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License Plate Detection And Recognition System Using Yolov8 And Lprnet

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Abstract: With the growth of smart transportation systems, there is a need for reliable ways to detect and read license plates automatically. This research introduces an ALPR (Automatic License Plate Recognition) system that works well even in difficult situations, like poor lighting, messy backgrounds, or unusual license plate designs. The system uses two main technologies. It finds the license plate in an image with a fast and accurate model called YOLO (You Only Look Once). After the License plate is detected then, it uses LPRNet (License Plate Recognition Network) to read the letters and numbers on the plate. These steps make the system quick and accurate. The process involves finding the license plate, breaking the characters into separate parts, and creating a text box with the results. It can handle challenges like low-quality images, dirty plates, and background noise while still working well. Tests on different datasets show that the system works in both indoor and outdoor conditions and can recognize license plates in many languages and styles. This system has many practical applications, including automatic payment collection at toll booths, traffic monitoring, law enforcement, and smart city projects, where fast and accurate vehicle identification is essential. By providing reliable results in real-time, this ALPR system helps make transportation systems more efficient and supports various operations like managing traffic and enforcing laws. By using advanced computer vision techniques, this recognition system provides an efficient solution for vehicle identification tasks.

Index Terms - License Plate Recognition, YOLO, LPRNet, Smart Transport, Vehicle Identification, Edge detection

I. INTRODUCTION

With cities growing rapidly and the number of vehicles on the road increasing, managing traffic has become a big challenge. License Plate Detection and Recognition (LPDR) systems are an important solution to automate tasks like tracking vehicles, collecting tolls, and supporting law enforcement. These systems use computer vision to quickly and accurately detect and read license plates, making them much faster and more reliable than manual methods. This study builds on ideas from the base paper and uses OpenCV and LPRNet to create an efficient LPDR system. OpenCV helps process images, while LPRNet is used to recognize text on license plates. The system is designed to handle real-world challenges like poor lighting, bad weather, and different types of license plates, ensuring high accuracy and adaptability. The process starts with preparing images for analysis, followed by detecting edges, finding license plates, and reading the text on them. Real-time performance is a key focus, so the system can quickly process video or image streams in busy traffic situations. The goal of this project is to build a reliable and accurate LPDR system that can handle real-world traffic needs. By using a simple, modular design in Python, the system can be easily updated and improved in the future. This approach also encourages other researchers to build upon it, helping advance traffic management and surveillance technologies.

II. EXISTING WORKS

The paper introduces a system for vehicle number plate detection using YOLOv8 for plate localization and EasyOCR for character recognition, designed for real-time applications. The combination of YOLOv8 and EasyOCR ensures efficient and accurate license plate detection and recognition in real-time. The author highlights that the system struggles with low-resolution images and challenging environmental conditions, which limits its effectiveness in real-world scenarios. [1] The paper presents an Automatic Vehicle Number Plate Recognition (AVNPR) system utilizing TensorFlow's object detection API for vehicle and license plate identification, followed by EasyOCR for character recognition. The system's Optical Character Recognition (OCR) accuracy is limited by the performance of the EasyOCR library, which may struggle with certain fonts or image qualities. The authors highlight that the system's character recognition performance is limited by EasyOCR, which impacts its ability to handle diverse and degraded plate images effectively [2] The paper proposes a multistage approach for license plate detection and recognition, utilizing YOLOv5 for license plate detection, YOLOv8 for character detection, and a custom convolutional neural network for character recognition. The multistage approach improves detection and recognition accuracy by assigning specialized tasks to different models. The research should focus on enhancing robustness under challenging conditions, optimizing real-time performance for low-resource devices, and expanding adaptability to diverse license plate designs and formats for global applications. [3] The paper presents an efficient and layout-independent Automatic License Plate Recognition (ALPR) system utilizing the YOLO object detector. The system is designed to handle various license plate layouts without requiring manual adjustments. The system is designed to be layout-independent, effectively handling various license plate formats across different regions. Through optimization of model components and training with diverse datasets augmented for robustness, the system achieves an impressive end-to-end recognition rate of 96.9% across eight public datasets from five regions. Additionally, the authors contribute to the research community by providing a manually annotated dataset comprising 38,351 bounding boxes on 6,239 images, facilitating further advancements in ALPR research. In this paper a gap is observed in the system's effectiveness under varying environmental conditions needs further evaluation and improvement to ensure consistent performance.[4] The paper proposes a license plate detection method using a Convolutional Neural Network (CNN) optimized with a Design of Experiments (DOE) approach to improve training efficiency and accuracy. By applying DOE, the method systematically identifies optimal training parameters, enhancing detection performance. The author highlighted the gap in extending the approach to include character recognition for a complete ALPR system.[5] The paper introduces a license plate detection and recognition model that uses an attention mechanism to handle various layouts and improve accuracy in diverse environments. The attention-based approach increases precision by focusing on the most relevant parts of the license plate, working effectively across multiple layout. The model struggles with detecting and recognizing heavily distorted or low-resolution license plates. The performance decreases when handling heavily distorted or low-resolution license plates, which limits its robustness in challenging real-world conditions.[6] This research focuses on real-time recognition of Bangla number plates using computer vision techniques combined with CNNs. The authors report significant improvements in recognition speed and accuracy, making it suitable for practical applications. The study also addresses preprocessing techniques that enhance image quality before recognition, contributing to overall system efficiency. The authors utilize computer vision techniques in conjunction with convolutional neural networks (CNNs) to address the challenges posed by Bangla script, which includes complex characters and varying plate formats. The system processes images by first converting them to grayscale, applying edge detection methods to locate the license plate region, and then using a CNN model to recognize the characters on the plate.[7] In this paper Uses YOLOv3 for real-time license plate detection with accuracy. It uses ILPRNet, or Intelligent License Plate Recognition Network, for character recognition. Real-time detection and recognition system capable of handling varied environmental scenarios. It gives end-to-end real-time processing, which is suitable for intelligent transport systems. YOLOv3, known for its real-time object detection capabilities, is utilized to accurately and efficiently locate license plates within images. Following detection, ILPRNet—a specialized deep learning model—is employed to recognize the characters on the license plates. This combination aims to enhance the overall accuracy and speed of the ALPR system, making it suitable for real-world applications such as traffic monitoring and law enforcement. The study demonstrates that the integrated approach effectively addresses challenges like varying lighting conditions and complex backgrounds, contributing to the advancement of robust and efficient license plate recognition technologies. [8] The paper introduces Gaussian filtering with adaptive image contrast enhancement and other preprocessing techniques combines with Convolutional Neural Networks (CNNs) for the license plate detection and recognition. Deep encoder-decoder architectures are implemented for better segmentation accuracy. This works well with challenging scenarios such as tilted plates, low illumination and diverse fonts. The authors examine the challenges faced in real-

