# Automatic Recognition of License Plates

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2021 International Conference on Emerging Techniques in Computational Intelligence (ICETCI) | 978-1-6654-1559-0/21/$31.00 ©2021 IEEE | DOI: 10.1109/ICETCI51973.2021.9574072

***Abstract*—As our lives are getting automated with the Internet of Things, Machine Learning it is very important to get accurate results. This paper is a study of Automatic License Plate Recognition (ALPR) using various Python libraries and hence recognize the information on images and videos. We will discuss a novel image processing method which will be used for the recognition of Indian Number Plate Recognition in videos. Further, it will explain about the need of this system in India and also the importance of high intensity images so as to detect them. Also, some future prospects are proposed which will enhance the current working model keeping intact the security and privacy of the data of people. It can later be linked with the database of VAHAN and SARTHI for quick responses regarding the owner of the vehicle and other necessary information. The ALPR system is detected using Local Binary Pattern algorithm and is subsequently recognized using HTTP server using beanstalkd queue thus making a complete software implementation.**

***Index Terms*—license plate detection, image processing, automatic license plate recognition (ALPR), Local Binary Pattern.**

## I. Introduction

Automatic License Plate Recognition is a software which is used to perform Optical Character Recognition on images of cars which contains the license plate. The information is supplied in the form of an image to the next stage of computer processing and then it can be translated, compared and stored to create an application deployed using ANPR. ANPR is a specialised tool which anticipates assistance to the imposition of the law and order, thus ensuring the continued safety of all people driving on the road. Safety and security of all the users has been braced by ANPR throughout the world and is strengthening the effective transport flow of people in real time.

The simulation used in this project takes into input an image and a video file, detetcts the characters present on it using the LBP algorithm [1] and then recognizes all the numerals present according to the beanstalkd queue and then returns the contents of the number plate/s as per the no. of license plates available along with their confidence value and dimensions of the number plate and various other parameters desired by the user. This system works fine for the recognition of license plates in varied environments and dimensions. It is also capable of detecting low contrast images to a certain extent.

The current stumbling block with the existing system is that this automated number plate recognition works fine for controlled environments only. To improvise this, the paper will propose a new method that will work for low illuminated and noisy images. The training of the openalpr library in python was done by training the system for a large set of manually clicked data. This system can be made smart by incorporating an IoT system in it, so that we can auto alert the nearby police station for notification of wanted, listed and stolen cars and take action at the earliest. With the help of the datasets of SARTHI and VAHAN the search for the cars can be accelerated this will make the system reliable and fast [2].

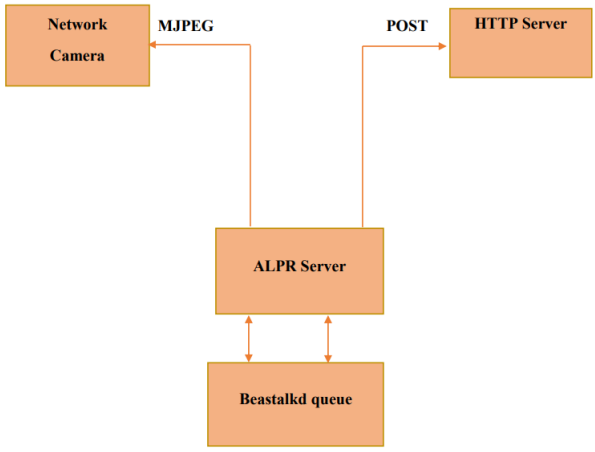


Fig. 1. Architecture of the Algorithm.

## II. Literature Survey

To date, fuzzy logic and neural networks together are being used for the detection in Dutch number plates. Segmentation is performed using Fuzzy logic and for extracting and classifying the features present in the image or video file, neural networks are being used. Furthermore, in the case of distorted background, character extraction utilizing the wavelet transform method is used. Segmentation is done using an algorithm and then distinguishing between different characters in the number plate is done using Optical Character Recognition[3]. Furthermore, in advanced research, Morphological operations for plate extraction and character recognition can be used. This approach works fine for the recognition of license plates in varied environments and dimensions. It is also capable of detecting low-contrast images to a certain extent. It was

also observed that in the latest developments, number plate detection uses the Support Vector Machines (SVM) algorithm [4].

