Automatic Number Plate Recognition System using Deep Learning

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Abstract- *Number plate recognition systems are commonly used in various real-life applications. The detection and recognition of a vehicle NumberPlate is a key technique in most of the applications related to vehicle movement. In this world of new upcoming technologies which leads to our ease and comfortable life style, we also demand a comfortable traveling life, be it private or public vehicle. With increasing number of vehicles every day, it is very difficult to keep track of every vehicles manually. Traffic control and vehicle owner identification has become major problem in every country. Keeping this in mind, we think of an idea of vehicle monitoring at security gateways to facilitate the activity of vehicle clearances.*

Keywords- CCTV footage, Number Plate(NP), Convolution Neural Network (CNN), Character segmentation, Character recognition.

I. INTRODUCTION

This proposed system targets at designing an environment friendly automatic authorized number plate identification system that can be implemented at the place of private and public parking gateway entrances.A live video is being captured from surveillance units,which is then fed to the system. The system chiefly detects the moving vehicle at the entrance and then captures the vehicle Number Plate image. The vehicle Number Plate identification is carried out through a collection of steps beginning from detection, segmentation, and recognition of the Number Plate. To enhance and fabricate a system that is faster, we use real-time Number Plate detection using YOLO. The captured image is then segmented and recognized. This recognized Number Plate is cross-checked with the database of authorizes owner's of the vehicle, the ensuring records is then fed to the database so as to come up with the specific information like the vehicle details, time of entry-exit and location.This project targets building up an effective programmed authorized Number Plate recognizable proof framework that can be actualized at the entrance for protection control.Further enhancement such as face recognition can be added later to make this work more dependable and efficient.

II. CONCEPTUAL STUDY OF THE PROJECT

Vehicular traffic on the roads has increased drastically that stimulates great demand in technology for transportation monitoring and management. In this situation, the manual tracking of fast moving vehicles on the road is not possible.There will be a waste of manpower and time. Even if it is rated manually, it will still be huge difficult. There are already many solutions available for tracking vehicles and number plates using machine learning algorithms. But in real time,these algorithms actually fail because of its complexity for processing in the real time background. So there is an instant need to create an automated system to help monitoring the number plates of vehicles by tracking them in most efficient way. In addition to playing a key role in vehicle monitoring, Automatic Number Plate Recognition (ANPR) plays an indispensable role in systems such as parking management, toll payment processing systems, and many other systems where authorization is much needed. This greatly helps to save the time of the security officers by automating the process. In recent decades, computer vision technology has made great strides in many real-world issues. In the early days, vehicle number plates were identified using width, height, margin, etc., using template fitting techniques, and now many in-deep learning models trained with a enormous amount of data are widely used in number plate recognition.

III. OBJECTIVES OF THE PROJECT

Nowadays Automatic Number Plate Recognition(ANPR) plays an unavoidable role in many applications. Although ANPR uses many algorithms, it fails in terms of real-time accuracy.

It can be overcome by implementing it using deep learning techniques. Deep learning is a broad field of Artificial Intelligence (AI) that uses neural nets to learn from a large amount of data. It is a subgroup of Machine Learning that uses multiple layers to derive high-level features from source input. Deep learning is now used in almost all real-time applications. Unlike other algorithms, it shows a high accuracy and minimal

acceptable errors. The system uses the Convolution Neural Network (CNN) to locate the vehicle and number plate. The main purpose of the system is to design a deep learning model that can read the number plate of moving vehicles on the road using a surveillance camera and store the extracted number plate data in database. Also, this system makes the process easier and more efficient. The whole system is implemented using the Python programming language.

IV. SCOPE OF THE PROJECT

In recent years, Automatic Number Plate Recognition(ANPR) has made a vast advancement in the applications of machine vision technology. It is expected to come with further improvement in the future. It can support a wide range of communities through its efficient and effective applications such as parking management system, toll collection system, vehicle toll collection system, road vehicle monitoring system, in cities with large population. They need safe parking space to avoid access by unauthorized persons. ANPR helps to identify the number plate of the vehicle and collect the fee in the toll. Vehicle monitoring helps to collect fines from those who attempt to violate traffic and road rules. It also helps maintain a database of vehicles moving on the road.This project creates an efficient system for providing parking management. Vehicles with registered plates can automatically enter into parking areas while non-registered vehicles will be charged by the time of check. This ANPR is a very complex task. At the speed at which the vehicles are moving, the captured images should be adequate in brightness, intensity and clarity. Also, the angle at which the pictures are taken is an important part. The most complicated part is that each country has a unique standard for printing number plates. But there is no standard for this in India. It can have variations in font, spaces, letters and numbers. The main objective of the project is to locate and recognize Indian number plates with greater accuracy and using this system there is no need of hiring any human effort to maintain it and also it reduces the paper load.