world applications, such as varying lighting conditions, occlusions, and diverse plate formats, and discuss how contemporary algorithms address these issues. Additionally, the paper evaluates the performance metrics of different models and emphasizes the importance of dataset diversity in training robust ALPR systems. By synthesizing findings from numerous studies, this review serves as a valuable resource for researchers and practitioners aiming to understand the current landscape and future directions of license plate detection and recognition technologies.[9] This focuses on number plate detection and recognition combined with a deep learning model through OpenCV combined with YOLO. Such a system finds the number plate in real time and extracts information with OCR. This retrieves information including vehicle ownership along with theft probabilities, which feeds it into smart transport systems: ITS. The author propose an integrated approach that leverages OpenCV's image processing capabilities alongside deep learning models to enhance the accuracy and efficiency of number plate detection systems. By utilizing various image preprocessing techniques such as edge detection and thresholding, the system first locates the number plate in vehicle images. Subsequently, deep learning models are employed for the recognition and analysis of the characters on the plate. The paper demonstrates that this hybrid approach outperforms traditional methods in terms of accuracy and robustness, particularly in complex and unconstrained environments where factors like angle variations, poor lighting, and occlusions are common. This research contributes to the development of more reliable and real-time automatic number plate recognition (ANPR) systems for applications in traffic monitoring, security, and vehicle tracking.[10] This study introduces BLPnet, a deep neural network designed specifically for recognizing Bengali license plates. The authors demonstrate the model's effectiveness in enhancing accuracy and speed in automatic license plate recognition tasks. The research highlights the potential of integrating OCR technology with deep learning to address challenges in recognizing regional scripts.[11] The study explore methods to enhance the performance of license plate recognition systems under difficult conditions, such as poor lighting or occlusion. The paper proposes novel algorithms that adaptively adjust to varying environmental factors, improving detection rates. Results indicate that their approach significantly outperforms existing methods, providing a more reliable solution for real-world applications.[12] The authors explore an implementation of license plate detection and recognition using OpenCV in Python, focusing on practical aspects of development. They provide a detailed methodology that includes image processing techniques essential for effective recognition. The study concludes with performance evaluations, indicating satisfactory results that can be replicated by practitioners in the field. The method suggested combines image processing methods like edge detection, morphological operations, and contour analysis in the OpenCV platform to detect license plates in intricate backgrounds. Optical Character Recognition (OCR) techniques are used after detection to read the plate numbers. The system is made to be efficient and feasible for application in real-world scenarios, such as traffic control and vehicle tracking. By experimental verification, the authors prove that their method yields high accuracy and reliability, with the OpenCV-based system capable of functioning under varying environmental conditions like light and angle.[13] The work proposes an improved YOLOv5m for detection and LPRNet for end-to-end character recognition in a car license plate recognition system with high accuracy and real-time capability. Despite detection being robust, recognition accuracy is low in low-resolution or highly angled plates, revealing an issue with OCR robustness. Enhancing recognition accuracy in adverse environmental conditions (e.g., blur, occlusion, nighttime images) and incorporating multilingual plate support can be further investigated. The model had high mAP for detection, with recognition accuracy over 90% in ideal conditions and significant improvements in speed and resource utilization compared to conventional models.[14] The paper review and categorize existing license plate recognition algorithms based on deep learning. This research identify challenges in recognizing license plates in complex environments. This paper suggests future research directions for improving recognition accuracy and efficiency. By employing deep learning to perform feature extraction, classification, and recognition, the paper shows a more flexible method of dealing with these problems. The authors have carried out thorough experiments using a varied data set of license plate images with varied conditions and have shown that deep learning-based models outperform classical methods markedly in terms of robustness and accuracy. The findings show that deep learning-based LPR systems are able to sustain high recognition rates even under poor conditions, demonstrating the capability of these algorithms for practical uses.[15]

