Vehicle License Plate Detection and their Count for Traffic Management

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Abstract: - Vehicle License Plate Detection and their count deals with providing an effective solution for traffic management and monitoring of vehicles. In this study, we construct a model that provides two functionalities, one is to effectively extract the license plate number from the given input image or live streaming data and the other one is to count the number of vehicles. There are many such Automatic Number Plate Recognition (ANPR) models prevailing but this particular model is built considering the Indian vehicles. For license plate detection, we used OpenCV which is a computer vision-based library, and for Character recognition and segmentation process we applied Optical Character Recognition (OCR) method. For the vehicle counting we applied a background subtraction algorithm that detects moving objects in a series of static camera frames. Our model has the simplest implementation and at the same time its highly accurate for Indian vehicles.

Key Words: — ***Automatic Number Plate Recognition, OpenCV, Optical Character Recognition, Computer Vision, Region of Interest, License Plate Recognition.***

I. INTRODUCTION

By the past decades, as the usage of the number of vehicles has increased drastically in India, so is the need for their monitoring for proper traffic management. Every year the major number of road accidents in India are caused by over speeding. Also, the data says over 30 percent of all road accidents in India are hit-and-run cases, but only 10 percent of hit-and-run accident drivers are booked. It's because it might be tough to spot drivers who break traffic laws and drive too fast at times. As a result, it is impossible to apprehend and penalize such individuals. So, to provide an effective solution to this, it's better to build a system that can effectively track vehicles and extract their license plate number through live streaming data.

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There are various challenges for building ANPR systems in India.

The very first is the license plate variations. In India, we would come across 8 different types of number plates as shown in figure 1. These are -White number plate, yellow number plate, green number plate, red number plate, blue number plate, Black number plate, Number plate with an upward-pointing arrow, red number plate with the emblem of India. These different colored license plates have their own meaning and importance and also define the boundaries of usage of vehicles. Like the white number plates with numbers written in black color depicts the private vehicles and can't be used for commercial purposes, the one with yellow number plate can only be used for commercial purposes, the green one belongs to electric cars while the black one is for luxury hotel transport, the red number plates symbolize a new car with temporary number plate and lastly the blue one is issued by reputed authorities like foreign diplomats. Hence building a system that can well learn these patterns is essential for successful functioning of such a system, that's why to overcome this challenge we trained our model on such different colored number plates.

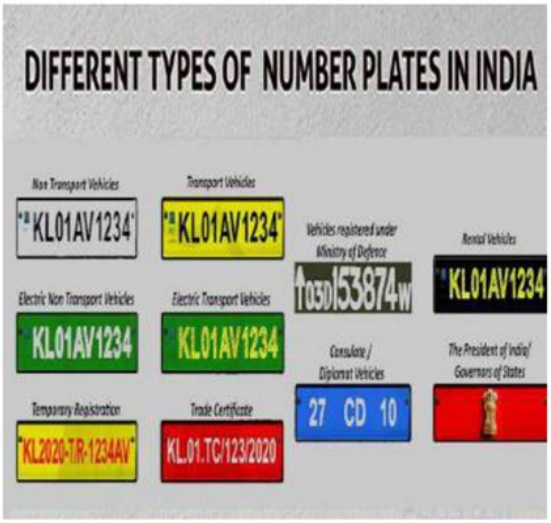

Figure 1 : Different types of Number plates in India.

The other major challenge is the deployment of low-cost, low-quality cameras that have limited visual coverage, equipped with less acute motion, which results in low quality images captured that are often blurred or have less resolution. To avoid this, we have used the " cv2.filter2D" method which is a generic sharpening kernel that converts the blur image to a clear sharper image.

In India 200,000 cars are stolen per year. This number can lessen if proper steps are taken and ANPR system is used to track cars so that if vehicles are stolen, law enforcement will be able to identify when, where and the route taken by a stolen vehicle. This can help bring justice swiftly to such a vast nation.

Another major issue is the lack of proper traffic control in India. Congestion of a large number of vehicles on a single route causes traffic jam. Our vehicle counting model would help in counting the number of vehicles passing on a route. This helps in keeping account of areas which are more concentrated with vehicles and hence this information can be further used by the Ministry of Road Transport and Highways for building more roads and flyovers to distribute traffic.