V. LITERATURE REVIEW

For many useful applications such as automatic toll gates, traffic violation control, and private areas access control, Automatic Number Plate Recognition (ANPR) has been a popular area of research. [3] They developed a strong real-time end-to-end ANPR system that detects using modern YOLO object detection CNN's. The character division and recognition stages are currently the bottleneck of ANPR frameworks. In this regard, we tested a few approaches to dealing with increasing recognition in the two phases, such as data augmentation to replicate Number Plates from other vehicle classifications and character design with few instances in the training set. To recognize the characters on a Number Plate in the mentioned system, the Tensor-flow framework will be reused to classify the characters with a second CNN model with 37 classes. For training, 36 entry classes (10 digit classes (0 to 9) and 26 uppercase characters (A..Z) are considered, as well as every other non-character classification [3].

According to another article, the number plate extraction stage has a significant impact on the accuracy of an ANPR system. The NumberPlate could be located anywhere in the image. The qualities of the number plate can make it unique. The characteristics are obtained from the number plate layout and the characters that comprise it. Instead of processing every pixel in the image, which respectively will increase the processing time, the system can be built to process only the image pixels that are required for certain features [4]. Character location can be used as a function to extract only the specific number plate from an image. It's difficult to find a reliable number plate detection solution due to plate formats and varied outside lighting conditions during the image acquisition stage. To detect Number plates areas, a robust technique employing a large number of Ada-Boost cascades with three layers pre-processing local binary pattern classifiers is utilized in the study [5].

A study was carried out on the various methods used in the implementation of Automatic Number Plate Recognition (ANPR) [6]. The authors took approximately 78 reference sheets and evaluated their accurate results. The basic steps of ANPR include vehicle image capture, number plate detection, character segmentation and character recognition. Factors such as plate size, plate location, plate background and screw must be considered for number plate detection. Maximum accuracy for plate detection was achieved by Canny's edge detection according to the survey. The character segmentation can be executed using image binarization, CCA (Connected Component Analysis), vertical andhorizontal projection. Character recognition is usually done through Artificial Neural Networks, template matching or Optical Character Recognition (OCR)techniques. Maximum accuracy for character recognition was achieved by tesseract OCR.

In [7], a review is performed based on Automatic Number Plate Recognition (ANPR). The proposed system includes a camera module, sensor, control unit, GSM and embedded server. It tries to block the unauthorized vehicles by comparing the vehicle database saved already. Images taken from the camera are converted to gray scale and enhanced by adjusting the histogram. The edges are detected using Sobel's edge detection method. Then morphological image is then

processed. After that, the edge of the detected image is segmented. Finally, the characters are recognized using a machine learning approach.

In [8], a plate recognition system was developed using deep learning approach. They created the OCR system with customized dataset. The dataset was artificially created by taking some images from the internet and adding noises and backgrounds to those images. For background, the SUN database and the Stand ford database are used. YOLO (You Only See Once), the object detection framework is used for number plate detection. For character recognition, the Convolution Neural Network (CNN) is used. CNN's output layer contains 7.62 neurons for 7 characters. 10 times cross-verification is applied in the output to detect accuracy.

In [9], an automatic system for number plate recognition is developed. The system was divided into three categories: license plate detection, character segmentation and character recognition. In number plate detection, the input image is converted to HSV image and applied with several filters. Then CNN is applied over the images to detect the plates. In character segmentation, the images are again pre-processed. The second CNN model is applied to segment the characters in the image. Finally, soft max layer is applied to predicate the class probabilities. The dataset used is of two classes: positive class and negative class. The first dataset is Number Plate dataset and non-Number Plate dataset. The second dataset isfor characters and non-characters.

In [10], a deep learning model is created to recognize the number plate using the Turkish dataset made by them. They used Tensor flow framework with the Keras deep learning library. They collected 34, 58 images of which the smearing algorithm is applied using a MATLAB program. 75% of the images were used for training, 25% for testing and 5% for validation. Since the images were taken from the real time background, they carried out several image processing techniques like median blur smoothening, Adaptive Gaussian thresh holding and morphological transformations. After the sepreparations, the CNN model is trained using the images. The image features extracted from CNN are applied to LSTM network followed by the decryption algorithm.

Thus, in order to build up a robust and efficient system, the process of Number Plate detection must be speed up with additional feature extraction to recover the number plate pixels and destroy other pixels, as well as a faster technique of processing the pictures for segmenting and recognizing the characters.