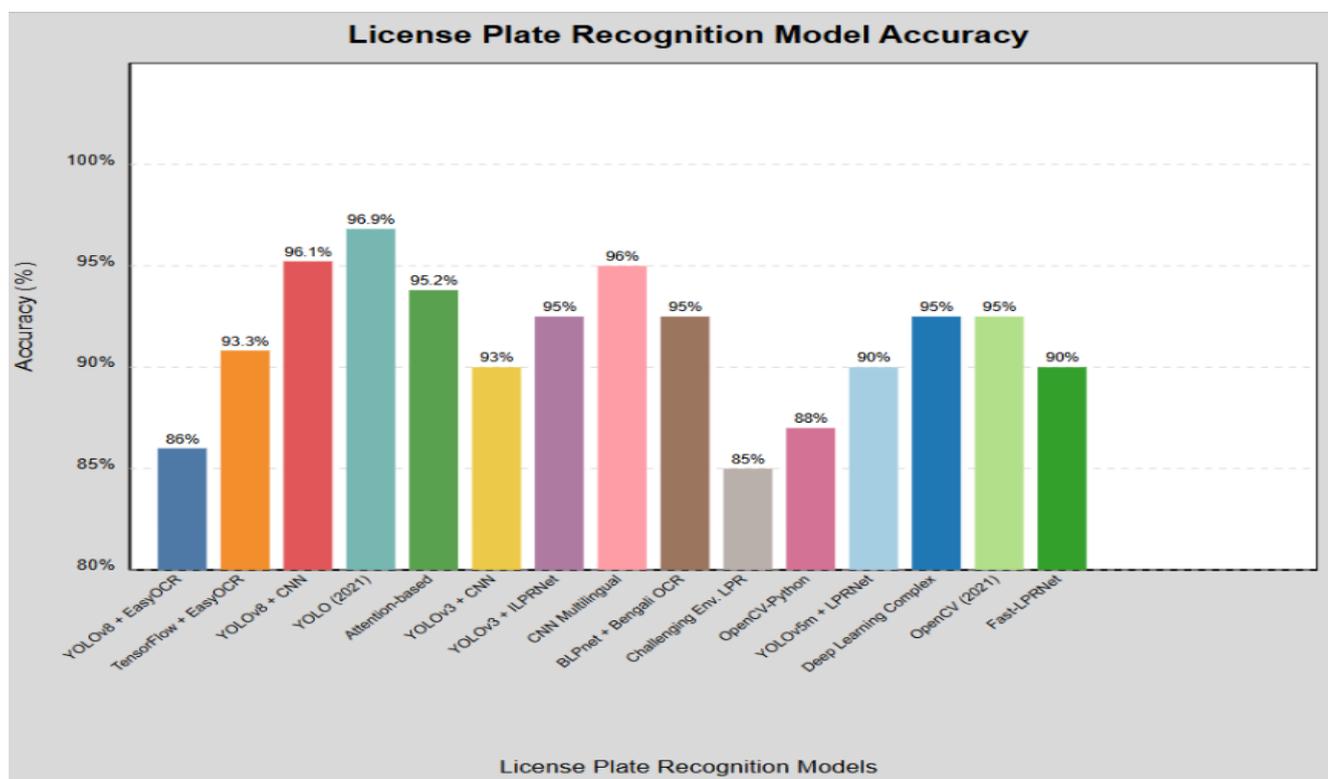


Figure 1: Performance Comparison of License Plate Recognition Models

III. METHODOLOGY

The system is intended to detect and recognize vehicle license plates in real-time using two state-of-the-art deep learning models: YOLOv8 for object detection and LPRNet for optical character recognition (OCR). The system starts with data annotation and collection, where a large variety of vehicle images—taken under diverse environmental conditions like different lighting, angles, and partial occlusions—is gathered. Each image is manually labeled with bounding boxes around license plates to train the YOLOv8 model, while character-level annotations are created to fine-tune LPRNet. YOLOv8 is trained using the annotated dataset to detect and localize license plates in vehicle images. After training, the model correctly predicts bounding boxes for license plates in novel images. The identified license plate areas are then cropped and then processed using contrast adjustment, resizing, and sharpening enhancement processes to enhance the plate quality prior to OCR processing.

The preprocessed plate images go through several preprocessing processes including grayscale conversion for reducing color noise, noise filtering to remove undesirable patterns, and adaptive thresholding to emphasize character and background contrast. These steps are important to maintain robustness to changing lighting and image quality. The preprocessed image is subsequently forwarded to LPRNet, a light-weight, CNN-based OCR network for character sequence recognition in a license plate image without the need for individual character segmentation. LPRNet does end-to-end character recognition and produces the license plate number as text. This established book can be effortlessly incorporated into downstream tasks like car identification, smart parking access control, or traffic surveillance systems.

YOLOv8's structure is a methodical pipeline: starting with preparation of data, where labeled images are transformed to YOLO format; model configuration, where parameters like variant type (e.g., yolov8n, yolov8s) and training are specified. The model is subsequently trained to maximize bounding box predictions and class confidence. After training, its performance is confirmed through measures such as mean Average Precision (mAP) and visual inspection on validation sets. At inference time, YOLOv8 recognizes objects in real-time from images or video streams and returns bounding boxes, class labels, and confidence scores. The postprocessing phase includes filtering such outputs with confidence thresholds and generating annotated boxes, which are then fed to LPRNet for character recognition. This end-to-end system effectively integrates detection and OCR for real-time license plate recognition that is robust and accurate.

