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AUTOMATIC NUMBER PLATE RECOGNITION USING MACHINE LEARNING

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Abstract:
Automatic number plate recognition uses image processing and machine learning to identify license plates regardless of weather conditions. Since the number of vehicles increases day by day, security measures need to be taken. It is used in many ways such as traffic management, automatic toll collection in toll areas, and parking in congested areas. The purpose of this system is to create a powerful automation system that enables the identification of vehicles using bus cards. To check the license plate, use an infrared (IR) detector that will help capture a clear image of the camera. Capturing the image of a moving car is the most important and difficult task. Character segmentation uses the R-CNN method to extract the license area from the image. Optical character recognition (OCR) method is used to identify correct characters. The data collected includes vehicle owner, place of registration, address, etc. In another way, machine learning enables computers to gain experience and learn from data to perform better on a certain activity.

Keywords: Automatic Number Plate Recognition (ANPR), Optical Character Recognition, Artificial Neural Network (ANN), Character Segmentation Image Segmentation, Number Plate

1. Introduction

1.1 What is Machine Learning

In the field of artificial intelligence (AI), machine learning is the study of creating algorithms and statistical models that allow computers to learn and make judgments without needing to be explicitly programmed for a particular task. In another way, machine learning enables computers to gain experience and learn from data to perform better on a certain activity.

1.2 Automatic Number Plate Recognition (ANPR)

Automatic number Plate Recognition (ANPR) is an advanced technology that revolutionizes the vehicle identification and registration process. It is a system that uses optical character recognition (OCR) technology and image processing algorithms to capture information.
Alpha numeric characters from license plates. ANPR systems have gained immense popularity and are used in many areas such as law enforcement, traffic management, toll collection, parking management and security.[1] ANPR systems include many key components, including specialized cameras, imaging software and databases. Cameras are placed in places such as highways, intersections, parking lots or toll booths to capture images of passing vehicles. These cameras are equipped with high-resolution sensors, often using infrared technology to ensure that images can be captured accurately even in low light conditions.[2]

Once the camera captures the image, the ANPR software will process it to extract the plate file. The software uses advanced techniques to identify and classify license plates from images, distinguish individual characters and recognize characters using OCR technology.

In law enforcement, license plate recognition systems have proven to be a valuable tool in investigating stolen vehicles, tracking criminals, and improving overall public safety. When integrated with law enforcement, ANPR systems can produce instant alerts when a valid license competes with a vehicle sought or contains suspicious activity.[3] This capability allows law enforcement to respond quickly and effectively to threats or crimes. ANPR systems also play an important role in traffic control. ANPR systems can collect valuable information about vehicle movement, average speed, and congestion patterns by constantly monitoring traffic. This information can be used to improve signal timing, identify traffic conflicts, and improve overall traffic flow. Additionally, the ANPR system can be integrated with the registration of the phone number, thus ensuring a smooth and automatic payment process.[4] Parking management is another area where ANPR systems have had a significant impact ANPR Cameras installed in parking lots can accurately track vehicles entering and leaving. Physical parking pass.

In conclusion, ANPR systems have revolutionized vehicle identification and registration processes, finding applications in law enforcement, traffic management, toll collection, parking management, and security systems. By utilizing OCR technology and advanced image processing algorithms, ANPR systems enable efficient and accurate identification of vehicles in real- time. While privacy and data protection are important considerations, responsible implementation, and adherence to legal and ethical frameworks ensure the effective and ethical use of ANPR technology in society.

1.3 Previous work on ANPR system

Since it is not easy to decide which method is better, many instructions are analyzed by level and grouped according to the method used in each method. Only platform, speed, accuracy, performance, and thumbnail metrics are provided for each method. Examining business projects is beyond the scope of this article, as they often promise the truth, which is not always true. Research based on deep neural networks has made significant progress in license plate recognition (LPR). An important study published in 2021 introduced the LPR Net model, which is designed to process complex data and achieve recognition accuracy of up to 95% [5]. Another study using the CNN model for LPR achieved an accuracy rate of 99.02%, with 98.46% accuracy for good examples and 99.3% accuracy for negative examples, partly because there were many bad examples in the training process. [6]. A report tested the performance of the collaborative network in a vehicle license plate detection and detection setting compared to a search-only Faster R-CNN network and reported an improvement of approximately 1% in detection accuracy up to 98.33% [7]. In a study using a Brazilian license, the system was able to identify and recognize all seven characters in 63.18% of test cases and achieved a recognition rate of 93% when character segmentation was considered (2020) [8]. Finally, an automatic card recognition (ANPR) system was developed for the Indian environment. The success rate in detecting single- and two-line license plates under different lighting conditions is approximately 82% [9].