VI. METHODOLOGY

In general, the ANPR system may be divided into two modes:

- The ANPR engine
- The ANPR equipment

Thus, it includes all of the essential equipment, ranging from the surveillance camera module to the training model, that are required to locate the Number [11]. The basic technique for an ANPR system is image processing, which may be generically split into three steps:

- Number plate detection
- Number plate segmentation
- Number plate recognition

On a more detailed level, these are explored further here.

i) Number plate recognition

It is the first step in identifying a vehicle's characteristics. Because Number Plate includes the shape of a rectangle, the edge-based technique is typically used to detect rectangle contours. As a result, this approach is commonly used to discover these rectangles.

ii) Number plate segmentation

After extracting the Number Plate from the image or video using simple image processing techniques, the next task is to separate the characters from the context of the number plate, which is known as segmentation.

iii) Number plate recognition

The last stage in the development of an Automatic Number Plate Recognition system is Number Plate focus. Thus, it complete all of the procedures, beginning with the capture of the image from the video and continuing through the localization of the plate location and character segmentation. The segmentation output is fed into recognition as input, and the mastering model must be capable of analyzing the images and rendering the relevant characters out of it. When using a Multilayer Perceptron , increasing the number of hidden layers can improve performance, however the ability to alter the overall performance of the KNN classifier is extremely limited [12] [17].

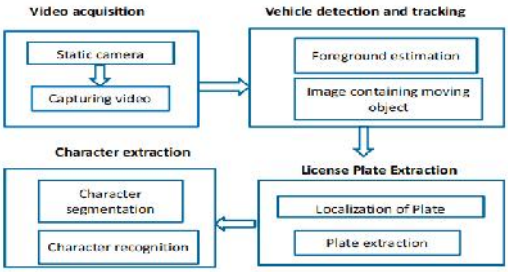

Fig. 1. NP Detection, Segmentation and Recognition procedure

VII. PROPOSED SYSTEM

The proposed approach aims to provide an efficient Automatic Number Plate Recognition(ANPR) system that may be implemented at parking entrances for security control. Using real-time object detection, a camera is positioned at the entry and exit to identify moving vehicles and capture vehicle number plates. The vehicle number plate region is separated from the video as an image, which is then fed into character segmentation. The vehicle number is then predicted using character recognition. The generated data is then recorded in a database to provide specific information such as vehicle details, time of entry-exit, and location.

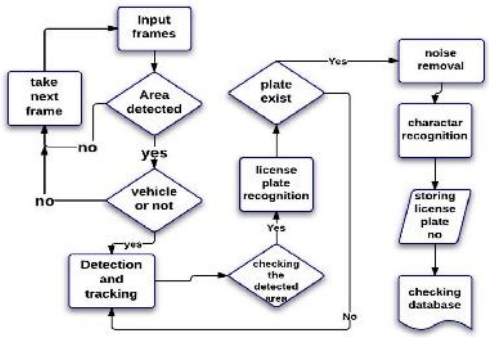

Fig. 2. Working of proposed system

By extracting text from images, the Automatic Number Plate Recognition system must detect and recognize the vehicle number. We require a system capable of generating images or videos from the environment using a camera at the hardware end and processing the image to detect the number plate registered number at the software end for classification. For accurate outcomes, the system must complete many image processing techniques. It is divided into the following steps: detection, segmentation, and recognition.

Before proceeding to the next stage, we must ensure that the image is noise-free and processed. This system operates across many levels:

A. Deep Learning Computer Vision [16]
B. Web Environment
C. Front-end and Back-end Design

A. Deep Learning Computer Vision

It is accomplished in several stages:

Fig. 3. Number Plate Detection

1) Number Plate Detection

We used YOLO (You Only Look Once) profound learning object detection approach based on Convolution Neural Networks(CNN) to recognize the number plate.YOLOv3(YOLO variant 3), a state-of-the-art YOLO object detection, is used here [4]. YOLOv3 is extremely fast and accurate. The image captured by the camera is fed into a pre-programmed neural system that is ready to detect the Indian licence plate.

2) Number Plate Segmentation

The image of the recognized plate is provided as a contribution to the division access for extracting the uni character segments. A decent division must be assured because the final output is dependent primarily on this procedure. If everything goes well in the location procedure, we should extract the characters from the plate. This should be possible by thresh holding, dissolving, expanding, and obscuring the picture ability completely, so that the picture we have at the end is nearly commotion free and simple for additional capacities to work on. For legitimate character recognition in each segment, we require an all-around characterized twofold image. All of the forms in the data image must be recognized. After discovering all of the forms, we take each one as an individual and consider it by assuming each one's bounding rectangle.