II. Literature Review

Computer Vision plays a key role in object detection, motion tracking, number recognition and has its various real-life applications one of which is vehicle number plate recognition & vehicle counting.

Building an ANPR system has been an active research project for the past few years. The very first ANPR system was invented in 1976 in UK so as to help detect, deter and disrupt criminality including tackling organized crime groups and terrorists. Afterwards there were many new algorithms introduced to enhance the accuracy of such systems.

In [1] the paper of year 2021 shows a detailed survey on various relevant algorithms for automatic number plate recognition. In this a brief about various technologies in this field are described like Deep learning technologies, ANPR systems integrated with RFID systems, GPS, Android based ANPR systems, etc.

In [2], the researcher has provided an effective solution for different coloured number plates using an SSD based LPR system using Deep Learning.

The reference [5] shows the effective solution for region proposal algorithms to hypothesize object locations.

In [6], the study about vehicle motion tracking & traffic count is being implemented where the basic idea was to perform vehicle counting from an unmanned aerial vehicle (UAV). There were sensors attached on the UAV and moving objects were monitored based on two conditions: static background & moving background. The reference [7] shows another research on a video-based vehicle detection, counting & classification system, where an excellent use of Contour Comparison (CC), Bag of Features (BOF) & Support Vector Machine (SVM) is demonstrated.

Hence, we can observe that vehicle detection, counting and license number recognition has been a major area of research for the past many years. Various appropriate solutions are being provided and the research is still in progress, so as to find a solution that is easy to implement, cost effective & can be implemented at a large scale.

III. Proposed System Model Methodology

3.1 Vehicle License Plate Detection

The flowchart in figure 2 describes the basic workflow of the system for vehicle license plate detection. It begins with giving an image as an input to the system, then performing image preprocessing so as to reduce noise in the image, below are the basic steps involved in license plate detection:

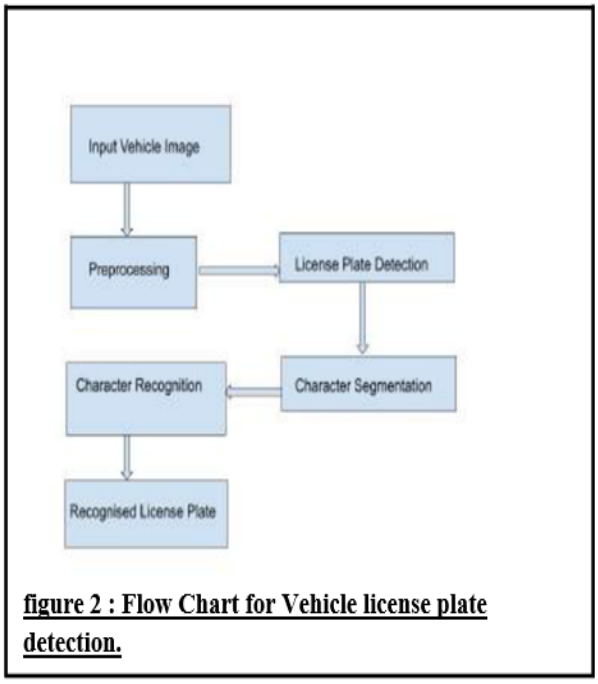

figure 2 : Flow Chart for Vehicle license plate detection.

- The very first step is an image processing step where we convert the given input image into a grayscale image. This is done to remove noise in the image. The method cv2.COLOR_BGR2GRAY in OpenCV library helps in performing this step.

figure 3: Converted original image to Grayscale.

3.2 Canny Edge Detection

The second step is to perform an edge detection. This method is used for finding edges in the image so as to better locate the license plate as shown in figure 4. cv2.Canny() method helps in executing this step.

Figure 4: Canny Edge Detection

- Find Contours based on edges, which will help model for detecting rectangular objects based on above detected edges and finally creating ROI around it shown in figure 5.

figure 5 : License plate detected, marked as red rectangular box around the plate.

