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# Indian License Plate Recognition – A Review

***Varsha K. Hadke, Rutuja K. Deode, Sonali P. Shejwal***

Department of E&Tc, TSSM's BSCOER, Narhe, University of Pune, India

**E-mail:** varshahadke@gmail.com, rutuja.k.deode@gmail.com, sonali.shejwal@gmail.com

***Abstract***

*Automatic Number Plate Recognition (ANPR) is a real time embedded system which identifies the characters directly from the image of the license plate. Due to the different types of number plates being used, the requirements of an automatic number plate recognition system are different for each country. License plate detection is an important stage in vehicle license plate recognition for intelligent transport systems. This paper presents approaches for license plate detection for Indian license plates. The basic step of license plate detection is localization of number plate. An extensive experimentation has been carried out for various types of Indian license plate to verify and authenticate the results. The aim of this paper is to study and evaluates accuracy at each stage of license plate detection algorithms.*

***Keywords***: *License plate localization, morphological operation, character segmentation, license plate recognition*

## INTRODUCTION

Detection, segmentation and recognition are the steps involved in ANPR. License Plate Recognition (LPR) is an important function in intelligent traffic control systems. LPR is an image processing technology used to identify vehicles by their license plates. LPR system plays an important role in many applications like electronic payment system (toll payment and parking fee payment), to find stolen cars, traffic surveillance [1, 2].

License plate numbers area unit being employed to unambiguously determine a vehicle. As an example in parking, range plates area unit accustomed calculate period of the parking. Once a vehicle enters the gate, registration number plate is mechanically recognized and holds on in info. Once a vehicle later leaves the car park through the gate, registration number plate is recognized once more and compared with the first-one hold on within the info. The time distinction is employed for calculative the parking fee. The LPR system is convenient and automatic. Additionally, it is value economical as a result of solely less human resources area unit required.

LPR system for Indian license plate is difficult compared to the foreign license plate as there are no standards followed for the aspect ratio (length to width ratio) of license plate. Figure 1(a) shows the foreign license plates and Figure 1(b) shows the Indian license plate.


***Fig. 1:*** *(a) Foreign License Plates (b) Indian License Plates.*

Most of the LPR systems are based on image processing techniques and character recognition systems. Each LPR system consists of three basic sections namely, License Plate Detection (LPD), segmentation and recognition. This paper presents for detecting and segmenting the characters by the license plate from a gray scale image. First a pre-processing is used, consisting median filter for removing noise

and morphological dilation, erosion for edge enhancement of image. Figure 2 shows the block diagram of LPR system. Images are collected from the parking lots and roadside.

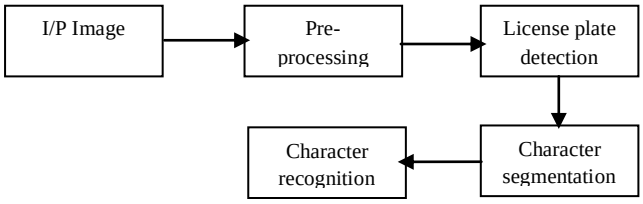


***Fig. 2:*** *Block Diagram of LPR System.*

## LITERATURE REVIEW

There are several commercial LPR systems. Table 1 highlights performance of the LPR systems presented in the literature issues such as detection rate and recognition rate are featured. Some of those algorithms are computationally intensive.

***Table 1:*** *Performance of the LPR Systems in the Literature.*

| **Ref No.** | **Method** | **Detection Rate (%)** | **Method** | **Recognition Rate (%)** |
|---|---|---|---|---|
| [12] | Connected Component Analysis | 100 | PNN | 92.5 |
| [13] | Sliding Concentric Window (SCW) | 96.5 | PNN | 89.1 |
| [15] | Vertical Edge Detection | 92.5 | Template Matching | 91.1 |
| [10] | Search Window Method | 96.7 | Artificial Neural Network | 97.1 |
| [11] | Edge Analysis | 95.9 | Artificial Neural Network | 92.3 |
| [3] | Fuzzy Discipline | 97.9 | Neural Network | 95.6 |
| [8] | Improved Barnsen Algorithm | 97..16 | SVM | 97.8 |
| [14] | Hough Transform Counter Algorithm | 98.76 | HiddenMarkov Model | 92.85 |

## PREPROCESSING TECHNIQUES

### Input Image

The image is captured by optical (digital) camera. The images stored in JPEG format.