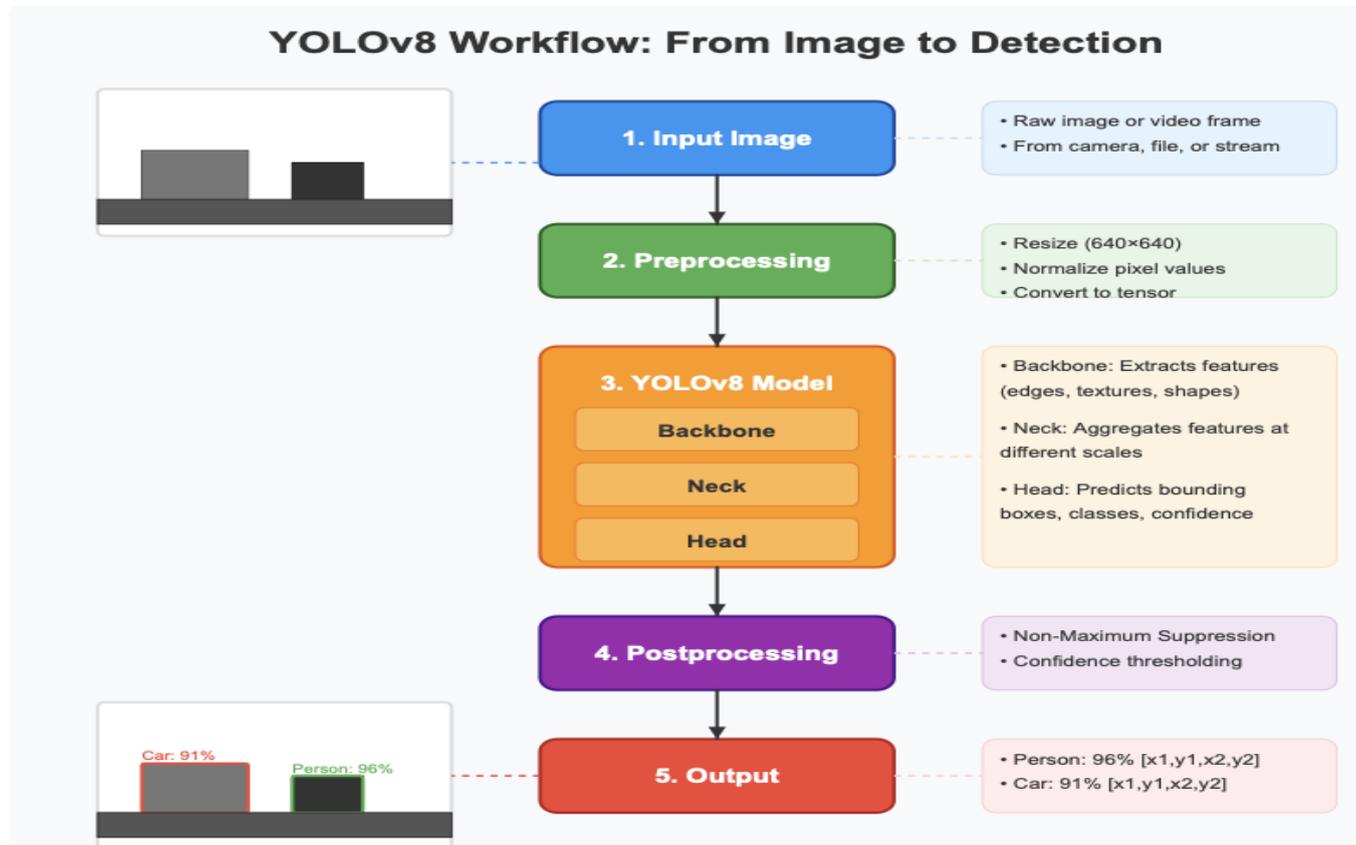


Figure 2: Workflow of YOLOv8

LPRNet is a fast, efficient, end-to-end neural network that is tuned specifically for the recognition of license plates without explicit segmentation of characters. The network has its architecture optimized for efficiency and accuracy purposes so that it can be used for real-time applications. The input for the network is a license plate image that is resized to a fixed size of 94x24 pixels in RGB format to normalize data and minimize computational overhead. The foundation of LPRNet is in its backbone composed of several 3×3 convolutional layers merged with ReLU activations and Batch Normalization for robust and efficient training. In addition to faster processing without any sacrifice to performance, several of these convolutional layers are depthwise separable convolutions. One strong optional element in the architecture is the Global Context Embedding module. This block takes spatial context from the whole image with average pooling and combines it with the local features learned by the backbone. This combination improves the model's capability to identify characters under different spatial arrangements and distortions. The output head consists of a 1×1 convolutional layer with a softmax activation, which produces a probability distribution over character classes for each time step, effectively treating the license plate as a sequence recognition problem.

For training and decoding, LPRNet uses the Connectionist Temporal Classification (CTC) loss function, under which the model can learn alignment between input features and output sequences without pre-segmented character labels. The alignment-free design makes the training process easier and the network stronger against character spacing and distortion variations, thus achieving efficient and accurate license plate recognition in real-world applications.

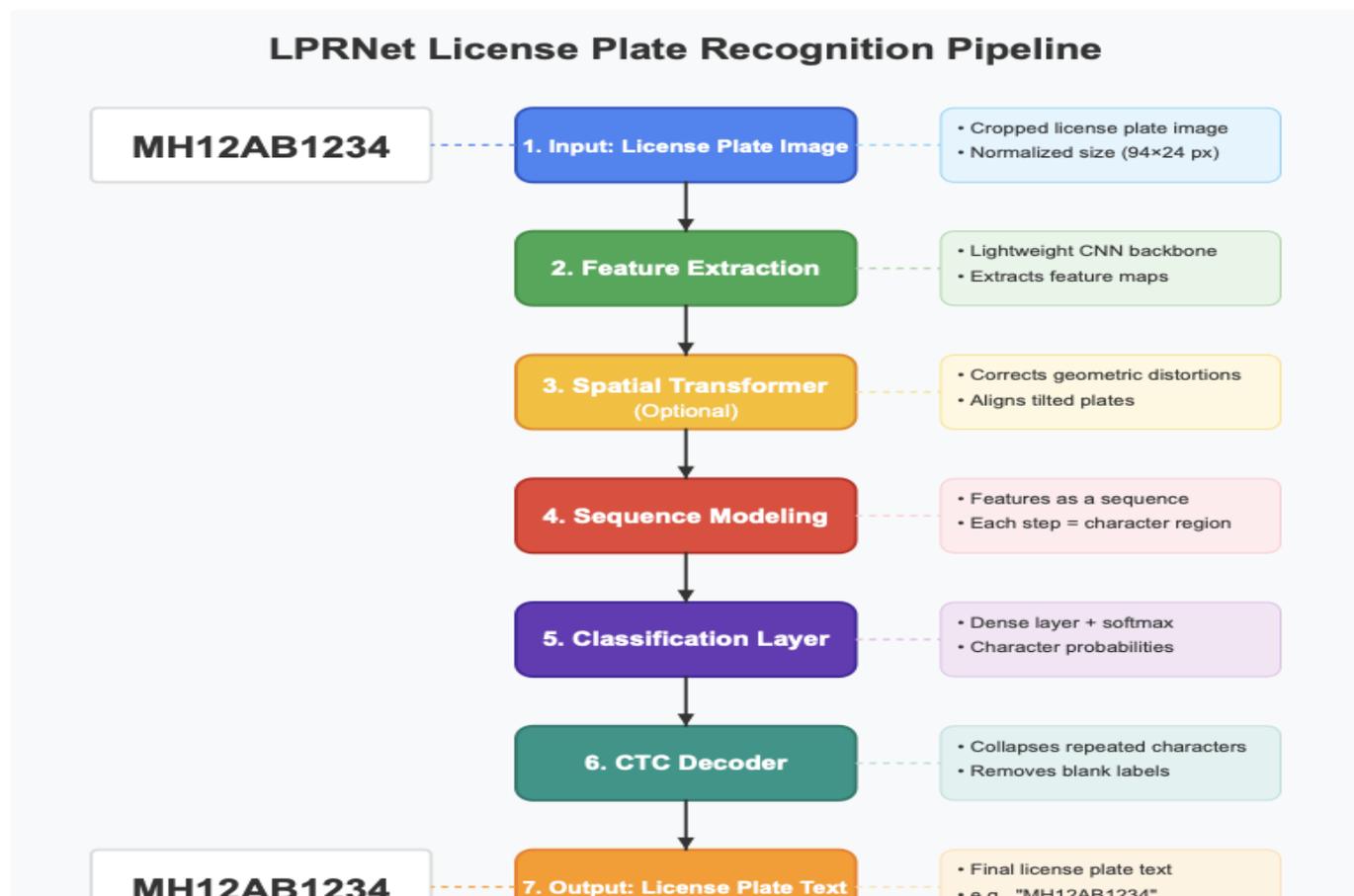


Figure 3: Workflow of the LPRNet

The figure illustrates the LPRNet License Plate Recognition Pipeline, starting with a cropped license plate image resized to 94×24 pixels. It passes through feature extraction, optional spatial transformation, sequence modeling, and classification layers. Finally, the CTC decoder generates the recognized license plate text, such as "MH12AB1234".

Workflow of License Plate Detection and Recognition System:

In the YOLOv8 and LPRNet-based number plate detection and recognition system, the operation starts with an input image or a live video frame with a vehicle. YOLOv8 is applied first to detect the vehicle and exactly identify the location of the number plate by enclosing it within a bounding box. After detection, the license plate area is cut from the image and sent through a preprocessing process where it is converted to grayscale, resized, and normalized to improve recognition accuracy. The preprocessed image is then fed into the LPRNet model, which is particularly trained to recognize characters from a license plate. The model generates a string of characters that comprise the license plate number. This string is optionally cross-checked with a database of vehicle registration for the purpose of validating its authenticity. Upon finding the plate number valid and matching, the system fetches further details of the vehicle, like model and type. Last but not least, the recognized license plate and vehicle's details are output by the system or flagged in the result if the plate is non-existent.

