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Vehicle Number Plate Detection through live stream using Optical Character Recognition (OCR)

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***Abstract*-- Vehicle Number Plate Detection or Automatic Vehicle Plate Recognition (AVPR) is a technology that is applied in urban areas to help the law enforcement in investigation and crime prevention. Vehicles going at illegal speeds, stolen vehicles etc. can all be recognised automatically using AVPR without human intervention or human errors. It has been used widely in vehicle toll booths on the highways as well as in Parking Management Systems where there is a rigid shooting angle that can capture the licence plates of the vehicles efficiently. The main aim is to create a useful model for handling challenges such as traffic jams in parking areas due to incorrect parking, automobile insecurity, etc.**

In this paper, an approach of Automatic Vehicle Plate Recognition using livestream is discussed by considering image size, success rate and processing time as parameters. An extension to Automatic Vehicle Plate Recognition (AVPR) is also suggested towards the end of this paper.

Keywords: Optical Character Recognition, Licence Plate Recognition, Automatic Vehicle Plate Recognition, AVPR, Real-time Systems

I. INTRODUCTION

Automatic Vehicle Plate Recognition (AVPR) technology is a tool that uses OCR-optical character recognition on images to recognise and read the licence plates of vehicles. In India, there is one death in every four minutes, with 60% of the deaths occurring due to over speeding. AVPR can be used to observe the average speed of the automobiles and can identify and recognise the vehicles that have exceeded the legal speed limit. In such cases, a fine ticket will be generated automatically by calculating the distance between two cameras. This helps minimise the number of road casualties significantly. The number of vehicles being bought is increasing proportionally with the economic growth which in turn makes the governance of the transportation system in a country extremely difficult and complicated.

Two of the significant problems in every nation is the identification of vehicle owners and efficient parking management. At times, it is challenging to identify the owner of the automobile who violated traffic rules. This makes it impossible to catch hold of them and penalise these sorts of people since the traffic police might not be able to retrieve the registration numbers from fast-moving vehicles.

Also, one of the major setbacks in today's overpopulated and fast-paced world is the inconvenience of being unable to find free parking slots in most parts of the cities which leads to wastage of time and energy[13]. This is especially for the people who go shopping or to work and are looking for a spot to park their vehicles.

II RELATED WORK

1. X. Zhai and team[1] presented a model which uses optical character recognition in the last step of the number plate recognition process. This stage involves converting the characters on the number plate into encoded texts. It not just uses optical

character recognition but also applies artificial neural networks to the algorithm for better results. This paper presents a model that is trained using a database of more than 3500 UK binary character images, which are used to test the model accuracy and performance of the algorithm proposed in the paper. The results described in the paper have shown that the algorithm presented in this paper can meet the real-time requirement of the number plate recognition system with a 97.3% accuracy.

2. P. Kulkarni and group[2] proposed a real time embedded system which automatically recognises the license number of vehicles. In this survey, the task of recognizing number plate for Indian conditions is considered, where number plate standards are rarely followed.

3. M. Y. Aalsalem and team[3] developed a system that resolves parking problems and also to provide a more pleasant parking experience to automobile owners by allowing the increasing vehicles in an efficient manner, an automated- car parking management and monitoring system (CPMMS) is proposed. This system uses Automatic Number Plate Recognition (ANPR) cameras to manage and observe the parking the facilities of institutions.

4. A. Bevilacqua and team[4] implemented a way to identify the centres of non-motion that are realized using short stability intervals. These are further connected to build the long stability interval used to measure the overall vehicle stopping time. The sequences provided by the AVSS 2007 were examined and observed which confirms that our way of approaching the problem was effective compared to other ground truth.

III PROPOSED WORK

A. *Methodology*

Automatic Vehicle Plate Recognition (AVPR) is an important system which helps us in monitoring and tracking down the registration number by reading the vehicle number plate. An open-source Python library - Pytesseract is used to implement the OCR.