### Gray Scale Conversion

The red, green and blue components are separated from the 24-bit color value of each pixel to calculate the 8-bit gray value using the formula:

$$gray = 0.59 * R + 0.30 * G + 0.11 * B \quad (1)$$

### Median Filtering

It is used to replace the gray value of each pixel with the median of the gray values of its neighbor. It helps to remove the salt-and-pepper noise.

### Image Enhancement

An image enhancement techniques consists process of sharpening the edges of image, contrast manipulation, reducing noise. A new nonlinear spatial domain edge enhancement method based on gray tone morphological operator is used. The method employs a morphological gradient as it can effectively preserve the details feature of the image [4].

***Fig. 3:*** *a) RGB Image b) Gray Scale c) Edge Enhancement Image.*

## LICENSE PLATE DETECTION

### Morphological Technique

The basic step in detection of license plate is to estimate the plate size. In general the license plates are rectangular plate. In paper, morphology technique is used to detect the license plate [2].

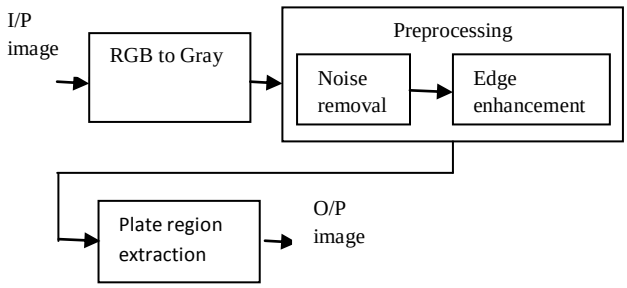


***Fig. 4:*** *Block Diagram of LPD.*

**Binarization**

As binary method with global threshold cannot always generate satisfactory results in such case; the adaptive local binary method is used [3].

**Extraction of License Plate**

After the license plate is processed with the adaptive local binary method, the system steps into license plate detection. Morphological erosion operation with the line Structuring Element (SE) is performed on the binary image. Erosion is a morphological transformation that can be obtained by dilating the complement of the black pixels and the taking the complement of the resulting point set. Let B denote an SE which is a line and length is 50. The erosion of the image A by SE B is the binary image z defined as follows:

$$A \ominus B = \{z|(B)_z \subseteq A\} \quad (2)$$

In erosion, every object pixel that is touching a background pixel is changed into a background pixel. It makes the object smaller. By subtracting the original image from the eroded image, the number plate would be extracted as there as a large difference between the images. Reconstruction is a morphological transformation involving two images and a structuring element.The marker is the starting point for the transformation. A hole may be defined as a background region surrounded by a connected border of

foreground pixels. Figure 5 a), shows the result of binary, 5 b) filling all holes of image and 5 c) final extracted license plate.


***Fig. 5:*** *a) Binary Image b) Filling Holes c) Extracted LP.*

**Histogram Based Approach**

Figure 6 shows the block diagram of LPD using histogram based approach.

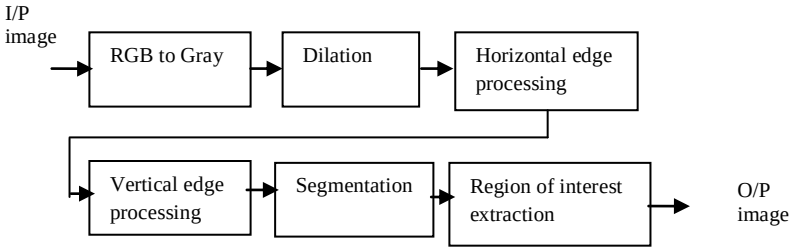


***Fig. 6:*** *Block Diagram of LPD using Histogram based Approach.*

**RGB to Gray**

Color component 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 original input image and gray image are as shown in Figure 3 a) and 3 b).

**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 within an image can also be removed.

**Horizontal and Vertical Edge Processing**

Histogram is a graph representing the values of a variable quantity over a given range.

