

# Automatic License Plate Recognition System using Histogram Graph Algorithm

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**Abstract**—Character recognition is one of the most important applications of image processing. In last couple of decades, the numbers of vehicles have been increasing day by day. With this increase, it is becoming difficult to keep track of each vehicle for the purpose of law enforcement and traffic management. Thus, we need that type of system, which is capable of providing appropriate solutions to the traffic issues and hence this Automatic License Plate Recognition System is developed using Histogram graph algorithm in MATLAB. In which image is captured from camera and converted into Gray scale image for preprocessing. After conversion, dilation process is applied on image. After dilation horizontal and vertical edge processing has been done and passed these histograms through low pass filter. After filtration, image is segmented and license plate is extracted. For detection each character separately from detected license plate smearing algorithm is used.

**Keywords**-ALPRS, LPF, Histogram Algorithm, Smearing Algorithm

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## I. INTRODUCTION

In last couple of decades, the number of vehicles has been increasing day by day. With this increase, it is becoming difficult to keep track of each vehicle for purpose of law enforcement and traffic management. These functions are implemented using Automatic License plate recognition system (ALPR System) using Histogram Graph Algorithm.

Automatic license plate recognition System (ALPRS) is a mass surveillance method that uses character recognition on images to read vehicle registration plates in the form of segmented characters. They can use existing closed-circuit television or road-rule enforcement cameras. They are used by various police forces and as a method of electronic toll collection on pay-per-use roads and cataloging the movements of traffic or individuals. ALPR can be used to process and stores the images captured by the cameras as well as the characters from the license plate

Moreover, the study on License Plate Recognition can be subdivided into two broad categories as:

- Active System
- Passive System

**Active system** use laser, radio frequency and other technologies for recognition of the vehicle. A barcode is placed on the car in laser systems. The vehicle has a tag in the radio frequency system. Into this tag, it is also possible to install some other information along with the license plate of the vehicle. The RFID reader is placed where we would like the vehicle to be identified. RFID reader can read the tag information of the vehicle from a certain distance. Thus, the recognition of the vehicle is provided. In India only high security license plates are applicable for this type of system.

**Passive systems**, the vehicle license plate image is processed for recognition. Therefore, license plate recognition depends on the image quality. Noises in the image plate make the recognition difficult. Therefore Low pass filter is used to remove noise from the image using image processing technology. Passive systems are more applicable in India compare to active system because mostly vehicles are using old non high security license plates like painted or sticker type characters. Passive system works great with High security license plates and non high security license plates.

"Passive approach is proposed in this paper, for the Indian license plate recognition and segmentation. The method mainly based on horizontal and vertical histogram and Low pass filter using image processing."

ALPRS plays an important role in numerous real-life applications, such as automatic toll collection, traffic law enforcement, parking lot access control, and road traffic monitoring. ALPRS recognizes a vehicle's license plate number from an image taken by a digital camera. Algorithm of ALPRS is fulfilled by the combination of many techniques of image processing such as preprocessing, license plate detection, and character recognition. ALPRS is also known as automatic vehicle identification, car plate recognition, automatic number plate recognition for cars.

## II. INDIAN LICENSE PLATE

In India the number, plate contains white background with black foreground color for private cars and for the commercial vehicle used yellow as background and black as foreground color. The number plate start with two digit letter "state code" followed by two digit numeral followed by single letter after those four consecutive digits as the below figure 1



Fig. 1 Indian High Security License Plate

From the figure 1, 1 indicates the Country code, 2 indicate the state code, and 3 indicate the district code, 4 indicate the type of vehicle and 5 indicates the actual registration number. Locating the number plate is very challenging work in the field of image processing.

The whole system mainly consists of two steps. First is to identify the position of the number plate from the particular vehicle and then segmentation of all the numbers and letters of the number plate.

### III. PROBLEM DEFINITION

License plate recognition of Car Vehicle is the most interesting and challenging research topic from past few years. Here, our aim is to locate the license plate from vehicle image and segment the number plate into individual characters and numbers.