- *Optical Character Recognition (OCR):*

The Python-tesseract library is regularly used for recognition of characters embedded in optical images. OCR (optical character recognition) engine uses tesseract as an open-source API to identify various languages. It is a wrapper of Google Tesseract OCR Engine that has the ability to read every possible image type, return the recognised text rather than writing it to a file. Pytesseract can be easily used by simply installing the Tesseract OCR engine and then install this module. This module uses page segmentation mode to run OCR on minute parts of an image. OCR gives more accurate results when a standard image is passed as an input to the system. Histogram equalisation adjusts the intensities to improve the contrast of the image. Morphology is used to exclude the unwanted objects from the obtained image. Sharpening is used to enhance the performance of the OCR. This increases the visibility level of characters and makes it readable for the OCR engine. OCR, or Optical Character Recognition, is a process of recognizing text inside images and converting it into an electronic form. These images could be of handwritten text, printed text like documents, receipts, name cards, etc., or even a natural scene photograph. OCR has two parts to it. The first part is text detection where the textual part within the image is determined. This localization of text within the image is important for the second part of OCR, text recognition, where the text is extracted from the image. Using these techniques together is how the text can be extracted from any image. One of the most common OCR tools that are used is the Tesseract. Tesseract is an optical character recognition engine for various operating systems. The first step is to install the Tesseract. With Tesseract, text localization and detection from images can also be performed. Optical character recognition (OCR) uses a scanner to process the physical form of a document. Once all pages are copied, OCR software converts the document into a two-color or black-and-white version. The scanned-in image or bitmap is analyzed for light and dark areas, and the dark areas are identified as characters that need to be recognised, while light areas are identified as background. The dark areas are then processed to find alphabetic letters or numeric digits. This stage typically involves targeting one character, word or block of text at a time[15]. Characters are then identified using one of two algorithms — pattern recognition or feature recognition. The most well-known use case for optical character recognition (OCR) is converting printed paper documents into machine-readable text documents. Once a scanned paper document goes through OCR processing, the text of the document can be edited with a word processor like Microsoft Word or Google Docs[14]. OCR is often used as a hidden technology, powering many well-known systems and services in our daily life. Important — but less-known — use cases for OCR technology include data-entry automation, assisting blind and visually impaired persons and indexing documents for search engines, such as passports, license plates, invoices, bank statements, business cards and automatic number plate recognition. Pattern recognition is used when the OCR program is fed examples of text in various fonts and formats to compare and recognise characters in the scanned document or image file. However, there are possibilities that the number plate cannot be

detected. This can be due to poor quality of vehicle number plates of old vehicles or poor maintenance of the camera. Also, the presence of difference in fonts and vehicle registration number formats, in different states throughout the country can sometimes make it difficult for the model to predict the number plate accurately.

B. Implementation

The proposed system is implemented in the following ways, starting from taking video input to getting a list of all the recognised vehicle registration numbers extracted:

- Frame acquisition
- Pre-processing
- Plate localisation
- Character segmentation
- Character recognition

1. Frame Acquisition

The first step in detecting number plates is to input a video stream from the user and perform the process of frame acquisition on it to detect the frames which contain vehicles. Frame acquisition involves collecting the images. These images are usually present in the RGB format, which is an additive format of the colours red, green and blue. Since the input is a real time video, it is necessary to obtain frames containing vehicles with number plates. After the image frames are obtained, the process proceeds to the next step[12].

2. *Pre-processing*

The second step is to process the obtained frames to get an enhanced image which gives better recognition results. This stage is used to remove noise and unnecessary parts from the image. This process is called pre-processing, which by name means processing the image before performing further advanced steps. Performing this step involves cleaning the image and transforming it removing the noise and disturbances from the images which hinder prediction performance. To perform this step binarization techniques and grayscale conversion is used. The image is first changed into greyscale, then the plate binarization is applied. This involves converting the image into a 2 level document where the main contents of the image are highlighted from the less significant background, providing better emphasis and giving better and more accurate results[14]. It is known as binarization because the binary numbers contain only 1 and 0 and the grayscale contains only the black and white colours, so the image is then converted to the binary numbers (assigning the colour white as 1 and the or 1color black as 0 otherwise). Converting the image to grayscale helps reduce the image complexity as it contains only black and white pixels which helps clean the image efficiently.