The LPD algorithm uses horizontal and vertical histogram, which represents the column-wise row-wise histogram. These histograms represent the sum of differences of gray values between neighboring pixels of an image, column-wise and row-wise [4, 5].

**Passing Histogram through a Low Pass Digital Filter**

Figure 7 a) and 7 b) shows that the histogram values changes drastically between consecutive rows and columns. Therefore, to prevent loss of important information in upcoming step, it is advisable to smooth out such drastic changes in values of histogram. Both the horizontal histograms as well as vertical histogram are passed through a low pass digital filter. This step is performed on both. Figure 7 a) and 7 b) show the histogram before passing through a low pass digital filter and after passing through a low pass digital filter.

**Filtering out Unwanted Regions in an Image**

Once the histograms area unit versed an occasional pass digital filter, a filter is applied with dynamic threshold to get rid of unwanted areas from a picture. During this case, the unwanted area unit as area unit the rows and columns with low bar graph values are removed. This leads to a high bar graph price for such a part of a picture. Therefore, a section with probable registration number plate contains a high horizontal and vertical bar graph values are far away from a picture by applying dynamic threshold.

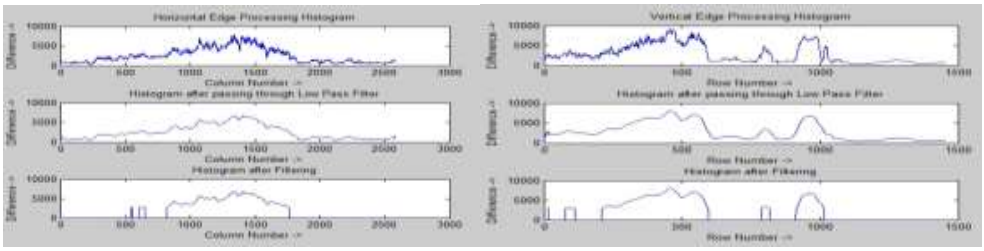


***Fig. 7:*** *a) Horizontal Edge Processing Histogram b) Vertical Edge Processing Histogram.*

**Segmentation**

In this step is to find the entire region in an image that has high probability of containing a license plate. Co-ordinates of all such probable regions are stored in an array.

**Region of Interest Extraction**

The output of segmentation process is all the regions that have maximum probability of containing license plate. Out of these regions, the one with the maximum histogram value is considered as the most probable candidate for license plate [6].


***Fig. 8:*** *a) Segmented Image b) Detected LP.*

**Mathematical Morphology**

Morphological image processing is a type of processing in which the spatial form or structures of objects within an image are modified. Two algorithms dilation and erosion are used. These algorithms are also called morphological operators.This mathematical morphology contained more mathematical computations.

**Morphological Dilation and Erosion**

The dilationprocess uses a mask, or a structuring element, B, which can have different size and pattern for different tasks. The algorithm fills a pixel if the mask cantered over that pixel covers one or more set pixels in the input image A.

$$A \oplus B = \{z | (\hat{B})_z \cap A \neq \varnothing\} \forall_z \in E \quad (3)$$

where, E is a euclidean space or an entire grid and A is a binary image in E.

The erosion is the opposite of the dilation. The result is that areas connected only by a thin line of pixels are disconnected, that small sets of pixels are erased and the areas of marked pixels shrink [7, 8].

$$A \ominus B = \{z|(\hat{B})_z \cap A \neq \varnothing\} \forall_z \in E \quad (4)$$

**Morphological Opening and Closing**

The process to perform first dilation and then erosion with the same mask is called a morphological closing operation, the reverse is called opening operation. Morphological opening removes completely regions of an object that cannot contain the structuring element; smoothed object contours, breaks thin connections and removes thin protrusions.

$$A \circ B = (A \ominus B) \oplus B \quad (5)$$

$$A \cdot B = (A \oplus B) \ominus B \quad (6)$$

**Detection of Discontinuities**

Discontinuities are detected by using first and second order derivatives. The first and second order derivative of choice in image processing is the Gradient and the Laplacian respectively.