### IV. PROPOSED METHOD

Number plate extraction is hotspot research area in the field of image processing. Many of automated system have been developed but each has its advantages and disadvantages. Here, histogram approach algorithm is used for license plate detection. It is assumed that this algorithm worked on images, which have been captured from fixed angle parallel to horizon in different luminance conditions. It is also assumed the vehicle is stationary and images are captured at fixed distance. The ALPR system that extracts a license plate number from a given image can be composed of five stages:

In first stage, an automated system is developed using MATLAB in which image of license plate will be captured from fixed distance camera. In second stage, captured image will be converting into Gray scale image for pre processing. After conversion, dilation process is applied on the third stage, where unwanted holes in image have filled. After dilation at fourth stage, horizontal and vertical edge processing has done and passed these histograms through a low pass filter. Low pass filter out unwanted regions or unwanted noise from image. After this filtering in fifth stage, image will segment, and region of interest (ROI) has extracted, and image is converted into binary form. Binary images are easily process as compared to colored images. After Binarization, each alphanumeric character on number plate is extracted and then recognized with the help of segmented images of alphanumeric characters. After this each alphanumeric

characters and whole license plate is extracted successfully. [2]

### V. VARIOUS CHALLENGES DURING RECOGNITION

The variations of the plate types or environments cause challenges in the detection and recognition of license plates [1].

They are summarized as follows.

#### A. Plate Variations

- 1) *Location*: Plates exist in different locations of an image.
- 2) *Quantity*: An image may contain no or many plates
- 3) *Size*: Plates may have different sizes due to the camera distance and the zoom factor.
- 4) *Color*: Plates may have various characters and background colors due to different plate types or capturing devices.
- 5) *Occlusion*: Plates may be obscured by dirt.
- 6) *Inclination*: Plates may be tilted
- 7) *Other*: addition to characters, a plate may contain frames and screws.

#### B. Environment Variations

a) *Illumination*: Input images may have different types of illumination, mainly due to environmental lighting and vehicle headlights.

b) *Background*: The image background may contain patterns similar to plates, such as numbers stamped on a vehicle, bumper with vertical patterns, and textured floors. Plate color is one of the features since some jurisdictions (i.e., countries, states, or provinces) have certain colors for their license plates. The rectangular shape of the license plate boundary is another feature that is used to extract the license plate. The color change between the characters and the license plate background, known as the texture, is used to extract the license plate region from the image. The existence of the characters can be used as a feature to identify the region of the license plate. Two or more features can be combined to identify the license plate. In the following, we categorize the existing license plate extraction methods based on the features they used. [1]

### VI. METHOLOGIES

Methologies describes the implementation of License Plate Detection algorithm using MATLAB. MATLAB is a very powerful software tool used to implement the tasks that require extensive computation.

It provides easy and quicker implementation of algorithms compared to C and C++. The key feature in MATLAB is that it contains a rich library functions for image processing and data analysis. This makes MATLAB an ideal tool for faster

implementation and verification of any algorithm before actually implementing it on a real hardware.

Sometimes, debugging of errors on actual hardware turns out to be a very painful task. MATLAB provides an easy approach for debugging and correction of errors in any algorithm. Other than this, MATLAB contains many features including workspace, plot, imread, imhist, imshow, etc. for data analysis and image processing, which makes it a better choice over other software languages like C and C++.

Considering the above advantages, the writer of this project initially implemented an algorithm for License Plate Detection using MATLAB. The algorithm initially used various inbuilt functions and implemented few user defined routines related to image processing. Once the algorithm was developed, it was verified with multiple input images containing car number plates. The input images contained number plates that were aligned horizontally as well as at some angle from horizontal axis. Once the algorithm was completely verified, the in-built functions of MATLAB were replaced by user defined functions. A block diagram showing the basic implementation of algorithm is shown below:

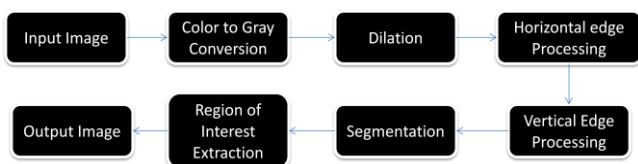


Fig.2 Block Diagram of ALPRS

### ALPR Algorithm using Histogram

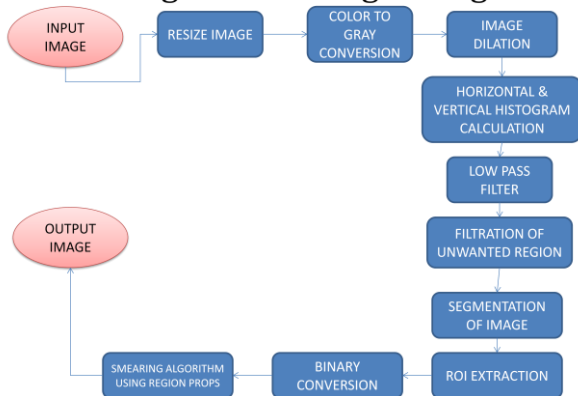


Fig.3 Full Algorithm of License plate recognition

The steps of implementing License Plate Detection algorithm in MATLAB are described below.

#### A. Image Acquisition/ input image

In this step image is captured from digital camera. Image should be taken from fixed angle parallel to horizon. Vehicle should be stationary. Input image is shown in figure 4 [2]



Fig.4 Input Acquired Image

#### B. Convert a Colored Image into Gray Image

The algorithm described here is independent of the type of colors in image and relies mainly on the gray level of an image for processing and extracting the required information. Color components like Red, Green and Blue value are not used throughout this algorithm. So, if the input image is a colored image represented by 3-dimensional array in MATLAB, it is converted to a 2-dimensional gray image before further processing. The sample of gray image is shown below: [2]



Fig.5 Gray Scale Image

### C. Image Dilation

Dilation is a process of improvising given image by filling holes in an image, sharpen the edges of objects in an image, and join the broken lines and increase the brightness of an image. Using dilation, the noise with-in an image can also be removed. By making the edges sharper, the difference of gray value between neighboring pixels at the edge of an object can be increased. This enhances the edge detection. In Number Plate Detection, the image of a car plate may not always contain the same brightness and shades. Therefore, the given image has to be converted from RGB to gray form. However, during this conversion, certain important parameters like difference in color, lighter edges of object, etc. may get lost. The process of dilation will help to nullify such losses [2].

### D. Horizontal and Vertical Edge processing of an Image

Histogram is a graph representing the values of a variable quantity over a given range. In this Number Plate Detection algorithm, the writer has used horizontal and vertical histogram, which represents the column-wise and row-wise histogram respectively. These histograms represent the sum of differences of gray values between neighboring pixels of an image, column-wise and row-wise. In the above step, first the horizontal histogram is calculated [4]. To find a horizontal histogram, the algorithm traverses through each column of an image. In each column, the algorithm starts with the second pixel from the top. The difference between second and first pixel is calculated. If the difference exceeds certain threshold, it is added to total sum of differences. Then, algorithm will move downwards to calculate the difference between the third and second pixels. So on, it moves until the end of a column and calculate the total sum of differences between neighboring pixels. At the end, an array containing the column-wise sum is created. The same process is carried out to find the vertical histogram. In this case, rows are processed instead of columns. [2]

### E. Passing Histogram through a low pass filter

Referring to the figures shown below, one can see that the histogram values changes drastically between consecutive columns and rows. Therefore, to prevent loss of important information in upcoming steps, it is advisable to smooth out such drastic changes in values of histogram. For the same, the histogram is passed through a low-pass digital filter. While performing this step, each histogram value is averaged out considering the values on it right-hand side and left-hand side. This step is performed on both the horizontal histogram as well as the vertical histogram. Below are the figures showing the histogram before passing through a low-pass digital filter and after passing through a low-pass digital filter.