3. Plate localisation

The pre-processing stage consists of plate localisation and extraction. Plate localisation, as the name suggests, is the process of locating all the possible squares from the image frames which match with the pre-defined number plate dimensions. A predefined aspect ratio is provided to validate the recognised rectangles from the image frames to make sure the detected rectangle is a number plate. After all the number plates are localised or recognised, the plate extraction step is performed where all the located number plates from the image frames are extracted. The plate localisation step involves processes like Otsu thresholding and morphological operations. Otsu thresholding algorithm is a process which separates the pixels in the image into categories of foreground and background, i.e., it highlights the significant and dominant pixels from the insignificant ones. It groups the pixels into these categories using a variance-based threshold. This algorithm tries to reduce the variance difference between the black and white pixels and groups the pixels to enhance the grayscale image[11]. The plate extraction step extracts the number plates from the image frames so that these can be used to detect the vehicle registration numbers using character recognition and character segmentation techniques in the future step.

4. Character Segmentation

The previous step extracts the number plates from the image frames. After this step, character segmentation is performed to recognise all characters that are present in licence plate. To be able to obtain the registration number of the vehicle, first the characters from the number plate are to be segmented or separated, i.e., area, perimeter, texture, shape and other predefined specifications are used to compare the pixels to a letter or number [6]. The shapes that compare to the predefined parameters are considered to the next step where the segmented part of the image are recognised as a particular letter or number. Semantic Segmentation, Instance Segmentation and Panoptic Segmentation are the most commonly used segmentation techniques, which splits the image into sub images or sub levels to segment the significant required pixels.

5. Character recognition

The last step of this process is character recognition step. This step is implemented mainly using the OCR technique, which is Optical character recognition technique. This uses computer vision and neural networks to convert the pixels of the image to electronic form readable by the machine

to be able to recognise the respective character. The optical character recognition technique detects the hidden text or characters in an image and helps obtain the required information from an image. So this step recognises the individual number or letter from the segmented image region from the previous step. This is the last step and outputs the expected vehicle registration number which acts as a foundation for multiple purposes and can be put to an advanced use. Character recognition is achieved by OCR through steps like Image acquisition, Text recognition, Pattern matching, Feature extraction, Post processing. The OCR software analyzes the scanned image and classifies the light areas as background and the dark areas as text. The OCR software then cleans the image and removes errors to prepare it for reading. The two main types of OCR algorithms or software processes that an OCR software uses for text recognition are called pattern matching and feature extraction. Pattern matching works by isolating a character image, called a glyph, and comparing it with a similarly stored glyph. Feature extraction breaks down or decomposes the glyphs into features such as lines, closed loops, line direction, and line intersections. It then uses these features to find the best match or the nearest neighbor among its various stored glyphs. After analysis, the system converts the extracted text data into a computerized file.

Precondition:

• A camera is placed at 4-5 m away from the vehicle to get the clear view of the number plate.

• Videos are captured and stored in a repository.

Post condition:

• The license plate numbers are recognised and displayed on the terminal.

V RESULT ANALYSIS

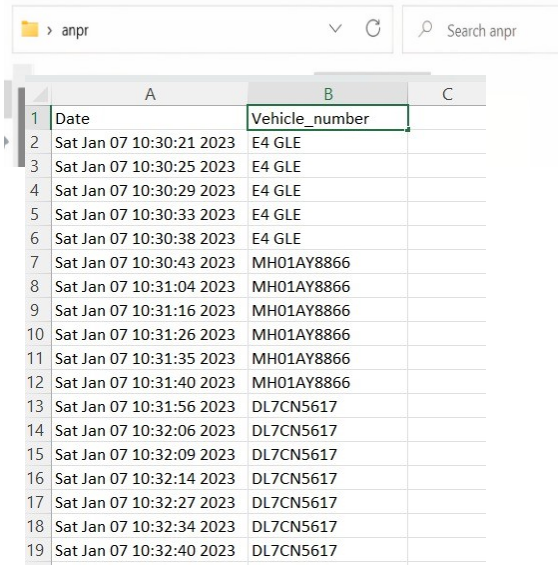
Fig. 1. Displaying a pop-up window

Fig 1 is displayed when the number plate is detected with a rectangular box over the license plate.