After the segmentation of each character, Artificial Neural Networks (ANN) are used for recognizing each element. Additionally, for the segmentation of number plates, the border of the image is taken into consideration and then the contours are drawn on it. Now based on the spatial localization and dimensions of the characters filtration of contours is performed. Finally, the character recognition is done by using the algorithm based on K-nearest neighbor after the region of interest filtering and De-skewing.

In the paper written by Panahi [5], the aim was to detect and recognize the Persian Number Plate System. The localization of the license plate was performed using Random Sampling Consensus (RANSAC) algorithm, which is used to form the output data from the best mathematical model. For the recognition of characters, the number of active pixels is calculated which represents the highest intensity values. These pixels are used for calculating the distance (both shortest and longest) from the walls. This feature is used to recognize the vehicle plate and Principal Component Analysis is used as a reduction method.

In [6], the images were recorded with the help of an IR camera and an ALPR system. The colour images were converted into grayscale to calculate the vertical edges and then a Sobel filter was applied for horizontal derivative and noise reduction. Then the segmentation of the image was carried out using Threshold filter. Thereafter, Morphological operations were performed. The area and aspect ratio of the part left out has been done with the help of contouring. Finally, Support Vector Machine (SVM) Algorithm has been used to train the data and enhance the output results.

In [7], Noise was reduced in the image by the process of Smoothening. The gray scale image was converted into binary image using Binarization and Dilation was used for noise removal. The surrounding masked image was created using minimum containing rectangle. The license plate candidate areas have been identified with the aspect ratio range allowable. Lastly with this procedure data was trained to observe the results.

In recent years, License Plate has been an engaging field for research. Various models and methods have been proposed on different methods like morphological extraction, colour segmentation, colour modeling, wavelet transform, neural network, and texture feature analysis of gray-scale images[8]. For Chinese number plate detection, extraction of number plates has been done using hue-saturation intensity and colour edge mapping-based transformation methods. The characters have been identified using OCR techniques [9]. Theoretically, it is believed to be 90% accurate but following the simulation method used in this paper, the accuracy is 65% were the noisy, blurred, and skewed image is not being taken into consideration. In Argentina, the number plates are matched using intelligent template matching.

In India, the number plate used for 4-Wheeler's is of the format "MP 04 CL 7704" where the first 2 characters are alphabets depicting the state of registration of the vehicle. The second 2 numerals are segregating the RTO districts and the cities numbered according to the capital of the state and so on. The third pair of characters portray the title of the record register book and the last numeric represents the entry number in the directory.

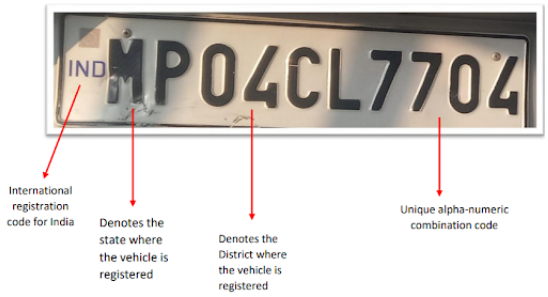


Fig. 2. Number Plate Description.

## III. Methodology

The aim of this project is to take the image as an input, perform various image processing operations on it and then finally detect the number plate data and display it in the form of text to the user. The various processes occurring at the back end is explained herewith and the output data can be saved in the form of a JSON/CSV file for data exchange. The process continues in the form of a pipeline and the various steps are-

### A. Detection

For starting the detection in the case of a video, first we need to extract frames from the video. After extracting the frames, for each frame, the Local Binary Pattern (LBP) algorithm is used which aims at finding the predefined plate of 'x' height and 'y' width. This is generally the most time taking and processing-intensive phase in the whole process. Local Binary Pattern- In this all the values of the 3*3 pixels are thresholded by the centre pixel. If the neighbouring value of the pixel is less than the centre pixel then it is given as 0 else the value is given as 1. All of them are combined to form a 8 bit value and this converted into the decimal is known as the LBP feature.

