

SMART ANPR SYSTEM FOR GATED COMMUNITY

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Abstract: Automatic Number Plate Recognition (ANPR) systems are commonly used in transportation and security for identifying and monitoring vehicles. This paper presents a real-time ANPR system that uses deep learning and video streaming from an IP camera. The system captures live video via RTSP from an IP camera and processes frames to detect vehicle number plates. A Convolutional Recurrent Neural Network (CRNN) model developed with Keras is used for accurate character recognition. To improve reliability, EasyOCR serves as a backup when the main model fails to recognize characters. Additionally, the system includes date and time stamps for each detected vehicle, which helps with tracking and data management. The proposed system is designed to deal with real-world challenges like varying lighting conditions, motion blur, and different plate formats. The implementation shows enhanced accuracy and real-time performance, making it suitable for applications in traffic monitoring, parking management, toll collection, and security surveillance.

Index Terms - Multi-Tenant SaaS, Healthcare Systems, RBAC, AI Integration, Redis Caching, Cloud Computing, Scalable Architecture

INTRODUCTION

The use of automatic number plate recognition (ANPR) system is crucial in modern-day intelligent transport management and security system control. As the population of vehicles increases day by day, manual observation of vehicles is becoming inefficient and ineffective due to human errors and the huge amount of time spent on that task. ANPR utilizes image processing technology and Deep Learning techniques to automatically detect and recognize vehicle plates numbers. The applications of these systems include traffic surveillance, parking control, toll collecting, security surveillance among many others.

In this work, there will be a construction of a smart ANPR system that will use the RTSP stream from an IP camera, YOLO for detection of plates and CRNN to extract characters from the number plates. In addition, EasyOCR will be employed as an alternative method of extracting the texts from plates in case the first fails. The purpose of this project is to create a system that will be able to work effectively and efficiently at any environment despite lighting conditions among others.

In addition to this, the suggested system incorporates high-quality preprocessing and deep learning models to ensure improved performance and reliability. Such a system will be able to tackle all sorts of issues ranging from blurry and poor resolution photos, plates placed in different formats, motion blur, and poor illumination. The efficiency of the process as well as high detection rates ensure the effectiveness and applicability of the created system in practice.

NEED OF THE STUDY.

An accelerated increase in the number of automobiles in the recent years has raised some concerns in traffic control, security surveillance, and number plate recognition and verification. Manual techniques for capturing and recognizing vehicle numbers are slow, less efficient, and also vulnerable to mistakes that may be caused by humans. This becomes quite problematic in monitoring vehicles, particularly in locations with a high density of moving objects such as parking lots, toll booths, residential societies, or restricted areas. Hence, the need for an efficient system capable of detecting and identifying vehicle number plates automatically becomes imperative.

However, current automatic number plate recognition systems encounter various problems including lack of illumination, image quality problems, diverse number plate formats, and others related to the environment like dirtiness, motion blurring, and so on. These affect greatly the accuracy and effectiveness of the process when deployed in actual situations. In order to deal with these problems, a combination of advanced machine learning algorithms including YOLO detector model, CRNN for number plates recognition and also EasyOCR as an alternative solution will be used in the proposed smart ANPR system. There is a great need for carrying out this research project.

Further, the existing ANPR systems also have several drawbacks like variable lighting conditions, motion blurring, low resolution of images and variable number plate types, which affect the overall performance and efficiency of the traditional systems. Thus,

this research aims at building an innovative ANPR system by leveraging deep learning methodologies like YOLO for detecting number plates, and CRNN for recognizing number plate text. EasyOCR has also been implemented as a fallback technique in this regard.

The second major need in this research is to integrate the proposed solution with smart city technologies and intelligent traffic management systems. An intelligent ANPR system could prove effective for purposes like traffic monitoring, automatic parking management systems, toll collection, law enforcement activities and vehicle tracking. The proposed ANPR system could play a significant role in traffic management and could be employed by the authorities to monitor traffic flow, avoid traffic congestion, enhance security, and identify any suspicious or stolen vehicles in the vicinity.

3.1 Population and Sample

The sample of this study comprises vehicles identified using the surveillance cameras placed at the entry/exit points of the specified area. The focus of the analysis is the recognition of number plates belonging to various kinds of vehicles such as cars, motorcycles, buses, and trucks. Such vehicles comprise the total population for the development of an Automatic Number Plate Recognition (ANPR) system. The information contains images of these vehicles that have been captured in real time using an Internet Protocol (IP) Camera (RTSP Stream). This process takes place in diverse environmental conditions.

The sample of this research includes vehicle images taken from the captured data to be used during training and testing processes of the suggested ANPR system. Various images of vehicles are collected and split into the training and testing datasets. Different forms of number plates in relation to various lighting and background conditions are used as samples.

3.2 Data and Sources of Data

Data in this study involves captured vehicle images from the IP camera through an RTSP stream. Data from the installed camera will capture vehicles that are moving in real-time at the entry points. The captured images contain different kinds of vehicles under various circumstances like daylight, night time, varying lighting, and varying angles. Such images will be the main source of data for the detection and recognition of number plates on the vehicles by the proposed Smart ANPR system.

