Vehicle Number Plate Detection and Recognition using Bounding Box Method

Mahesh Babu K
Dept. of Electronics & Communication
National Institute of Technology
Warangal-506004, India
kbabu2@student.nitw.ac.in

M V Raghunadh
Dept. of Electronics & Communication
National Institute of Technology
Warangal-506004, India
raghunadhmv@gmail.com

Abstract— The use of vehicles in our life is increasing exponentially day by day and as increasing vehicles are violating the traffic rules, theft of vehicles, entering in restricted areas, high number of accidents lead to increase in the crime rates linearly. For any vehicle to be recognized, vehicle license plate detection will play a major significant role in this active world. For finding vehicles commonly used in field of security and safety system, LPDR plays a significant role and we need to recognize vehicles registration number at a certain distance. This paper has four major steps as follows: Pre-processing of captured image, Extracting license number plate region, Segmentation and Character Recognition of license plate. In pre-processing the desired vehicle image is taken through the digital camera, brightness of image is adjusted, noise removal using filters and image is converted to gray scale. Exactions of license plate region consist of finding the edges in the image where exact location of licenses plate is located and crop it into rectangular frame. Segmentation plays a vital role in vehicle licenses plate recognition; the legibility of character recognition completely relies on the segmentation done. The approach which we have used is simple but appropriate. First we segmented all characters in the image (LP) using Bounding box method. Finally, recognition of each character is done. The template matching method is used for recognition each character in the vehicle license plate.

Keywords **— Licenses Plate Detection, Recognition, Segmentation, Noise removal, Bounding Box and filter**.

I. INTRODUCTION

In present day scenario vehicles play a vital role in transportation system and the use of vehicles is also increasing exponentially due to the population growth and their needs. License Number plate recognition is an image processing technology that recognizes the authorized vehicles by tracking their license plate without direct human interference. License number plate detection can be used in many applications such as traffic control, speed control, identifying the stolen cars, near toll gates, security application etc.

In India, basically two types of number plates are used: - 1) white background with black letters on plate. 2) Yellow background with black letters on plate. Indian License number plate recognition is laborious when compared to foreign license plate because Indian license plate does not follow any standard aspects ratio.

Over past few years, researchers have developed many techniques to detect vehicle license plate but still it remains a challenging task. Vehicle identification approach can be classified into 4 main steps such as pre-processing, License plate region extraction, characters segmentation and each character recognition in the licensed number plate. Every step has its own importance in order to recognize the vehicle, when license plate images are tilted and characters are not visible or broken which makes the segmentation of each character and recognition very tedious. In this paper, first various vehicle images have been acquired through camera, then input color image is converted to gray scale image, brightness adjustment, contrast up to optimum values and removing noise using median filtering is done in order to get better quality image. Finding exact location of license plate is the most important processing step in vehicle detection system, because all others steps depend on exact extraction of license plate region. Exact location of license plate region is masked and extracted from image. Segmentation of each character is done for extracted region. Segmentation is a process of subdividing a digital image into the consequent parts. The main purpose of image subdividing into consequent parts or objects present in the image is that we sought for the analysis extract some meaningful information. Segmentation is the crucial step in recognizing the vehicle license plate. After segmentation, character recognition is done. Each segmented character is compared with template matching, if characters are matched then it will display the output in text.

This paper is arranged as follows: in Section II Literature review. In Section III Methodology is described. Section IV discusses about Simulation results and concludes in Section V.

II. LITERATURE REVIEW

Vehicle number plate detection and recognition is very important in security transport system field. Researchers had used different techniques and methods to detect and recognition of vehicle number plate, by citing various journals, transactions, books and conference papers, information is collected in the relevant field from previous works. There are four fundamental processing steps [1] [2]: enhancement of a

digital image, license number plate region detection in the image, character segmentation and characters recognition. In first step enhancement of an image was done. Removal of noise, brightness and contrast adjustment were made and then converted the input image into grayscale [1] [2] [3] and then we got the binarized image. Sometimes first converting image to grayscale and later removing of noise was done. Locating the exact plate region with the help of Hough lines is done using [1] [4] Hough transform. Segmenting each character in the license plate region, finding edges in the image. Two Morphological [7] [9] operations are used such as area opening and erosion in order to remove shadow, dirt, screws...etc. In [4] Ant's colony optimization (ACO) algorithm is used for segmentation in order to give good performance in number plate detection. It creates a pherome matrix algorithm, which gives detail information about each pixel point at edges, with the movement of a numbers of ant's local variation of the image intensity driven. Segmentation pixel based algorithm [5] is used for alphanumeric characters in the license number plate. In [6][4] vehicle number plate recognition is done for Malaysia vehicles, combination of image processing technique and optical character recognition method is used to obtain exact results for recognition. To detect the vehicle number plate region in an image [8] discussed two techniques, boundary feature and color feature to possess better performance than single feature technique. The algorithm for number plate localization especially for Indian vehicles, [9] proposed a simple and good performance algorithm which uses Top Hat Transformation. By using suppression of image background and removal of non-uniform illumination, efficiently worked in Indian environment. The cross correlation comparison between template character and simulated data by using Normalized template cross correlation match is presented in [10].