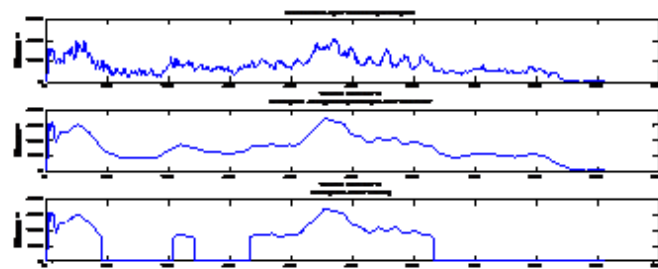


Fig. 6 Horizontal Edge Processing Histogram

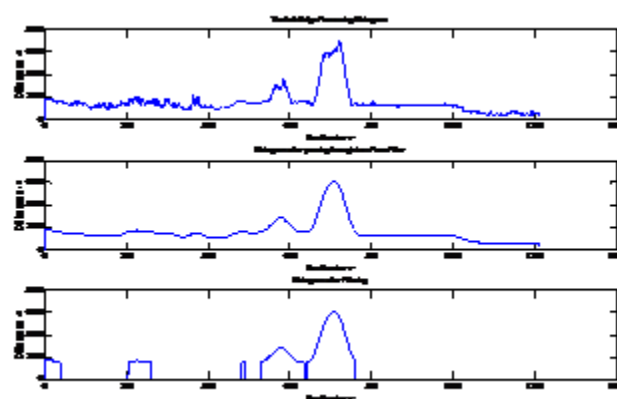


Fig.7 Vertical Edge Processing Histogram

### F. Filtering out unwanted regions in an image

Once the histograms are passed through a low-pass filter, a filter is applied to remove unwanted areas from an image. In this case, the unwanted areas are the rows and columns with low histogram values. A low histogram value indicates that the part of image contains very little variations among neighboring pixels. Since a region with a license plate contains a plain background with alphanumeric characters in it, the difference in the neighboring pixels, especially at the edges of characters and number plate, will be very high. This results in a high histogram value for such part of an image. [2][3]

Therefore, a region with probable license plate has a high horizontal and vertical histogram values. Areas with less value are thus not required anymore. Such areas are removed from an image by applying a dynamic threshold.

In this algorithm, the dynamic threshold is equal to the average value of a histogram. Both horizontal and vertical histograms are passed through a filter with this dynamic threshold. The output of this process is histogram showing regions having high probability of containing a number plate. The filtered histograms are shown in fig 6 and 7.

### G. Segmentation of an Image

The next step is to find all the regions in an image that has high probability of containing a license plate. Co-ordinates of all such probable regions are stored in an array. Image has been segmented [2]. In this step all the regions which have probability of license plate has been identified and coordinates of such probable region has been stored. The following figure



shows the segmented region. The segmented regions are shown in fig. 8 [2]



Fig.8 Segmented Images

#### H. Region of Interest of Extraction

The output of segmentation process is all the regions that have maximum probability of containing a license plate. Out of these regions, the one with the maximum histogram value is considered as the most probable candidate for number plate. All the regions are processed row-wise and column-wise to find a common region having maximum horizontal and vertical histogram value. This is the region having highest probability of containing a license plate. The image detected license plate is shown below in fig. 9:

This algorithm was verified using several input images having resolution varying from 680 \* 480 to 1600 \* 1200. But best output comes in the resolution of 1216\*912. The images contained vehicles of different colors and varying intensity of light. With all such images, the algorithm correctly recognized the number plate. This algorithm was also tried on images having number plate aligned at certain angle (approximately 8-10 degree) to horizontal axis. Even with such images, the number plates were detected successfully.

**Note:** *Best Resolution for properly detection of license plate, which I found during research work, is 1216\*912.*



Fig. 9 Successfully Detected License plate

#### I. Convert into Binary Image

In a binary image, each pixel assumes one of only two discrete values: 1 or 0. A binary image is stored as a logical array. An image consists of numeric values between 0 - 255. The numerical value of the picture is reduced to two values with binary level. Thus, an 8 - bit image is converted into 2 - bit format.

The threshold value must be determined for this conversion. If the pixel value in the image is greater than threshold value, then the pixel value is shown as "0"; and if the image pixel value is less than threshold value, the pixel value is shown as "1".

In this way the image is converted to the binary level. Image is converted into binary image from Gray scale. Intensity change value is calculated easily as compared to Gray scale and color image. Binary image is shown in figure 10.