- In the above step, the model has successfully detected the license plate, now it's time to perform character segmentation as shown in below figure 6 and character recognition in figure 7.

figure 6: Character Segmentation

Figure 7: Character recognition

- Finally, the license number is displayed to the user shown in figure 8.

figure 8 : Output displayed to user

3.3 Vehicle Detection and Counting

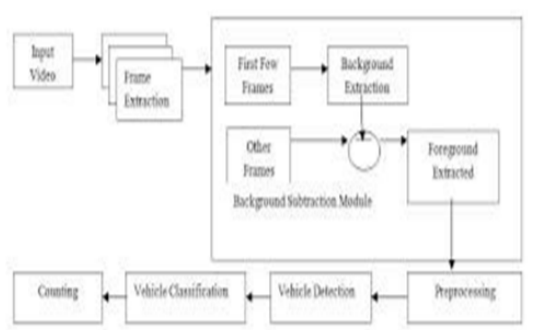

figure 9 : Flow chart for vehicle detection and counting

Steps involved in vehicle detection and counting:

- Apply background subtraction shown in figure 10 and Extract foreground mass in figure 11. **Background Subtraction Algorithm**: Background subtraction is a common technique used to detect moving objects in a series of static camera frames. This method relies on detecting moving objects looking at the difference between the current and reference frames, which is commonly referred to as a 'Background Image' or a 'Background Model.' This background subtraction is typically done by detecting foreground entities in a video frame, and foreground detection is the prime objective of this methodology.

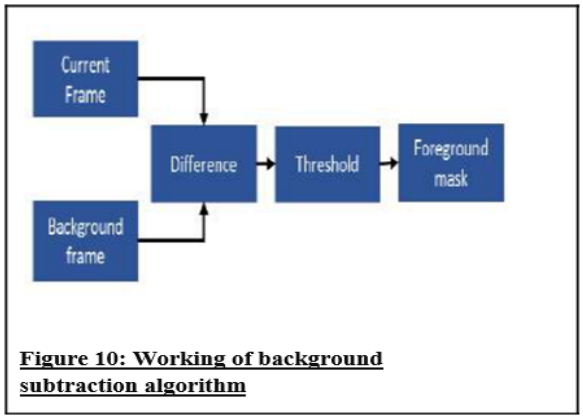

Figure 10: Working of background subtraction algorithm

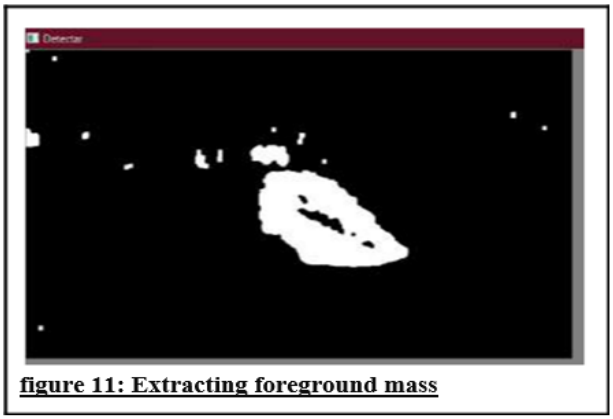

figure 11: Extracting foreground mass

- Create a line of reference shown as a blue line in figure 12.

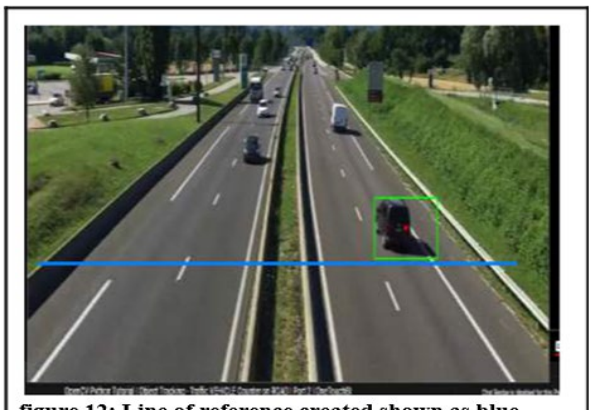

figure 12: Line of reference created shown as blue line on the lane.

- Detecting the vehicle indicated by a green rectangle around the vehicle in figure 12 and counting them represented in below figure 13 depicts the total number of vehicles passed through the lane.