III. METHODOLOGY

The general block diagram for vehicle number plate detection and recognition system as shown in figure (1). There are four main steps and each step has their own vital role in number plate detection and recognition.

a. Pre-processing
b. Localization of license number plate region
c. Character Segmentation of license number plate
d. Character Recognition of license number plate

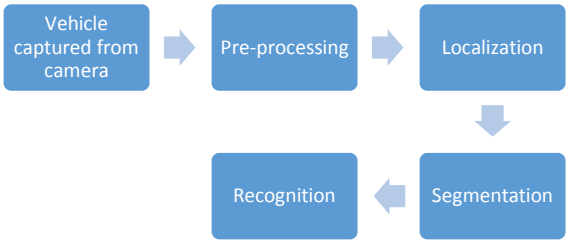


Figure 1. General System Block Diagram

A. *Pre-Processing*

The Video or image of the vehicle is captured using camera of 13-megapixel resolution, whose vehicle number plate to be identified. If it was a video, converted into frames and selecting the frame depending video length and time in which frame vehicle is clear. Selecting of frame can be done using equation (1).

$$F=N*t/T \text{..... (1)}$$

Where F is the required frame or image, N number of frames, t time required and T is total time of video or length of video. The size of image used 120 x 160 or 1200 x 1600. First we need to convert the RGB image to Gray-scale image using equation (2) it will be easier to number plate extraction.

$$I = 0.114 *R+0.587*G+0.299*B \text{..... (2)}$$

To enhance the number plate recognition further, we use median filter to eliminate noises but it not only eliminates noise it concentrates on high frequency also. So it is more important in edge detection in an image, generally the number plates are in rectangular shape, so we need to detect the edges of the rectangular plate.

B. *Localization of the License Plate*

The main aim of this work is to identify the exact location of the license plate region in the digital image, the result must be a sub-image that contains only the license number plate. This can be achieved in two steps.

a. Determining the exact location of the license plate.
b. Locating a large bounding rectangle over the license plate.

The advantage of vehicle license number plates lies in having high contrast areas in an image black-and-yellow or black-and-white. In license number plate the alphanumeric characters are placed vertically in same line and vary in intensity horizontally. The alphanumeric characters and background in an image have a sharp variation in intensity, it will help for detecting the license number plate region. Sobel edge filter is used to identify the boundaries in an image. It identifies the edges when there is a sharp variation in intensity gradient in an image. Edges having very huge intensity contrast in an images, when a sudden variation occurs in intensity from one pixel to other pixel then edges are detected. Identifying the edges in number plate plays a vital role, it reduces the data and helps in removing the unnecessary information. At the same time, it also preserves the structural properties of an image.

Calculating gradient of the image for each pixel position in the image.

$$\Delta f = mag(\Delta f) = [G_x + G_y]^{\frac{1}{2}}$$

Where Δf represents magnitude vector, G_x for x direction and G_y for y direction.

Sobel Mask (3 x 3)

For x direction

$$\begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$$

For y direction

$$\begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

C. Character Segmentation of the number plate

After extracting number plate region, it scans for the connected objects in an image. Once the connected components are identified it will assign a special label to it. Each connected components have different labels in order to differentiate each other. The process of character segmentation, it will divide the number plate into different sub images, each sub image prefers one character. Segmentation is the important part in the vehicle license plate detection system because the character recognition completely depends on segmentation only. If segmentation is not done properly recognition will not be accurate. So, to solve this problem bounding box method has been used to achieve better results. In bounding box method, it encloses the labelled region with rectangular box completely. When the specified the connected region is labelled, it determines the corner co-ordinates of bounding box and also its height and width. It always specifies the boundaries of connected objects. In this paper filled bounding boxes are used which completely relay on covering the corresponding connected objects and also measures the image region properties. Each alphanumeric characters are covered with bounding boxes which are present on number plate which as shown in figure (9) and then recognition of number plate is done.