Overall, this study demonstrates the success of LPR systems and the effectiveness of deep neural networks in solving different problems in this field.

2. Literature

The initial study focuses on developing a Nigerian license plate algorithm, achieving 100% accuracy in plate localization and 90% in reading [1]. Tested on stationary vehicles under different illumination, it anticipates improvements for motion and diverse databases. The second paper introduces a real-time CNN-based ANPR system, capturing live frames and connecting to a Firebase database for owner details [2]. The third survey highlights ANPR systems' role in intelligent transportation, leveraging image processing and neural networks for improved recognition [3]. Lastly, an automatic vehicle identification system, utilizing OpenCV, stresses the need for enhancements like a high-resolution camera [4]. Together, these studies advance ANPR technology, addressing accuracy, real-time processing, database integration, and system robustness.

2.2 Conclusion of the Literature

Automatic Number Plate Recognition (ANPR) systems serve a crucial role in plate recognition for license plate registration, vehicle access control, and maintenance. Modern approaches often employ Convolutional Neural Networks (CNN) and the YOLO (You Only Look Once) algorithms. YOLO, specifically, rapidly identifies products, including licenses, by enclosing them in bounded text boxes. The process begins with the collection and storage of license plate registration photos, which are then used to train the detection algorithm. The model is trained to recognize license features, patterns, and information, enabling efficient scanning of photos or video streams, identification of license plates, and delivery of their coordinates. Post-processing methods are employed to ensure accurate localization and eliminate false positives, refining the results further.

The automation of processes involving tracking and identifying cars relies heavily on number plate detection. This procedure involves taking the detected license plate, extracting a Region of Interest (ROI), preprocessing it, and applying a segmentation model—typically based on a CNN—to draw bounding boxes around characters. Post-processing adjustments are made to these boundaries. Following segmentation, character recognition interprets and converts characters into text using Optical Character Recognition (OCR) methods or specific deep learning models. This step is vital for deciphering the contents of license plates, and additional post-processing can enhance accuracy by ensuring that recognized characters comply with predetermined standards.

Previous research has made significant strides in leveraging deep neural networks for Automatic Number Plate Recognition (ANPR) systems. Noteworthy achievements include a model attaining an impressive 99.02% accuracy and another enhancing detection accuracy by 1%. In specific scenarios, an ANPR system designed for Indian plates exhibited an 82% success rate, while a counterpart for Brazilian license plates achieved a notable 93% recognition rate. These outcomes collectively underscore the substantial progress within License Plate Recognition (LPR) systems, showcasing the capability of deep neural networks in effectively addressing a variety of challenges. The varying success rates in different contexts highlight the adaptability of ANPR systems to emphasize the ongoing evolution of these systems for enhanced accuracy and utility.

3. Methodology Used

3.1 Dataset

To add useful data resources to our study and analysis, we have downloaded a dataset from Kaggle for our project.

LINK-
https://www.kaggle.com/datasets/dataclusterlabs/indian- number-plates-dataset/

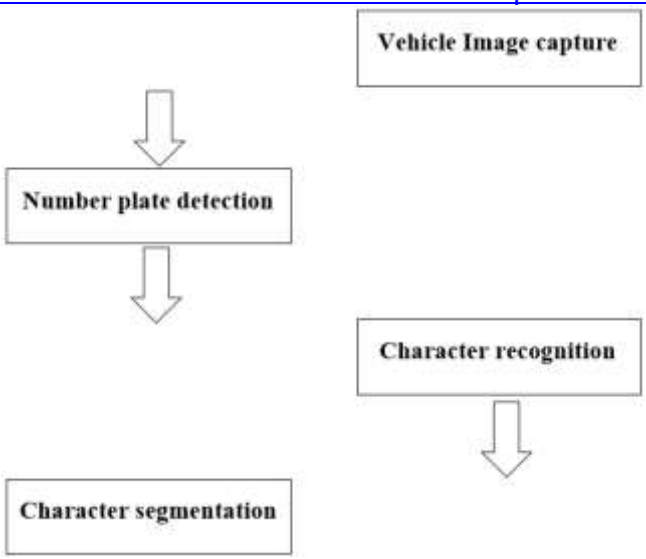


Fig.1 Methodology for ANPR system

3.2 Vehicle Image Capture

The first step is to capture an image. This procedure entails taking high-quality pictures of cars and their license plates using cameras or other sensors. These photos must be of the highest quality and clarity because they have a direct bearing on the precision of the later phases, which include character and license plate identification. ANPR systems frequently use specialized cameras and image capture methods designed for varied lighting scenarios and situations, such as day and night settings, moving vehicles, and varying weather conditions, to guarantee accurate and dependable results. The ANPR system's efficacy is contingent upon its capacity to acquire images that furnish the requisite information for precise identification and processing them.