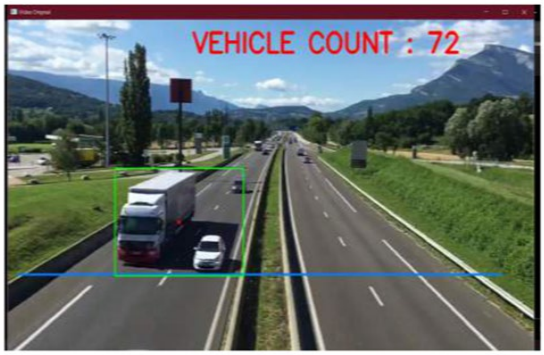

figure 13: Vehicle detection and count

IV. Result Discussion

4.1 For license plate detection:

The table1 and table2 shows the result of our analysis for license plate detection on various different images of vehicles. Since our model is particularly built for Indian vehicles, hence we have taken images of vehicles belonging to regions like Haryana, Delhi, Uttar Pradesh, Maharashtra. In the below table we have shown the detected number plate and their valid license number. According to our analysis the model serves well on images having minimum size approximately 400x400 pixels and maximum size of 1750x980 pixels with 96 dpi of horizontal and vertical resolution. Model tends to fail on highly blurred, unclear and small images.

Table.1. Result analysis on successful cases.

Detected Number Plate	Actual License Number	Predicted License Number	Result
	MH01AV 8866		Correct
	DL2CAW 2075		Correct
	UP15BU4 150		Correct
	HR26BR9 044		Correct

Table.2. Result analysis on failed cases.

Car Image	License plate detected (yes/no)	Number Detected (yes/no)	Reason of failure
	Yes	No	Image size was 300x220 pixels which is less than the minimum size required
	Yes	No	Image was unclear and was taken from some angle more than 30 degrees due to which the model could not predict the correct number.
	NO	NO	Highly Tilted image

4.2 For Vehicle Detection and Count:

figure 14 and 15 shows the result of analysis on two different sources of input data. We can clearly see that the model has well detected and predicted the count of each vehicle passed by the lane. According to our analysis the input video with

minimum Frame Size =1280, Frame width=720, Data Rate=218Kbps, Total bitrate = 287kbpsand Frame rate = 29.97 frames/sec are the best suited for successfully predicting results by the model.

4.3 Result analysis for vehicle counting

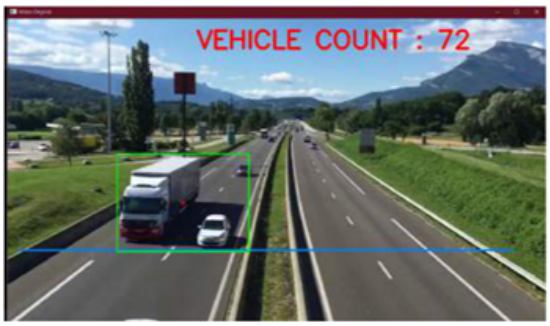

figure 14: Detects vehicles approaching line of reference and increments the count.

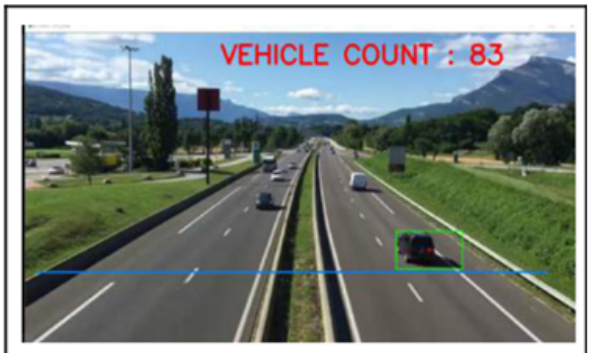

figure 13: Successfully detects and counts the vehicle going in opposite direction to line of references.

V. CONCLUSION

The proposed model has successfully predicted most of the Indian vehicle's license plate number and also detected the count of vehicles in the given captured video. By the use of a simple and efficient algorithm we have attained a good accuracy of about 60% which can be further improved upon training.

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