D. Character Recognition of the number plate

After segmenting, the next step is character recognition. The main aim of recognition is to employ conversion of image text to characters. Each characters from the license plate is compared completely against with the alphanumeric database which uses template matching. In matching process, the obtained sub-image will be compared against the template images in all possible position in the database and it calculates all numerical index for each characters in order to get better matching from template images. Template matching is the process of finding the exact location of sub-image inside the template images. It will compare both image pixel by pixel match until the corresponding exact matching is found. To find the similarity between the objects and template images normalized cross correlation is used.

$$N_{CC}(I_1, I_2) = \frac{1}{N\sigma_1\sigma_2}\sum_{x,y}(I_1(x,y) - \sim I_1) * (I_2(x,y) - \sim I_2)$$

where N_{CC} is Normalized Cross Correlation, I_1& I_2 are Template image and Input image respectively.
If the obtained value of normalized cross correlation is greater than the preferred threshold, then it is updated to the new one. The match score is generated on every template image, if it scores more values than the previous threshold values it will update with the higher one threshold for the better match. The best matched characters are recovered and the output is stored in a text file. The size of images in template is 42 x 42 pixels which as shown in figure (2).

Figure 2. Templates Used for Template Matching

IV. SIMUULATION RESULTS

Experiment is conducted on Matrix Laboratory, (MATLAB) R2014b simulation used for image analysis.

Algorithm

Step1. Image Acquisition-Captured the image through digital camera and given as input to process.

Step2. Converting into Color image to gray scale image using equation 2.

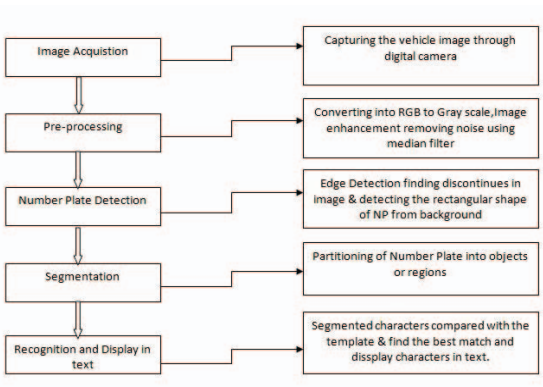
Step 3. Image Enhancement- Removing of noise using median filter.

Step 4. Plate extraction- Find rows and columns values of the image to identify the region. Sobel edge detector is used to find the boundaries, then dilated and removed connected objects which as show in figure.6, 7 and 8 respectively. Finally, we extracted the desired region.

Step 5. Character Segmentation- Bounding box method is used to map each character, for each letter it will be mapped a box and displayed each character into a single image which as shown in figure.10 and 11 respectively.

Step 6. Character Recognition- After Segmenting each characters are compared with the template. If each character matches pixel by pixel corresponding image is found, it will be displayed into text which as in figure 12.

Flow Chart



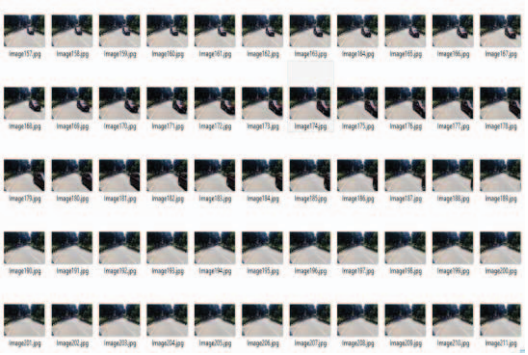


Figure 3. Frames.

Figure 4. Captured image or Selected image.

Figure 5. Gray Scale image

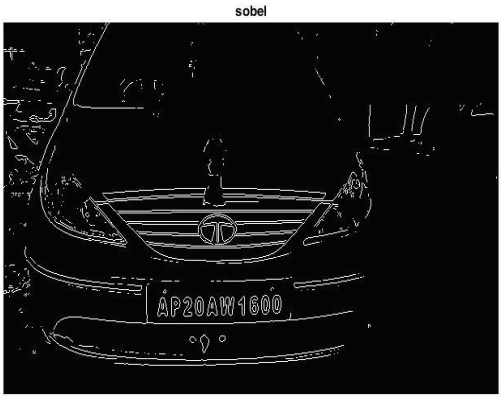


Figure 6. Binary gradient image with sobel edge detector.