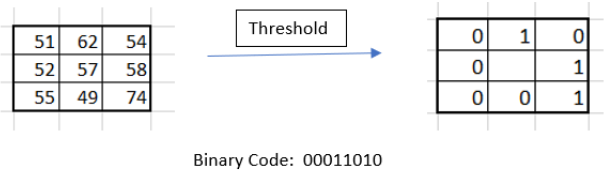


Fig. 3. Local Binary Pattern.

### B. Binarization

This will occur for all the plates which were achieved after the first step. Using the Wolf-Jolion method [10], this stage will form multiple binary plates for a single plate detected. It generally helps to detect all the characters properly in case of noise, improper sunlight, etc. Wolf-Jolion Method- This is done by taking into account the dilation and conditional erosion for neighbouring pixels. If the base pixel and the neighbouring pixel combined does not exceed the given threshold, then only dilation is performed. The conditional erosion is done on the basis of gray levels of the current and the neighbouring pixels [11].

### C. Character Analysis

The third step in this process aims at localizing all small-size characters which may be present in the plate region. After this, it aims to find large size characters in the region. If suppose no character is found, it will discard this plate and move on to the next.

### D. Edge Detection

The detection phase is supposed to detect a region that must be slightly bigger than the plate area so as to reduce the chances of missing any character. Now, this is the precision step in which we use the configurable weights method to determine the significant edges.

### E. De-Skew

This step focuses on converting the image into an ideal plate of standard height and width and also removing the rotation and skewness if any.

### F. Character Segmentation

This step tries to extract all the characters that may be present in the plate area. It also removes regions which aren't qualified to be under the category of characters and precisely mark the edges.

### G. Optical Character Recognition

This step aims at the electronic conversion of data in the image in form of text. Also, it suggests the characters with their respective confidence percentage enabling better results [12].

### H. Post Processing

This is a combination of all the characters which were earlier recognized by the OCR. Now it combines them into a complete license plate and then specifies the confidence percentage of each plate.

Thus, this way we can select the plate with the most confidence percentage at the end, and in the case of video, it detects all the plates which are present in the video.

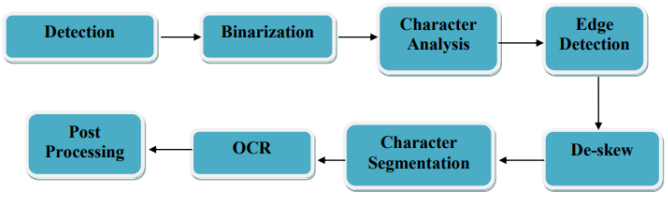


Fig. 4. Block Diagram.

## IV. Simulation and Output

The coding was done on Python and several classes were imported from Python to do the coding. The various libraries imported were-

1. openalpr- It is an open source code written in C++ and it has bindings in Python, Java, C etc. These bindings provide a way to extract and use the file or code into different software (generally by mapping one thing to the other) [13]. This software is used to- recognize license plates from camera streams, Analyze still images from command prompt, Integrate license plate recognition into your application.
2. argparse- This library makes it easy to write user-friendly command-line arguments.
3. Open-cv- This particular library in Python is used for performing computer vision problems, machine learning, and image processing operations.
4. Numpy- It is used for working with arrays. It has functions for working in the domain of linear algebra, Fourier transform, and matrices. It was used because lists in python were really slow.
5. JSON- This is used for the storage and exchange of data through the web. It is text, written with Javascript object notation [14].
6. Itertools-They are a core set of fast, memory-efficient tools that allow us to construct and return iterations.

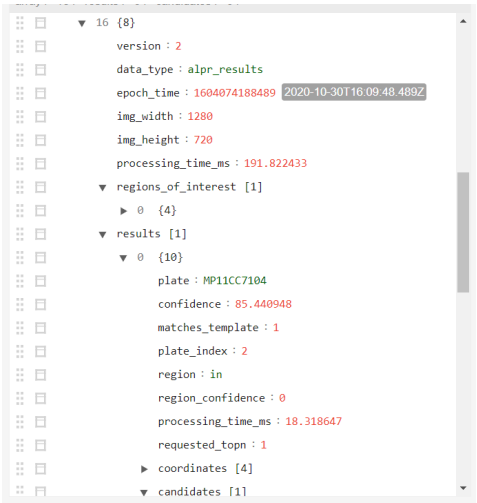


Fig. 5. JSON file.