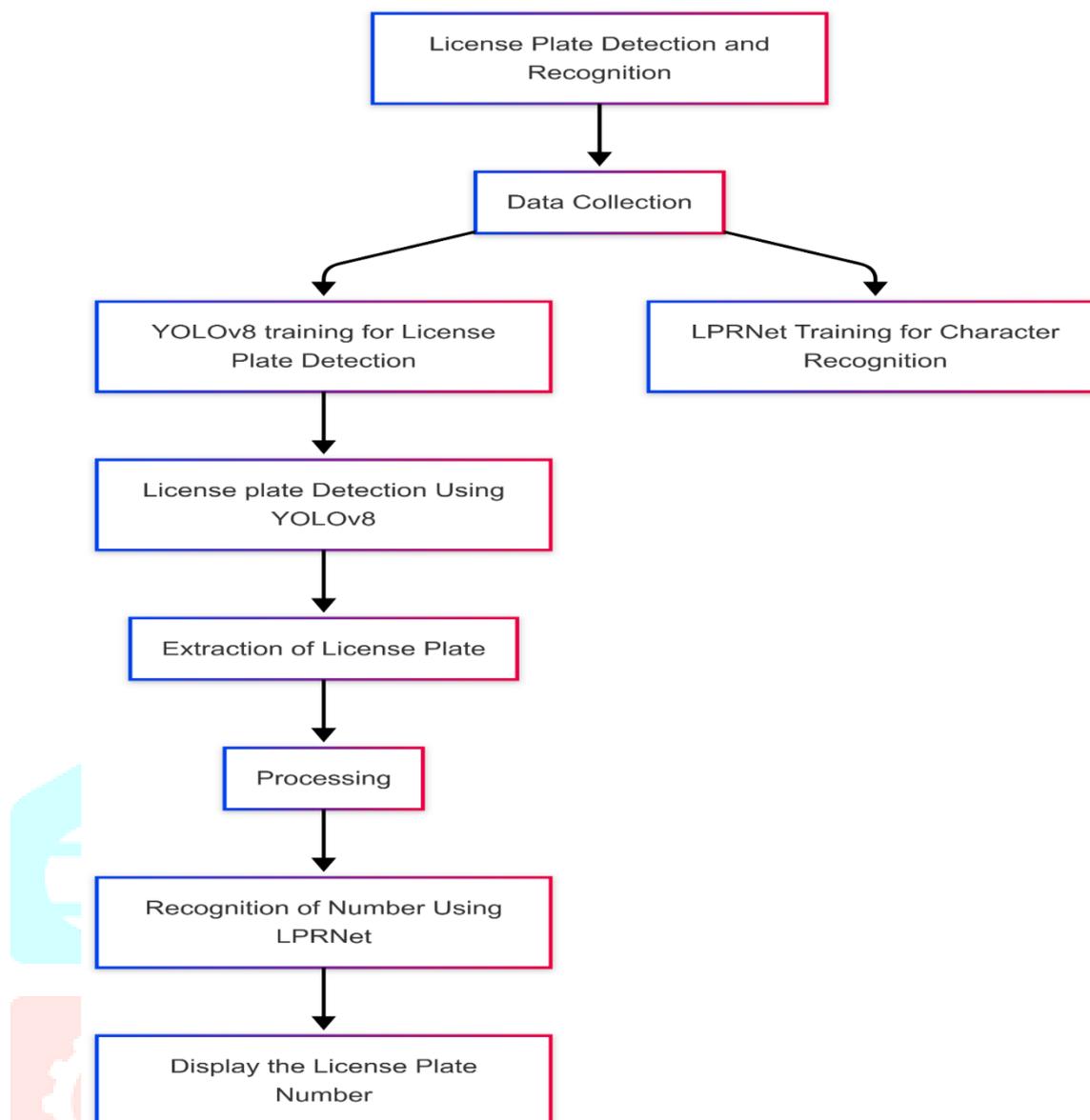


Figure 4: Workflow for License Plate detection and Recognition System

The figure illustrates the workflow for real-time license plate detection and recognition. It begins with data collection, followed by parallel training of YOLOv8 for plate detection and LPRNet for character recognition. After detecting and extracting the license plate, the image undergoes processing before the plate number is recognized and displayed.

In the design of a license plate recognition system, a number of challenges were faced that affected overall performance and reliability. One significant challenge was the inadequate amount of labeled license plate images, which restricted the model to learn from multi-modal visual patterns and resulted in decreased accuracy, particularly under changing environmental conditions. Further, heavy computational demands were also challenging during training and real-time inference since deep learning models such as YOLOv8 and LPRNet demand robust hardware for maximum performance. Low prediction coverage was also a challenge where the model could not always identify license plate text as the dataset size and variance were small. Additionally, discrepancies in license plate designs—e.g., varying fonts, layouts, and character sets among nations—worsened recognition performance even further, especially with pretrained OCR models not customized for local designs. To rectify these limitations, a remedy was employed through merging datasets of different origins, e.g., license plates for India, Europe, and the USA. This approach increased the size and scope of the dataset so that models could generalize further and perform better on various geographic regions and in real-world use.