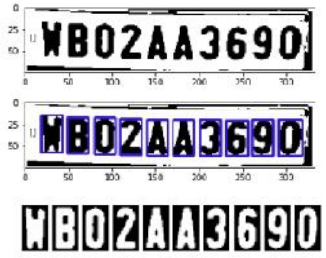

Fig. 4. Number Plate Segmentation

3) Number Plate Recognition

This must be done using the character images obtained at the end of the segmentation process. The learning model implemented for this recognition must be capable of reading a picture and rendering the appropriate character; in this case, we use a CNN model [15]. To prepare the data for training, we will use image processing processes to crop each picture character by character by scaling it to a square. Here, we must train the CNN model with pictures of alphabets (A-Z) and digits (0–9) of size 28x28. After 60 epochs of training, the model obtained an accuracy of 96.54 percent. We must now provide the binary image from the segmentation(A-Z) process and obtain the output as:

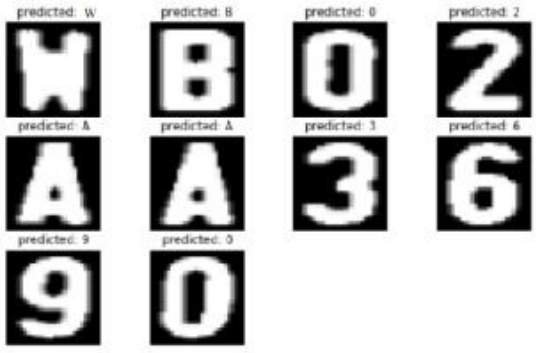

Fig. 5. Number Plate Recognition

B. Web Environment

The system is intended to be deployed at private and public parking gate entrances. To improve the user experience, a basic web application is created using Django. Django is a high-level Python web framework that enables rapid development of secure and maintainable websites. The desired user may log in to the system with their email address and password, and the authorization is granted using authentication. The user may check data such as the date and time of entrance for all vehicles entering through the gate. This is accomplished with the assistance of a database including vehicle information for individuals fromwhere the information is retrieved. The user can look forany vehicle to determine whether a vehicle is present inside the parking by giving a date, time of entrance, and other information.

C.Front-end andBack-end Design

Django handles most of the complexity of web development, allowing you to focus on developing your app rather than rebuilding the wheel. Django assists developers in avoiding many typical security mistakes by offering a framework that has been built to "do the right things" to automatically secure the website. SQL is a database computer language that is used to retrieve and manage data in relational databases. SQL to collect information of every vehicle, entry-exit time after identifying whether or not it is an registered person vehicle.

VIII. RESULTS AND DISCUSSIONS

Petty criminal acts, such as misrepresenting tolls on highways or skipping, speeding, vehicle burglary, and so on, are becoming more common in open traffic as the number of vehicles grows. As a result, recognizing vehicle tags is critical for safety. We were able to design an automatic vehicle monitoring system in the proposed design that may be implemented at the gates of the private and public parking entrances. The system was able to capture the vehicle's number plate as it was moving, providing a real-time object detection using YOLOv3 [3]. Using Convolution Neural Networks(CNN) and more hidden layers, we can detect and recognize considerably faster than the traditional systems. In practically all recent major conditions, the accuracy for recognizing the number plate from the vehicle was more than 90%. The system was able to detect the number plate for slanted plates with an inclination more than 60 in the video, but it requires more precision in eliminating unnecessary noises other than number plate pixels. With 25 epochs, the segmentation and recognition model reached an accuracy of 0.9, which is further boosted by further epochs and resulting in reduced loss. The number plate received from recognition is cross-checked with the individual information and is forwarded to the database together with the vehicle entry-exit time and date information. The user may access and read the information using a web application. Thus, one might determine how many vehicles are now parked on the parking areas.

IX. CONCLUSION

The dependence on vehicles for daily usage has been marginally increased by these years. As a result, it shows the importance for additional safety and security measures. The proposed framework can be implemented at the entrance of

parking for security control that use a programmed number plate recognition approach. This framework recognizes the moving vehicle in the gateway and then captures the vehicle number plate image. It's considerably easier to recognize a single Number Plate from a frame than it is to detect many Number plates. In the future, we intend to research new methods for identifying several Number Plates from a single frame at a time, as well as face recognition that matches wit the license of the owner. We also intend to adjust the layout of slanted number plates and characters in order to improve character division and recognition.

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