The code attached can be used for correct number plate detection in case of an image and video for all the number plates in use in India. The size of the number plate and its font and shape are already used for training this module and hence, we can see that the output can be read via text.

The JSON file (Fig 5.) that is used for the transfer of data on the web. The complete data can be transferred from the web. In our code, the Json file will tell us the options of all the number of plates detected with a confidence of more than 65%. Moreover, all the coordinates of the number plate are specified and all the possible options are stated.

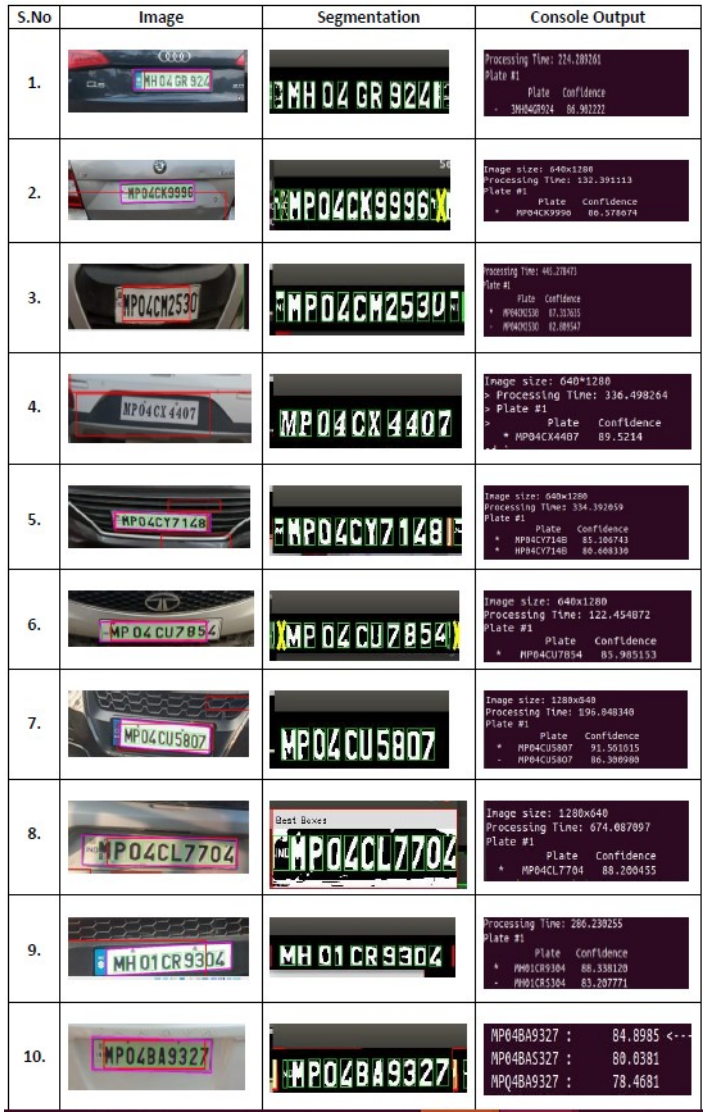


Fig. 6. Frame extraction and license reading from video.

The table attached (Fig 6.) is a compilation of the images taken from a video recorded from a moving car in a parking lot. The mobile used for recording this video was using 30 frames per second. The first row depicts the plate detection in the video followed by the recognition of the character using Segmentation. In the last row, the console results are attached which depicts the output parameters. Also, it has been noticed that in the figure above the number plate the blue rectangle depicts the number plate the system has detected. The recognition was done at every 10Th frame. This saved a lot of memory and also increased the speed and performance of the code. In comparison with the latest studies, it has been found that the efficiency of this code is approximately 88% which is at par with the existing methods.

The performance analysis (Fig 7.) for this project was calculated considering all the above images in the table. While the code simulation, the output consoles displays the Confidence Percentage of all the individual letters and the total Confidence Percentage is the mean of all the letter and numbers present in the number plate. Also, the time required for detection and recognition of the license plate is termed as processing Time and the graph is plotted considering both the parameters and hence the efficiency of the code is determined.