Figure 7. Dilated image

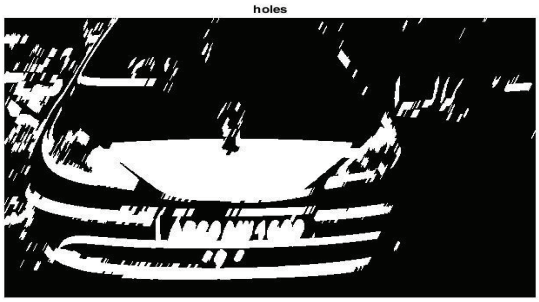


Figure 8. Removed connected object image.

Figure 9. Extraction of number plate area.

Figure 9. Number Plate with bounding box image.

Figure 10. Image of each character.

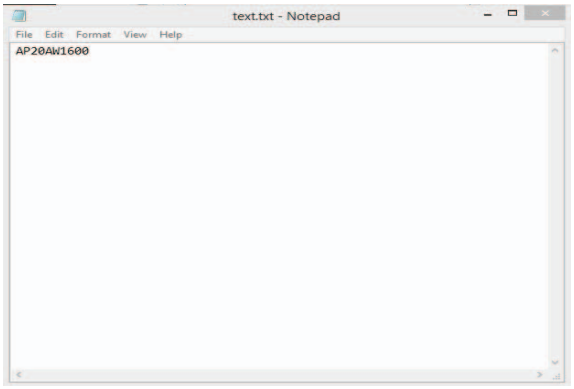


Figure 11. Image of results

TABLE.1. Results of Test

Units	Number of Accuracy	Percentage of Accuracy
Extraction	42/45	93.33%
Segmentation	39/45	86.67%
Recognition	42/45	93.33%

V. CONCLUSION

In the proposed system, we have designed for the detection of licensed number plate vehicles. First we select the image, remove noise and find the interested area of image, then the license plate location is extracted using edge detection then segmentation of each characters individually. At-last the template matching method is used with the use of correlation for recognition of each characters in the number plate.

Some difficulties as follows

1. Blur Images.
2. Broken Number Plate
3. Similarities between some characters such as O and D; 5 and S; 8 and B, E; O and 0...etc.

REFERENCES

[1] Prabhakar. P, & Anupama. P, "A novel design for vehicle license plate detection and recognition", IEEE 2nd International Conference on Current Trends in Engineering and Technology (ICCTET), 2014, pp. 7-12.

[2] Prabhakar, Priyanka, and P. Anupama. "A novel design for vehicle license plate detection and recognition." IEEE 2nd International Conference on Current Trends in Engineering and Technology (ICCTET), 2014, pp. 7-12 .

[3] Arulmozhi. K., Perumal. S. A, Deepak. T. T, & Nallaperumal. K, "A Centroid based Hough Transformation for Indian license plate skew detection and correction of IR and color images", IEEE International Conference on Computational Intelligence & Computing Research (ICCIC), 2012, pp. 1-4.

[4] Dewan, S., Bajaj, S., & Prakash, S, "Using Ant's Colony Algorithm for improved segmentation for number plate recognition", IEEE/ACIS 14th International Conference on Computer and Information Science (ICIS), 2015, June, pp. 313-318.

[5] Roy. A, & Ghoshal. D. P, " Number Plate Recognition for use in different countries using an improved segmentation", IEEE 2nd National Conference on Emerging Trends and Applications in Computer Science (NCETACS), 2011, March pp. 1-5.

[6] Sulaiman. N, Jalani. S. N. H. M, Mustafa. M, & Hawari. K, (2013, August). "Development of automatic vehicle plate detection system",IEEE 3rd International Conference on System Engineering and Technology (ICSET), 2014, July, pp. 130-135.

[7] Rabee. A, & Barhumi. I, "License plate detection and recognition in complex scenes using mathematical morphology and support vector machines", IEEE International Conference on Systems, Signals and Image Processing (IWSSIP), 2014, May, pp. 59-62.

[8] Veena. M. N, & Vasudev. T, "Localization of vehicle number plate based on watershed transform and visualization technique", IEEE International Conference on Contemporary Computing and Informatics (IC3I), 2014, pp. 1175-1181.

[9] Arulmozhi. K, Perumal. S. A, Sanooj. P, & Nallaperumal. K, "Application of Top Hat Transform technique on Indian license plate image localization". In Computational Intelligence & Computing Research (ICCIC), 2012 IEEE International Conference on 2012, December, pp. 1-4.

[10] Karwal .H, & Girdhar. A, "Vehicle Number Plate Detection System for Indian Vehicles", IEEE International Conference on Computational Intelligence & Communication Technology (CICT), 2015,February, pp. 8-12.

[11] Gonzales.R.C, R. E. Woods, and S.L.Eddins,"Digital Image Processing Using Matlab – Pearson", 2000.