Fig. 2. Detected number plates in a separate window.

Fig 2 shows the window pop up of the detected bounding box of the number plate.

Fig. 3. Folder containing the captured frames.



	A	B	C
1	Date	Vehicle_number	
2	Sat Jan 07 10:30:21 2023	E4 GLE	
3	Sat Jan 07 10:30:25 2023	E4 GLE	
4	Sat Jan 07 10:30:29 2023	E4 GLE	
5	Sat Jan 07 10:30:33 2023	E4 GLE	
6	Sat Jan 07 10:30:38 2023	E4 GLE	
7	Sat Jan 07 10:30:43 2023	MH01AY8866	
8	Sat Jan 07 10:31:04 2023	MH01AY8866	
9	Sat Jan 07 10:31:16 2023	MH01AY8866	
10	Sat Jan 07 10:31:26 2023	MH01AY8866	
11	Sat Jan 07 10:31:35 2023	MH01AY8866	
12	Sat Jan 07 10:31:40 2023	MH01AY8866	
13	Sat Jan 07 10:31:56 2023	DL7CN5617	
14	Sat Jan 07 10:32:06 2023	DL7CN5617	
15	Sat Jan 07 10:32:09 2023	DL7CN5617	
16	Sat Jan 07 10:32:14 2023	DL7CN5617	
17	Sat Jan 07 10:32:27 2023	DL7CN5617	
18	Sat Jan 07 10:32:34 2023	DL7CN5617	
19	Sat Jan 07 10:32:40 2023	DL7CN5617	

In Fig 3, we can see that the frames that have been captured are saved in a separate file.

Fig. 4. Recorded data in the excel sheet.

In Fig 4 an excel sheet is created where data such as day, date, month and time is recorded along with the recognised characters of the number plate.

A. *Metrics*

- *Accuracy*

In order to achieve the highest accuracy, the model training is stopped at an early stage. This avoids the over-fitting problem that usually occurs due to prolonged training of models. Accuracy can be calculated using the formula below:

Accuracy = TN + TP/ TP+FP+TN+FN

Accuracy = 94.7%

- *Loss*

  Loss = 0.0316

- *F1 Score*

  It is the harmonic mean of precision and recall. Over all to avoid Type 1 errors more than Type 2. To do so, we have an F1 Score. F1 Score is the harmonic mean of precision and recall.

  Precision = TP/ TP+FP

  Recall = TP/ TP+FN

  F1 Score = 0.9911

VI CONCLUSION

Normally, CCTV cameras are used for monitoring traffic which, in contrast with human checking, is more effective. The primary disadvantage with CCTV cameras is the low resolution of the output that makes it nearly impossible to detect the number plates of vehicles AVPR provides a useful approach to avoid the drawbacks of CCTV cameras.

The number plate of the automobiles can be directly linked with the mobile phone of the owner. Now, a fine-ticket can directly be sent to the identified owner and he can pay the fine against the ticket number generated without additional efforts. AVPR can be developed to support a cloud-based system in which a vehicle owner can pre-book a parking space by prepayment.

In India, approximately 200,000 cars are stolen per year. This number can be significantly reduced by taking proper and precautionary steps and using AVPR system to track the vehicles. If vehicles are reported to be stolen, then law enforcement will be able to quickly retrieve the information such as where the vehicle was last seen, when and the route taken by the stolen vehicle.

AVPR is a very complicated system due to a different number of stages [8]. It's currently impossible to carryout 100% overall accuracy since every stage in the process depends on the previous step.

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