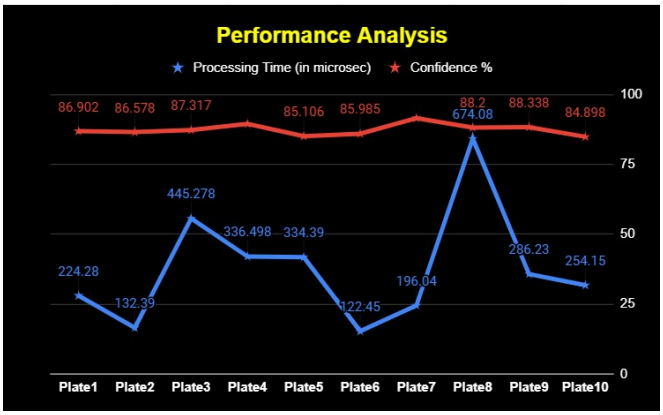


Fig. 7. Performance Analysis.

## V. Need for ALPR

1. Highway Monitoring- In India there is one death in every four minutes with most of them occurring due to over speeding. ANPR is employed to watch the vehicles' average speed and may identify the vehicles that exceed the regulation [15]. In this case, a fine ticket is often automatically generated by calculating the space between two cameras. This helps to take care of law and order which, in turn, can minimize the amount of road casualties.

2. Law Enforcement- It can be used for taking the criminals into custody and exonerating the innocent. Due to the automatic nature of this system it allows continuous tracking of the information from different sources and then it is coordinated and enhanced by a group of analytical tools to store the data in an organized, safe, feasible and convenient database.

3. Recovery of Stolen Vehicles and number plates- On an average around 2 Lakh cars are stolen every year. ALPR system can be used for continuous plate after plate detection against the active lists of stolen vehicles and vanished number plates [16], sending automatic alerts and notification instantaneously to an officer on duty in an immediate area who can suspect and monitor the situation.

4. Missing Person- In the US, this system is equipped with alerts, so that the officer on duty in the required area can be alerted as soon as possible and necessary actions could be taken.
5. Surveillance and Security- License plate reader data can help locate potential witnesses based on the last available location of the vehicle and can assist in validating an alibi for testimony.

## VI. Challenges of ALPR

1.Variability- The first step in the detection of the license plates is its recognition in the image, but the variable plate size in India makes it difficult to generalize the algorithm.
2.Divergent Font- At present, there are 50 styles of the font used in the Indian number plate system. Adding to the problem some number plates are even handwritten. So, to make an algorithm that would be able to detect all these types is very difficult [14].
3.Quality of Camera- The camera installed for the purpose of detection on roads is generally of low quality. This adds to the accuracy problem in the detection of the plates. These cameras have limited visual coverage and lead to an improved number of blurred images.
All the above challenges are written taking into account only the car number plates in the country. Two-wheeler and Three-wheeler have a double line number plate. At this point in time, we need a generalized and standardized number plate so as to automate our requirements.

## VII. Conclusion and Future Scope

While working on this project our software was tested with an IP camera which had the capability of video stream at 30fps FHD resolution 1080p and 10 frames were used per second keeping the time lapse at 4x, which is approximated to 0.12-second interval and the achieved number plate detection is 93% as per the software output and character recognition rate of 90% in worst condition including camera motion blurring, vehicle motion, and lighting condition. All the output achieved was performed on Python on Linux [18]. This system is currently able to detect the number of plates in images as well as videos with 30fps. In all the tests conducted during this experiment, it was observed that the current number plate detection fails while detecting non-standardised as two line number plates. Since standardization is difficult at this point of time for the vehicles already on road, we can train the existing model for maximum number of fonts and formats so that the confidence percentage of detection improves significantly. Moreover, we need permission to link the current system to the database of VAHAAN and SARTHI [19] so that we can link both of them. Also, we can connect all the cameras in the city as well as highways with this model to enable fast tracking of vehicles in case of crimes and traffic monitoring.

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