IV. IMPLEMENTATION

4.1 Frontend Development

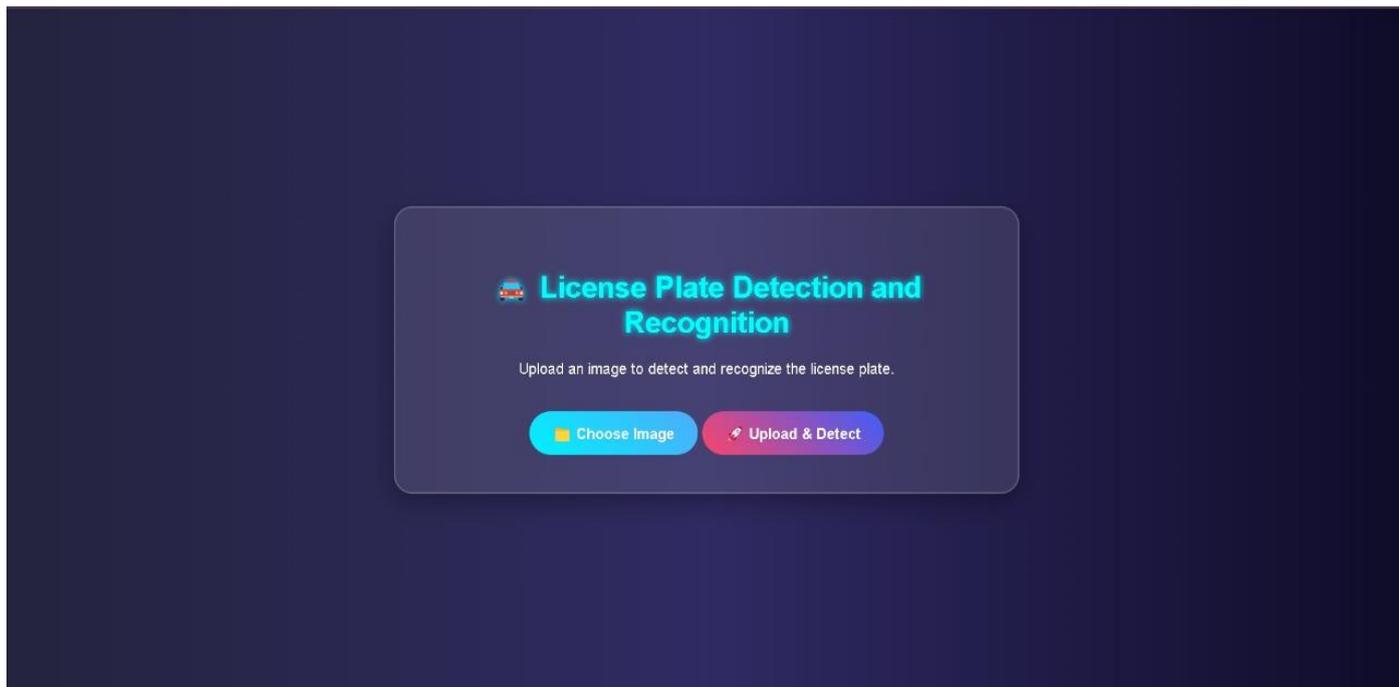


Figure 5: Web page for Uploading Image

The License Plate Detection and Recognition system has a minimalist and beautiful frontend developed through HTML, CSS, and Bootstrap. The structure of the app base was implemented with HTML, which categorized the primary content elements such as title, image uploading features, and action buttons. In contrast to achieve a minimalist and modern look, custom CSS was used, which implemented a dark-colored background, glowing text effects, and advanced button transitions. Bootstrap was utilized to make the webpage completely responsive, transforming effortlessly across desktops, tablets, and mobile devices. Bootstrap's grid structure and utility classes made it easy to line up and space elements evenly. The project also modularized its UI components for easy maintenance and scalability. The landing page is the main interface where users can choose or upload images to recognize and detect license plates. Overall, the project successfully combines web technologies to deliver a modern, interactive, and accessible platform for real-time license plate recognition.

Detection Results for License Plate:

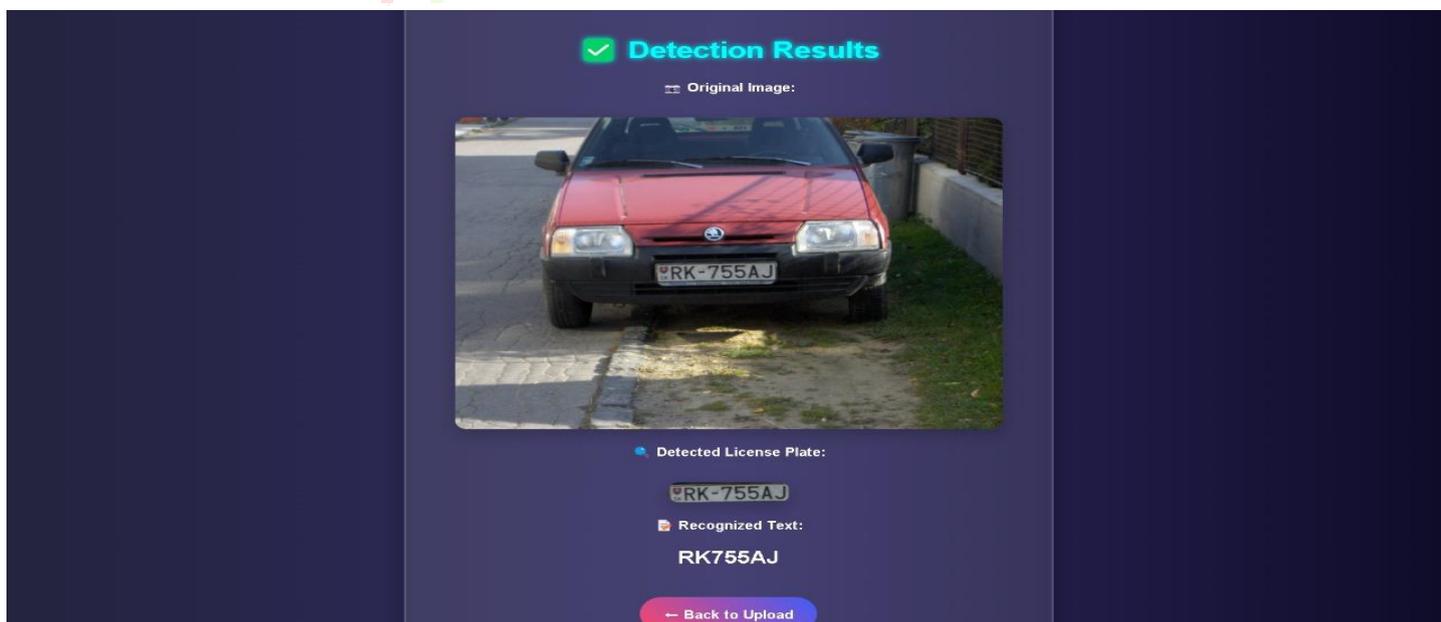


Figure 6 : Output of Detection and Recognition of License Plate

4.2 Machine Learning-Based License Plate number Prediction

The license plate recognition and number prediction feature uses LPRNet (License Plate Recognition Network), a deep learning algorithm known for its high accuracy in reading license plate numbers from various vehicles and environments. LPRNet processes complex and noisy images, including those taken in low light or from moving vehicles. The model first detects the license plate region using advanced image preprocessing, followed by optical character recognition (OCR) to extract the alphanumeric characters. Optimized for real-time performance, the LPRNet model, built with PyTorch or TensorFlow, is integrated via an API. Users upload a vehicle image, and the model quickly processes it to extract the license plate number. LPRNet ensures reliable predictions even under challenging conditions, such as off-angles or low-quality images. This automated recognition reduces manual effort and enhances the platform's ability to identify and track vehicles efficiently. By integrating LPRNet, the platform becomes a more intelligent and dependable solution for applications like vehicle registration, security surveillance, and parking management.