Apart from real-time capturing data, there are other sources of data in the study that can assist in making the system more effective. Existing data in the form of datasets of number plates as well as publicly accessible number plate images will be used to train and test the deep learning models. YOLO will be used in detecting number plates while CRNN model will be developed using Keras for character recognition. Additionally, EasyOCR will be incorporated as an alternative character recognition technique.

3.3 Theoretical framework

The theory behind the development of the proposed Smart ANPR is based on image processing and deep learning methods. There are several phases of the process, including image capturing, number plate detection, image preprocessing, character recognition, and outputting results. At first, the images of vehicles are taken by an IP camera through an RTSP stream. In addition, the taken images will be utilized as input data in the ANPR algorithm. Then, the captured images go under advanced detection algorithms, which enable identification of the number plate region in the picture.

At the next stage, the number plate detection will take place with the utilization of YOLO algorithm. This algorithm is aimed at identifying the location of the number plate in the image in real time. Upon detecting the number plate, the region will undergo preprocessing, including converting the number plate to Gray-scale mode, resizing, and noise elimination.

Once the preprocessing phase is completed, the character recognition is done by applying the CRNN (Convolutional Recurrent Neural Network). The CRNN model is designed with the help of Keras, and it is designed in such a way that it can recognize texts on the pre-processed images of number plates. In the situation when the CRNN fails to recognize the text successfully, then EasyOCR is applied as a backup approach for accurate recognition of texts. Finally, the number plate texts are displayed and saved in the database system.

RESEARCH METHODOLOGY

Methodology adopted by the suggested Smart Automatic Number Plate Recognition (ANPR) system research includes the creation of an efficient vehicle identification system using advanced machine learning and computer vision techniques. This methodology comprises several phases including image capturing, number plate recognition, pre-processing of images, character recognition, and results production, among others. They have been considered in order to improve number plate recognition processes in real-time environment.

During the first phase, real-time vehicle images are captured with the use of an IP camera which is integrated via RTSP stream. The camera is mounted at the entry or exit point where it captures real-time data related to vehicle movements. Images captured by the camera are then sent to a processing system for additional manipulation purposes. The method helps in efficient monitoring of vehicles without any need for any manual operations.

The next step involves the use of YOLO (You Only Look Once) model for vehicle number plate recognition. It is one of the fastest and most efficient algorithms in detecting objects within an image. Therefore, the model will help to detect number plate of a vehicle in the image. Once the location of the number plate is determined, it is cropped from the image.

OBJECTIVES

This research project will establish an intelligent ANPR (Automatic Number Plate Recognition) system that detects and recognizes vehicle number plates in real-time through deep learning and image processing. The outcome of this system will provide improved vehicle monitoring, enhanced security, as well as reduced human involvement in the vehicle identification process.

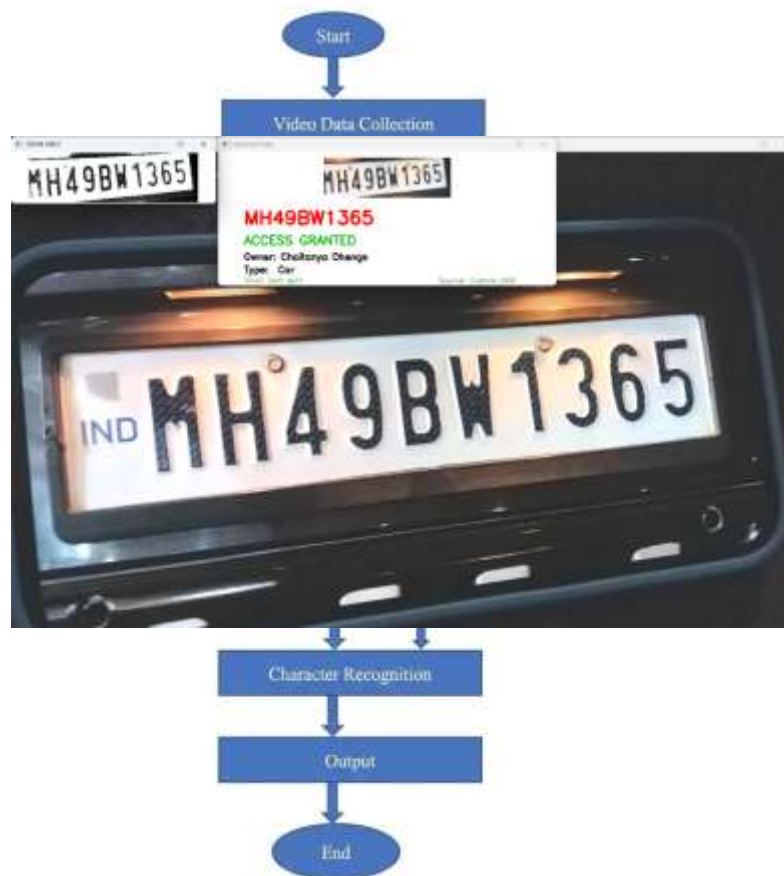
The objectives of this study are to:

- Create a vehicle number plate detection system that is fully automated using the YOLO algorithm.
- Utilize the CRNN model for vehicle number plate character recognition.
- Integrate EasyOCR to provide a backup method for character recognition to provide greater accuracy.
- Use an IP camera (RTSP stream) to capture real-time images of the vehicle and its license plate.
- Utilize image preprocessing techniques to improve image quality and performance of license plate character recognition.
- Determine the effectiveness of the automated detection and recognition of vehicle number plates through the use of accuracy, precision, recall and F1 score metrics.
- Create a reliable and efficient ANPR system that can monitor and track vehicles in real-time.
- Develop a scalable automated vehicle number plate recognition system that can be integrated within smart city and security applications.

SYSTEM ARCHITECTURES

Automatic Number Plate Recognition (ANPR) System Architecture Technology for Real Time Number Plate Detection and Recognition Through Deep Learning and Visual Recognition. The overall ANPR system architecture contains several different functional system modules that interact together to allow continuous video frame captures of incoming traffic; recognize number plates from captured video frames and display results. The following component parts are included in the overall system architecture.

- **IMAGE ACQUISITION MODULE:** Captures real time video data using an IP camera as an input source; the IP camera streams video continuously allowing the ANPR system to detect moving vehicles in real-time. Each incoming vehicle is processed frame-by-frame in order to provide continual and dynamic input to the ANPR system.
- **NUMBER PLATE DETECTION:** Captured frames are processed through a deep learning YOLO based network that detects and locates number plate regions in each incoming video frame, with detected number plates being extracted out of the frame image to be passed through to next processing steps.
- **IMAGE PREPROCESSING:** The extracted number plate image is pre-processed through a series of processing techniques (Gray scale processing, contrast enhancement, histogram equalization, resizing, straightening) in order to improve recognition accuracy for the following character recognition step.
- **CHARACTER RECOGNITION:** The pre-processed number plate image is passed into a CRNN model for character recognition; if the CRNN model fails to recognize all characters on the number plate, EasyOCR will be used to provide character recognition.



APPLICATION

The applications of the traffic management and monitoring systems are applicable to the proposed Smart Automatic Number Plate Recognition (ANPR). Due to the increase in the number of vehicles using the roads, the authorities require an effective solution for management purposes and reducing traffic congestion. The ANPR system detects and records numbers of vehicles automatically, making traffic management and rule enforcement easier. It also helps in recognizing over-speeding vehicles and their patterns.

One other significant application of the proposed smart ANPR technology is parking management systems. The ANPR system can help in automatic detection of vehicles entering and leaving the parking places without manually recording them. This will lead to effective management of parking places. The system is also helpful in calculating the bill of each vehicle through the automatic billing system.

The proposed system is very useful for security and surveillance. It can be set up in restricted areas like residential communities, offices, schools, and government buildings to monitor vehicle entry. The system can automatically recognize authorized and unauthorized vehicles and send alerts for suspicious ones. This improves security and helps control access to sensitive areas.

Additionally, the Smart ANPR system can be used in toll collection systems to automate vehicle identification and payment processing. This cuts down on traffic congestion at toll booths and improves efficiency. Law enforcement agencies can also use the system to track stolen vehicles, identify those involved in crimes, and monitor suspicious vehicle movements. These applications make the proposed system a good fit for smart city infrastructure and intelligent transportation systems.

RESULTS AND DISCUSSION

The proposed Smart Automatic Number Plate Recognition System (ANPR) was analyzed and evaluated using various images of vehicles taken by an IP camera under different environmental conditions. The efficiency of the system was determined by the capability of detection and recognition of number plates and characters respectively. According to the experimental results, the use of YOLO model led to a successful detection of number plates from vehicle images with a very high level of accuracy. The efficiency of the system was confirmed during the experiments conducted under various conditions, such as daylight, dim-light, and motion.

The developed model of CRNN applied in Keras library for character extraction and recognition showed an excellent level of accuracy in character recognition from number plates. In cases when the CRNN model did not manage to perform character recognition due to some problems with the image, EasyOCR was used as an alternative method for number plate

Image Recognition

System performance was analyzed using standard parameters like accuracy, precision, recall, and F1-score. The performance analysis results revealed that the suggested system offered a high level of accuracy and effectiveness in terms of performance evaluation metrics. The results showed that the YOLO model ensured fast detection speed, thus the system could be applied in real-time mode. As for the CRNN model, it helped to increase the recognition performance, while EasyOCR improved system robustness. Hence, the presented results prove the effectiveness and accuracy of the suggested Smart ANPR system.

All in all, it is possible to conclude that the presented experiments demonstrated the efficiency of the suggested ANPR solution. The

offered system could help to save time and improve security by reducing the necessity for performing some actions manually. Furthermore, the use of the system will help to make traffic control more effective.

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