$$R = w_1 z_1 + w_2 z_2 + \cdots + w_9 z_9 = \sum_{i=1}^{9} W_i Z_i \quad (7)$$

**Gradient Operator**

The gradient of a 2-D function1) $f$ is defined as the vector:

$$\nabla f = \begin{bmatrix} G_x \\ G_y \end{bmatrix} = \begin{bmatrix} \frac{\partial f}{\partial_x} \\ \frac{\partial f}{\partial_y} \end{bmatrix} \quad (8)$$

**Laplacian Operator**

The Laplacian of a 2-D function1) $f$ is formed from second-order derivatives, as follows:

$$\nabla^2 f(x,y) = \frac{\partial^2 f(x,y)}{\partial_x^2} + \frac{\partial^2 f(x,y)}{\partial_y^2} \quad (9)$$

The basic requirement in the definition of digital Laplacian is that the coefficients associated with the central pixel are positive and coefficients associated with the external pixels are negative. Because the Laplacian is a derivative, the sum of the coefficients must be zero. Commonly is applies digitally in the

form of two convolution kernels as shown in Figure 9.

| | | |
|---|---|---|
| 0 | -1 | 0 |
| -1 | 4 | -1 |
| 0 | -1 | 0 |

| | | |
|---|---|---|
| -1 | -1 | -1 |
| -1 | 8 | -1 |
| -1 | -1 | -1 |

***Fig. 9:*** *Masks of Laplacian.*

$$\nabla^2 f = 4z_5 - (z_2 + z_4 + z_6 + z_8) \quad (10)$$

$$g(m,n) = e^{\frac{m^2+n^2}{2\sigma^2}} \quad (12)$$

$$\nabla^2 f = 8z_5 - (z_1 + z_2 + z_3 + z_4 + z_5 + z_6 + z_7 + z_8) \quad (11)$$

The Laplacian helps us to find the location of the edges using the zero-crossing property and also plays the role of detecting whether a pixel is light or dark side of an edge

**Canny Edge Detector**

Canny algorithm is very efficient and gives a step in edge detection, detects significant edges.

The image is smoothed a Gaussian filter, $g(m,n)$, with a specified standard deviation, $\sigma$, to reduce noise.

The local gradient and edge direction are computed at each point of image.

$$g(m,n) = \sqrt{G_x^2(m,n) + G_y^2(m,n)} \quad (13)$$

$$\alpha(m,n) = \tan^{-1}\left(\frac{G_x(m,n)}{G_y(m,n)}\right) \quad (14)$$

An edge point is defined to be a point whose strength is locally maximum in the direction of the gradient. Finally, the algorithm performs edge linking by incorporating the weakpixels that are 8-connected to the strong pixels.

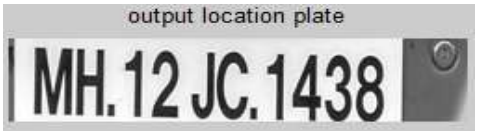


***Fig.10:*** *Output Location Plate.*

## CHARACTER SEGMENTATION AND RECOGNITION

The character segmentation process is act as a bridge between the license plate extraction and character recognition. There are several methods for character segmentation. Such as, template matching line scanning, maximally stable extreme region connected component analysis (CCA) and thresholding [9]. For the recognition of segmented character, numerous algorithms use statistical classifiers, computational intelligence architectures and Template matching.The template matching technique is a suitable technique for the recognition of single-font, not-rotated, and fixed-size characters. It is a technique to identify the segmented character by finding the small part in image that match with the template this method need character image as their template to store in the database. Template matching requires a library of a wide variation of character fonts and thicknesses [10].

## EXPERIMENTAL RESULTS

Success rate is computed for 30 different Indian license plates using MATLAB2012b. The Table 2 shows the detection rate of each license plate detection methods.

***Table 2:*** *Performance of Three Algorithms on the basis of Character Detection.*

| Sr. No. | Methods | Detection Rate | Recognition Rate |
|---|---|---|---|
| 1 | Morphological | 93.33% | 90.% |
| 2 | Histogram Based | 96.66% | - |
| 3 | Mathematical Morphology | 100% | 83.33% |

## CONCLUSION

This paper presented a performance of three different License plate detectiontechniques. Detection rate and Recognition ratehave been calculated for all three methods. Mathematical morphology is found to be best in terms of detection rate (100%) and Morphological methodin terms of recognition rate (90%).

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