V. RESULTS AND DISCUSSION

The YOLOv8-based license plate detection model performed exceptionally well across multiple metrics. During training, the model showed effective learning, with a steady decrease in box loss, class loss, and Distribution Focal Loss (DFL) from epochs 17 to 20. The performance metrics revealed an outstanding mAP@0.5 of 99.5%, indicating near-perfect detection accuracy, and mAP@0.5:0.95 of 82.8%, demonstrating strong performance across varying IoU thresholds. Precision and recall rates approached 99%, ensuring a balance between false positives and false negatives. In terms of inference speed, the model processed images at 76 milliseconds per image on a CPU, making it suitable for real-time applications like smart parking and traffic monitoring. However, the License Plate Recognition (LPR) phase, powered by LPRNet, only achieved 60% accuracy, revealing room for improvement. This limitation is likely due to the variability in plate designs, image quality, and environmental factors such as lighting and orientation. Although the dataset was augmented by combining images from multiple sources, the model still faces challenges with regional plate formats and OCR mismatches. The model's high computational requirements are another consideration for real-time deployment. To improve performance, future work should focus on enhancing the LPR model, expanding the dataset, and optimizing for hardware efficiency. Despite these challenges, the detection phase is highly reliable, making it a promising solution for intelligent transportation systems.

Metrics for License Plate Detection System:

