods for Number Plate Recognition. *International Conference on Artificial Intelligence and Computing Technology (ICAICT)*, 1-4. doi:10.1109/ICAICT.2014.7035951.

[16] Mustafa, T., & Karabatak, M. (2023). Deep Learning for License Plate Detection and Recognition at Campus Gates. *2023 11th International Symposium on Digital Forensics and Security (ISDFS), Chattanooga, USA*, 1-5. doi:10.1109/ISDFS58141.2023.10131758.

[17] Liu, Z., & Kircher, K. (2018). A Comparative Study of Time-Based and Speed-Based Traffic Light Assistance Systems. *Cognition, Technology & Work*, 20. https://doi.org/10.1007/s10111-017-0458-7.

[18]Rouigueb, A., Demim, F., Hadjira, B., Messaoui, A. Z., Benatia, M., & Djamaa, B. (2023). Enhancing License Plate Character Segmentation Using the Naïve Bayesian Network.61-68https://doi.org/10.5220/0012091500003543.

[19] Rajabi, M. S., Habibpour, M., Bakhtiari, S., Rad, F., & Aghakhani, S. (2023). Developing BPR Models in Smart Cities with Loop Detectors and License Plate Recognition: A Case Study. *Journal of Future Sustainability*, 3, 75-84. https://doi.org/10.5267/j.jfs.2022.11.007.

[20] Khinchi, M., & Agarwal, C. (2019). A Survey of Technologies and Methods for Automatic Number Plate Recognition.363-366. https://doi.org/10.1109/ISS1.2019.8908014.

[21] Laroca, R., Cardoso, E., Lucio, D. R., Estevam, V., & Menotti, D.(2022). Improving Cross-Dataset Generalization inLicensePlateRecognition.166-178. https://doi.org/10.5220/0010846800003124.

[22] Javed, S., Khan, A., Najeeb, F., & Sci and Tech, I. J. (2022). A Color Detection-Based Approach to Automatic Vehicle Number Plate Recognition. 3, 166-176.

[23] Kaur, A., Ranjan, S., & Kaur, H. (2023). A Review of Techniques for Automatic Vehicle Number Plate Recognition.

[24] Hossain, S., Hassan, M. Z., & Masba, M. (2021). A Deep Neural Network-Based License Plate Recognition SystemforBangladeshiVehicles. https://doi.org/10.1007/978-981-16-6636-0_8.

[25] Kashyap, A., Suresh, B., Patil, A., Sharma, S., & Jaiswal, A. (2018). Automatic Number Plate Recognition. 838-843. https://doi.org/10.1109/ICACCCN.2018.8748287.

[26] Friedrich, M., Jehlicka, P., & Schlaich, J. (2008). Using Automatic Number Plate Recognition to Study Travel Behavior. *Proceedings of the 8th International Conference on Survey Methods in Transport*.

[27] Hadavi, S., Buldeo Rai, H., Verlinde, S., Huang, H., Macharis, C., & Guns, T. (2020). Investigating Passenger and Freight Movement through Data from Automatic Number Plate Recognition Cameras. *European Transport Research*, 12. https://doi.org/10.1186/s12544-020-00405-x.

[28] Kommey, B., Kotey, S., & Agbemenu, A. (2019). Driver Drowsiness Alert System for Commercial Vehicles. *Computer Engineering and Applications Journal*, 8. https://doi.org/10.18495/comengapp.v8i3.308.

[29] S. Kaur, P. Badoni, R. Walia and G. Singh, "Machine Learning for Early Osteosarcoma Detection: A Systematic Review," 2023 Global Conference on Information Technologies and Communications (GCITC), Bangalore, India, 2023, pp. 1-5, doi: 10.1109/GCITC60406.2023.10426252.

[30] P. Badoni, S. Kaur, B. Sharma and R. Walia, "Enhancing Water Efficiency and Crop Yield in Agriculture Sector using IoT," 2023 International Conference on Advances in Computation, Communication and Information Technology (ICAICCIT), Faridabad, India, 2023, pp. 1039- 1044, doi: 10.1109/ICAICCIT60255.2023.10466092.

[31] P. Badoni, G. Kaur, M. M. Ishaq and R. Walia, "Potato Disease Detection through Leafs: Leveraging Deep Learning Algorithms for Accurate Diagnosis," 2023 International Conference on Advances in Computation, Communication and Information Technology (ICAICCIT), Faridabad, India, 2023, pp. 181-186, doi: 10.1109/ICAICCIT60255.2023.10466127.

[32] M. N. Ahmed, G. Singh, P. Badoni, R. Walia, P. Rahi and A. T. Saddiqui, "An Efficient ADA Boost and CNN Hybrid Model for Weed Detection and Removal," 2023 10th International Conference on Computing for Sustainable

Global Development (INDIACom), New Delhi, India, 2023, pp. 244-250.

[33] Parveen Badoni, Shahbaz A. Siddiqui, Niti Nipun Sharma; Scope of reference architecture model for industry 4.0 in mushroom production. AIP Conf. Proc. 31 May 2023; 2752 (1): 090005. https://doi.org/10.1063/5.0136561

[34] Badoni, Parveen, Harsh Raj, Shriyam Prashad, Harsh Kumar, Mihir and Kuldeep Kumar Gautam. "IoT-Based Health Monitoring System." 2024 2nd International Conference on Device Intelligence, Computing and Communication Technologies (DICCT) (2024): 1-6.

[35] P. Badoni, R. Walia and R. Mehra, "Enhancing Waste Separation and Management Through IoT System," 2024 1st International Conference on Innovative Sustainable Technologies for Energy, Mechatronics, and Smart Systems (ISTEMS), Dehradun, India, 2024, pp. 1-6, doi: 10.1109/ISTEMS60181.2024.10560260.

[36] Gupta, Ashish & Gupta, Deepak & Husain, Mohammad & Ahmed, Dr & Ali, Arshad & Badoni, Parveen & Madinah, Al & Munawarah, Al & Arabia, Saudi. (2023). A PSO- CNN-based approach for Enhancing Precision in Plant Leaf Disease Detection and Classification. Informatica. 47. 173- 182. 10.31449/inf.v47i9.5188.

[37] P. Badoni, R. Walia and R. Mehra, "Wearable IoT Technology: Unveiling the Smart Hat," 2024 1st International Conference on Innovative Sustainable Technologies for Energy, Mechatronics, and Smart Systems (ISTEMS), Dehradun, India, 2024, pp. 1-6, doi:10.1109/ISTEMS60181.2024.10560229.

[38] P. Badoni, M. Wadhwa and R. Walia, "System of IntelliGuard Access Using IoT," 2024 International Conference on Intelligent Systems for Cybersecurity (ISCS), Gurugram, India, 2024, pp. 1-6, doi: 10.1109/ISCS61804.2024.10581055.