Binary Converted Image



Fig.10 Binary Converted License Plate

#### J. Segmentation of Alphanumeric character of License Plate



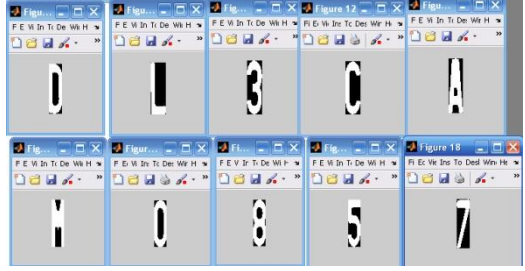
Character segmentation acts as bridge between the license plate localization and character recognition. Its main function is to segment the characters from the extracted license plate such that each character can be separated individually. Standardized license plates are important criteria for efficient segmentation.

Once license plate has localized we proceed for the segmentation part. A license plate as described above has high intensity variation regions.

This forms the basis for character segmentation. Sometimes it is observed that along with license number some text, graphics are present (like County code, symbol etc.), those has to be removed. There is another problem in segmenting license number are present, due to camera angle some time number plates tilt that is horizontally skewed. It has to be corrected also. [1]

So, Individual alphanumeric characters are segmented. Segmentation has been done by using smearing algorithms region props in both horizontal and vertical histogram. For filling space of inner part of each character the vertical smearing algorithm is applied and some threshold value is determined. Similarly, horizontal smearing algorithm is applied.

Each individual alphanumeric character is extracted by finding starting and ending points of character in horizontal direction. These characters are shown in figure 11

1) <i>Input image</i>	<i>Detected license plate</i>
	
	

Our Proposed method correctly located number plate and segmented the Number Plate into individual character in 18 images. Success rate depends on the condition number plate (e.g. damaged due to mud); light falls on the number plate area, size of images.

The algorithm was tested using different license plates having various background conditions, light condition and image quality. Some of the output results are shown below in table 1

The system correctly localized license plate with 96.66 % and correctly character segmentation of detected license plate with 93.33% when images are captured from fixed distance and captured from centre position. Car number plate should be according to 1989 and 2013 motor vehicle act.

TABLE I. RESULTS OF ALPRS

Total number of license plates	Correctly localized license plate	Correctly character segmentation of detected license plate	Efficiency of correctly localized license plate	Efficiency of correctly segmentation of detected license plate
30	29	28	96.66%	93.33%

VIII. CONCLUSION

Automatic License plate recognition is the most interesting and challenging research topic from past few years. It is shown that the number plates are in different shapes and sizes, and have different colors in different countries. In India the most common vehicle license plate used are white or yellow as a background, and black used as foreground color. In this paper, I proposed a system to localize license plate mainly for the vehicles in India and segmented the numbers as to identify each number separately.

The system works with more than 90% accuracy when images are captured from fixed distance and captured from the centre position. Vehicle should be stationary and image is captured from fixed angle parallel to horizon. Car number plate should be according to 1989 and 2013 motor vehicle act.

IX. FUTURE WORK

- The effect of ambient light on number plate reduces our accuracy when we apply our method, so there is some scope to improvement here.
- Camera angle of histogram approach is currently working up to 8 to 10 degrees. But the angle can also be enhanced in order to get more appropriate results.
- In such cases, where license plate color and body color of a vehicle are nearly same, sometime it will difficult to detection, So there is a scope to improve this method.
- This method is best suitable for stationary vehicle, but for moving cars or vehicles this method will not be applicable, therefore this problem can also be



Fig.11 Recognized characters from License plate

VII. EXPERIMENTS & RESULTS

We have run our proposed method on laptop computer with core i3 processor 2.30 GHz with 2 GB of RAM under MATLAB R2010a environment.

Several vehicle images are captured using 1.3 mega pixel camera as well as 8 mega pixel cameras. In the experiments, we test our proposed method on the 30 different type car images to identify the location accurately.

overcome in near future in order to get more appropriate consequences.

- There are still some further researches to do. For example, it can work with some other kind of license plate, such as two-row plate. But segmentation output is not good. This problem will be solved in the further work.

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