3.3 Number plate detection

YOLOv8 is a powerful implementation of this real-time object identification method that detects number plates. YOLO is quite good at quickly and correctly recognizing license plates in pictures and videos. To identify the distinct traits and patterns connected to license plates, a YOLOv8 model is first trained on a dataset of labeled license plates. The model can be used to process pictures or video streams after it has been trained. It detects every frame in real time, accurately locates license plates, and gives their positions. This improves efficiency and accuracy by enabling automation in several applications, such as vehicle entry control, toll collecting, and traffic monitoring.

3.4 Character segmentation

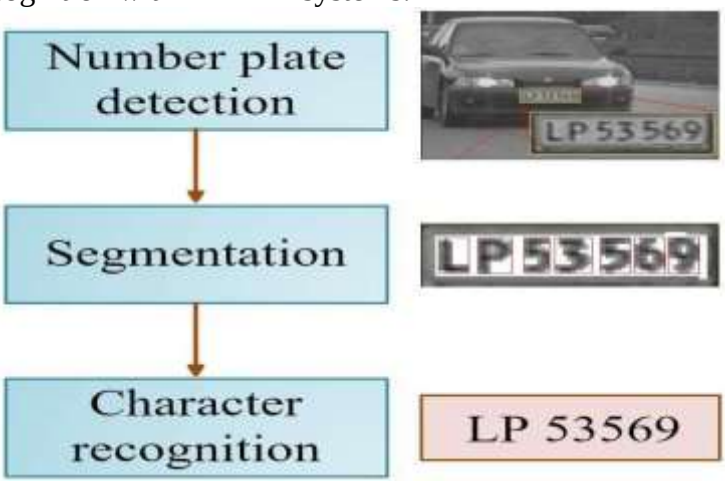
A vital step in Automatic Number Plate Recognition (ANPR) systems is character segmentation using YOLOv8. Character segmentation separates distinct characters from the license plate once YOLOv8 detects the license plate successfully. To precisely define each character's bounds, YOLO is adjusted or altered to generate bounding boxes surrounding them. Every character is isolated and ready for Optical Character Recognition (OCR) jobs after this segmentation process. The ANPR system effectively isolates license plate characters by utilizing YOLO's object detection capabilities and training it for character localization. This is a crucial step for precise character recognition and text interpretation, which are necessary for tasks like vehicle access control and traffic monitoring.

3.5 Character recognition

Combining easyOCR with YOLO (You Only Look Once) is a strong method for character recognition in Automatic Number Plate Recognition (ANPR) systems. License plate recognition is a strong suit for YOLO, while

easyOCR excels at distinguishing individual characters. Following the successful license plate identification using YOLO, the segmented characters are interpreted and turned into text using easyOCR. To handle different font styles and sizes, it makes use of deep learning models, such as Transformer-based models or Recurrent Neural Networks (RNNs) that have been trained on large character datasets. In applications like parking, traffic control, and security, where precisely deciphering license plate content is critical, the combination guarantees accurate and

Effective character recognition within ANPR systems.



Result

Total number of vehicle images	Total number of accurate reads	Accuracy / (Efficiency) in %
150	147	98.35

5. Conclusion

In conclusion, the integration of the YOLOv8 algorithm into our ANPR system has produced exceptional results, attaining an impressive accuracy of 98.35%. This success serves as a powerful testament to the transformative potential of AI technology in advancing and optimizing automated license plate recognition systems, marking a significant stride in the realm of intelligent surveillance and vehicle identification.

YOLOv8 is famous for its single search, which can find objects in a single pass, at various speed levels. YOLOv8 uses an end-to end learning method that is easy to train and can improve overall performance. In comparison, the complex architecture of layer PNN creates problems in terms of training and deployment, while YOLO's simplicity makes it easy to use. Combining YOLOv8 and easyOCR helps improve accuracy by relying on modern equipment for effective training. Traditional layer extraction methods (e.g., 2layer PNN) have limited representation capacity and are difficult to capture complex patterns. Moreover, compared to YOLOv8's automatic hierarchical feature learning, manual feature engineering in statistics may take a lot of time and important features may be lost.

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