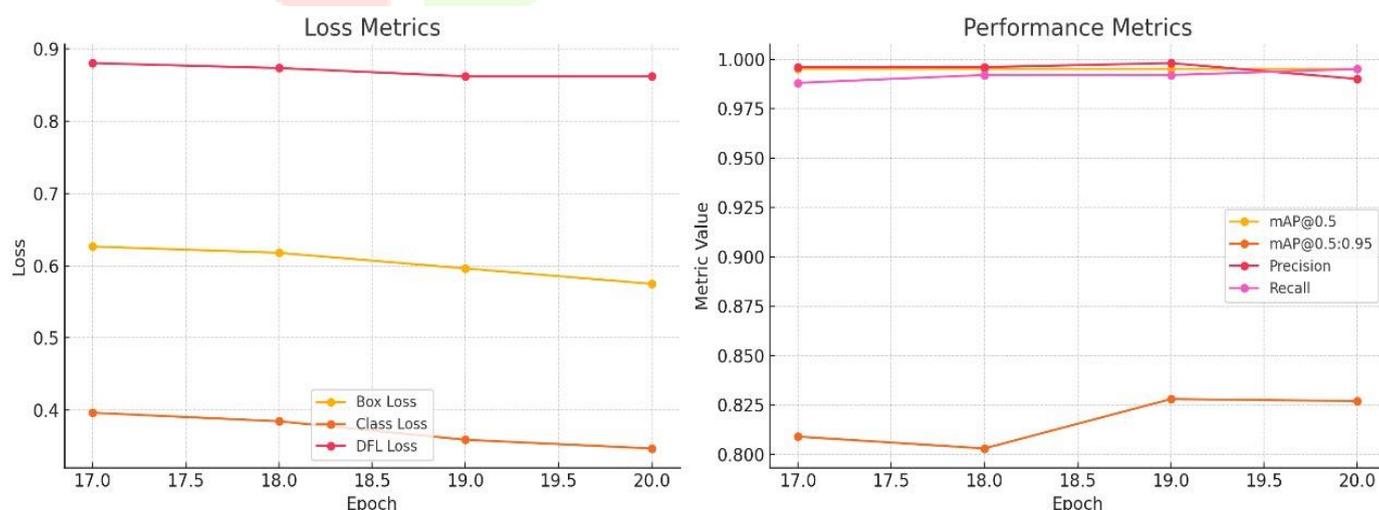


Figure 7 : Loss and Performance metrics for Detection System

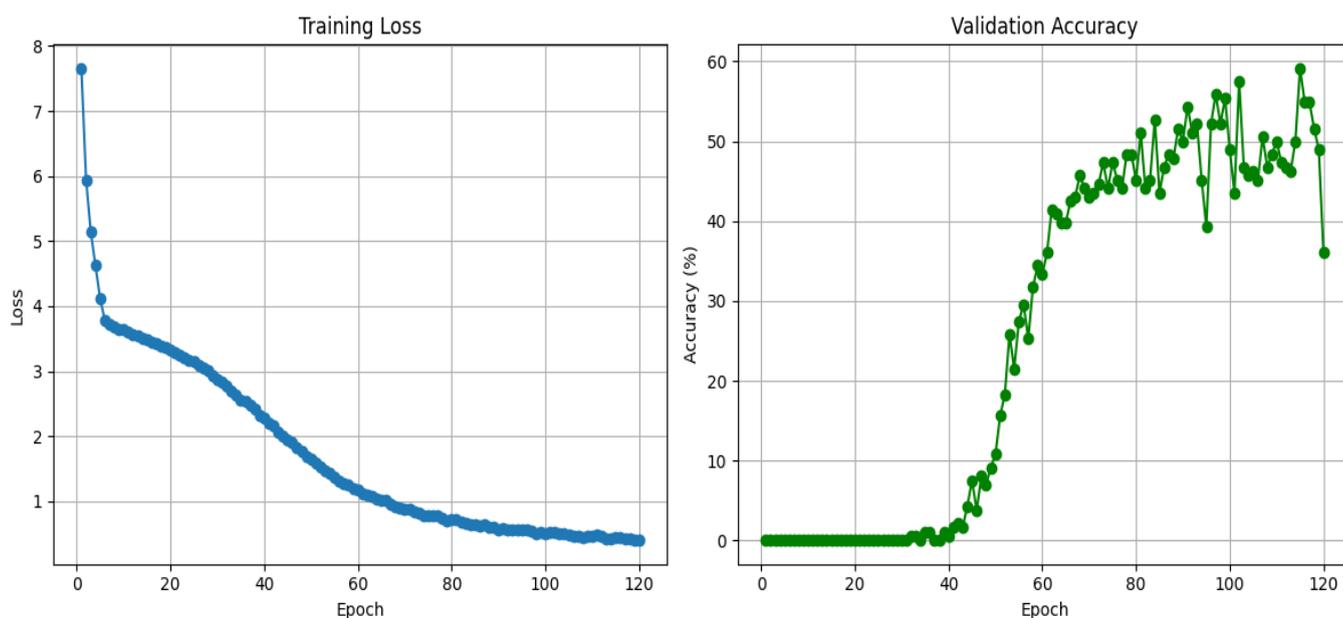


Figure 8 : Loss and Performance metrics for Recognition System

VI. CONCLUSION

The project successfully demonstrates a robust real-time License Plate Detection and Recognition System using YOLOv8 for plate localization and LPRNet for character recognition. The detection model achieved excellent performance with a mAP@0.5 of 99.5%, proving its capability to detect plates accurately even under diverse and challenging environmental conditions. However, the recognition phase using LPRNet attained a 60% accuracy rate, highlighting areas that require improvement, especially when handling varied fonts, low-resolution images, and regional plate designs. The project faced several challenges, including limited datasets, OCR mismatches with regional formats, and computational demands. To address these, data from multiple countries (India, Europe, USA) were combined, and preprocessing techniques were applied to improve image clarity and recognition robustness. Despite the lower recognition accuracy, the system shows great potential for real-time applications such as smart parking, traffic enforcement, and automated toll collection. Future improvements will focus on expanding the dataset, enhancing OCR capabilities for multilingual plates, and optimizing the system for deployment on edge devices. This project provides a solid foundation for advancing intelligent transportation systems through efficient and accurate vehicle identification.

REFERENCES

- [1] S. S. Patil et al., "Vehicle Number Plate Detection using YoloV8 and EasyOCR," 2023 14th International Conference on Computing Communication and Networking Technologies (ICCCNT), Delhi, India, 2023, pp. 1-4, doi: 10.1109/ICCCNT56998.2023.10307420.
- [2] Onyishi, D. U., & Emina, E. E. Automatic Vehicle Number Plate Recognition System Using Tensorflow Objection Detection.
- [3] Safran, M., Alajmi, A., & Alfarhood, S. (2024). Efficient Multistage License Plate Detection and Recognition Using YOLOv8 and CNN for Smart Parking Systems. *Journal of Sensors*, 2024(1), 4917097.
- [4] Laroca, R., Zanlorensi, L. A., Gonçalves, G. R., Todt, E., Schwartz, W. R., & Menotti, D. (2021). An efficient and layout-independent automatic license plate recognition system based on the YOLO detector. *IET Intelligent Transport Systems*, 15(4), 483-503.
- [5] Y. Y. Lee, Z. Abdul Halim and M. N. Ab Wahab, "License Plate Detection Using Convolutional Neural Network–Back to the Basic With Design of Experiments," in *IEEE Access*, vol. 10, pp. 22577-22585, 2022, doi: 10.1109/ACCESS.2022.3153340.
- [6] T. -M. Seo and D. -J. Kang, "A Robust Layout-Independent License Plate Detection and Recognition Model Based on Attention Method," in *IEEE Access*, vol. 10, pp. 57427-57436, 2022, doi: 10.1109/ACCESS.2022.3178192.
- [7] M. N. I. Suvon, R. Khan and M. Ferdous, "Real Time Bangla Number Plate Recognition using Computer Vision and Convolutional Neural Network," 2020 IEEE 2nd International Conference on Artificial Intelligence in Engineering and Technology (IICAET), Kota Kinabalu, Malaysia, 2020, pp. 1-6, doi: 10.1109/IICAET49801.2020.9257843.
- [8] Zou, Y., Zhang, Y., Yan, J., Jiang, X., Huang, T., Fan, H., & Cui, Z. (2022). License plate detection and recognition based on YOLOv3 and ILPRNET. *Signal, Image and Video Processing*, 16(2), 473-480.
- [9] Omar, N., Zeebaree, S. R., Sadeeq, M. A., Zebari, R. R., Shukur, H. M., Alkhayyat, A., ... & Kak, S. F. (2023, December). License plate detection and recognition: A study of review. In *AIP Conference Proceedings* (Vol. 2834, No. 1). AIP Publishing.
- [10] Kancharla, R., Sivakumar, P., & Kumar, P. Number Plate Detection and Analysis using OpenCV and Deep Learning.
- [11] Onim, Md. Saif & Nyeem, Hussain & Roy, Koushik & Hasan, Mahmudul & Ishmam, Abtahi & Akif, Md. Akiful & Ovi, Tareque. (2022). BLPnet: A new DNN model and Bengali OCR engine for Automatic Licence Plate Recognition. *Array*. 15. 100244. 10.1016/j.array.2022.100244.
- [12] Khan, K., Imran, A., Rehman, H.Z.U. et al. Performance enhancement method for multiple license plate recognition in challenging environments. *J Image Video Proc*. 2021, 30 (2021).
- [13] Sharma, V., Jain, M., Jain, T., Mishra, R. (2022). License Plate Detection and Recognition Using OpenCV–Python. In: Singh, P.K., Singh, Y., Kolekar, M.H., Kar, A.K., Gonçalves, P.J.S. (eds) *Recent Innovations in Computing. Lecture Notes in Electrical Engineering*, vol 832. Springer, Singapore.
- [14] S. Luo and J. Liu, "Research on Car License Plate Recognition Based on Improved YOLOv5m and LPRNet," in *IEEE Access*, vol. 10, pp. 93692-93700, 2022, doi: 10.1109/ACCESS.2022.3203388.
- [15] Weihong, W., & Jiaoyang, T. (2020). Research on license plate recognition algorithms based on deep learning in complex environment. *IEEE Access*, 8, 91661-91675.
- [16] Shariff, A. M., Bhatia, R., Kuma, R., & Jha, S. (2021, March). Vehicle number plate detection using python and open cv. In *2021 international conference on advance computing and innovative technologies in engineering (ICACITE)* (pp. 525-529). IEEE.
- [17] Wang, Zhichao & Jiang, Yu & Liu, Jiabin & Gong, Siyu & Yao, Jian & Jiang, Feng. (2021). Research and Implementation of Fast-LPRNet Algorithm for License Plate Recognition. *Journal of Electrical and Computer Engineering*. 2021. 1-11. 10.1155/2021/8592216.
- [18] D. Chowdhury, S. Mandal, D. Das, S. Banerjee, S. Shome and D. Choudhary, "An Adaptive Technique for Computer Vision Based Vehicles License Plate Detection System," 2019 International Conference on Opto-Electronics and Applied Optics (Optronix), Kolkata, India, 2019, pp. 1-6, doi: 10.1109/OPTRONIX.2019.8862406.
- [19] Selmi, Zied & Ben Halima, Mohamed & Pal, Umapada & Alimi, Adel. (2019). DELP-DAR system for license plate detection and recognition. *Pattern Recognition Letters*. 129. 10.1016/j.patrec.2019.11.007.
- [20] Silva, S. M., & Jung, C. R. (2018). License plate detection and recognition in unconstrained scenarios. In *Proceedings of the European conference on computer vision (ECCV)* (pp. 580-596).