

Vehicular Number Plate Recognition Using Edge Detection and Characteristic Analysis of National Number Plates

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ABSTRACT:

In this work, we propose a framework that uses a camera installed at roadside to detect the vehicle number plate. A typical video component requires several adjustments after image has been stored such as enhancement of image, localization of number plate, separating each character and recognition of each character. In this work we extract the vehicle number plate from our image and then recognize it based on the characteristics of number plates in different countries. We use Sobel edge detection for plate localization, template matching and fuzzy logic for recognition. We make use of the characteristics of the vehicle number sequences to further enhance performance. Vehicle number plate recognition can be used to decrease human effort by making systems automatic.

General Terms: Computer Vision.

Keywords: Number plate, Sobel algorithm, vehicle and camera

1. INTRODUCTION

Number plate recognition is a technology based on computer vision which involves image processing, fuzzy logic and many other techniques.

Applications of Vehicle Number Plate Recognition(VNPR) can vary from automatic parking facilities, automatic fuel pumping for registered vehicles, restricted areas reserved for VIP members, automatic toll sensors, vehicles involved in theft and other imaginative forms as shown in Figure 1^[1]. Unfortunately there exist various factors which restrict us from recognizing a license plate such as weather, lighting, visual occlusion, placement of number plate, speed of vehicle, damaged plates, angles of camera, color of number plate and different fonts used for the characters.^[2]

These factors can be overcome in some ways so that our results are more accurate. With correct evaluation and analysis of the results of recognition of number plate it is possible to improve the accuracy of the number plate



Figure 1: Vehicle number plate recognition systems

recognition system. In India there has been a lot of work done on number plate recognition. It is possible to recognize the characters of Indian number plate based on the specifications of Indian number plates.

DL 01 C 1234

Considering the standard specifications of Indian Number Plates: Here 'DL' that is the first 2 characters stands for the state code, '01' that is a two digit number code which stands for the regional transport office where the car has been registered. 'C' stands for car and similarly 'S' for scooter and 'P' for public transport vehicles. Finally there comes a four digit car number ('1234'). After the 4 digit car number reaches '9999' the next vehicle number becomes

DL 01 C 9999 → DL 01 C A 0001 → DL 01 C A 9999 → DL 01 C B 0001 → DL 01 C AA 0001

2. PROPOSED TECHNIQUE

Vehicle number plate recognition follows a structural pattern for the recognition of characters. Figure 2 gives a schematic diagram of the of the VNPR system.

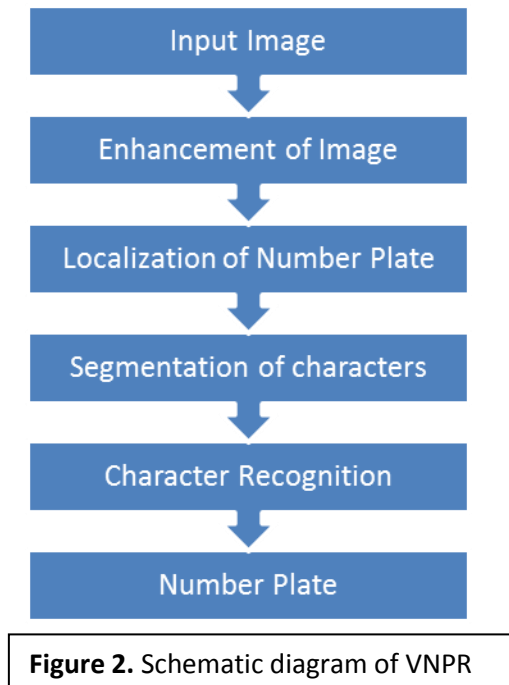
First of all we improve the quality of image by using familiar image processing techniques such as the following

2.1 Conversion to gray scale:

The RGB 24 bit color pixels are converted into 8 bit gray value as shown in figure 3(b).

2.2 Median Filtering

The non-linear filter changes the gray value of the pixels to the median of the gray value of surrounding pixels as seen in figure 3(c). We use a 3x3 mask and get the corresponding gray value of each pixel using the 8 neighbouring pixels which results in removal of noise with benefits^[7]. Median filtering gives advantages such



as no reduction in contrast since output values are its neighbourhood values, it does not shift the boundaries which is a contrast dependent problem and less sensitive than the mean values

2.3 Histogram Equalization

Histogram Equalization is used to enhance the contrast of the image for better functioning.^[3]

2.4 Edge Detection

After enhancement of image we perform extraction of vehicle number plate by localization of number plate region using Sobel edge detection and fuzzy logic as shown in figure 3(d). Sobel operator^[3] has a 3x3 convolution kernel. One kernel is the other rotated by 90 degree.

Masks used by Sobel operator are

$$\begin{pmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{pmatrix} \quad \begin{pmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{pmatrix}$$

The kernels respond to vertical and horizontal edges and the characters in the number plate have vertical edges of uniform nature at regular intervals. These characters are also equally distant to the number plate edge. These features help us to locate the number plate within the image.

After edge detection we perform smoothing of the image. Smoothing is often used to reduce noise within an image or to produce a less pixelated image. Most smoothing methods are based on low pass filters. It is done to reduce the no. of connected components so that the objects can be identified more efficiently (Figure 3(e)).

Finally we perform the Optical Character Recognition (OCR) clubbed with the fuzzy logic of character analysis of Indian Vehicle Number Plates which can be seen in [3]. However for accurate OCR, one of the key factors is the image quality. Hence it is important that for a fast travelling vehicle to be captured, the camera should have a short shutter time and high illumination for better image which avoids blurring of the image. One of the best illumination effects provided by a camera is an IR flash which gives very good results. We have used the template based OCR technique over the feature based OCR technique because the template based technique is more sensitive to font and size of the characters. Here the characters are correlated with the set of stored templates. The complete proposed technique that has been implemented can be seen in figure 3.

3. Characteristic Analysis

This system is designed on the basis of national number plate specifications and hence has characteristic features which can be taken into analysis^[1,4]:

- The background color of the plate is white or yellow and the characters are written in black.^[5]
- Characters ‘E’, ‘F’, ‘I’, ‘O’, ‘Q’, ‘V’, ‘X’ and ‘Z’ are not used in the first 2 characters in a number plate considering only national numbers and not the few exceptions such as numbers of diplomats, etc.
- The 5th character is mostly ‘C’, ‘S’ or ‘P’.
- The last 4 characters are always numbers. Hence alphabets need not be taken into account. This helps us in differentiating confusing matches between characters like ‘Z’ and ‘2’, ‘B’ and ‘8’, etc.
- The number plates in common have 10-12 characters at present.

Finally to calculate the efficiency of our number plate, we use the following parameters.

$$\text{Recognition Rate} = \frac{\text{Correct characters}}{\text{Total characters}}$$

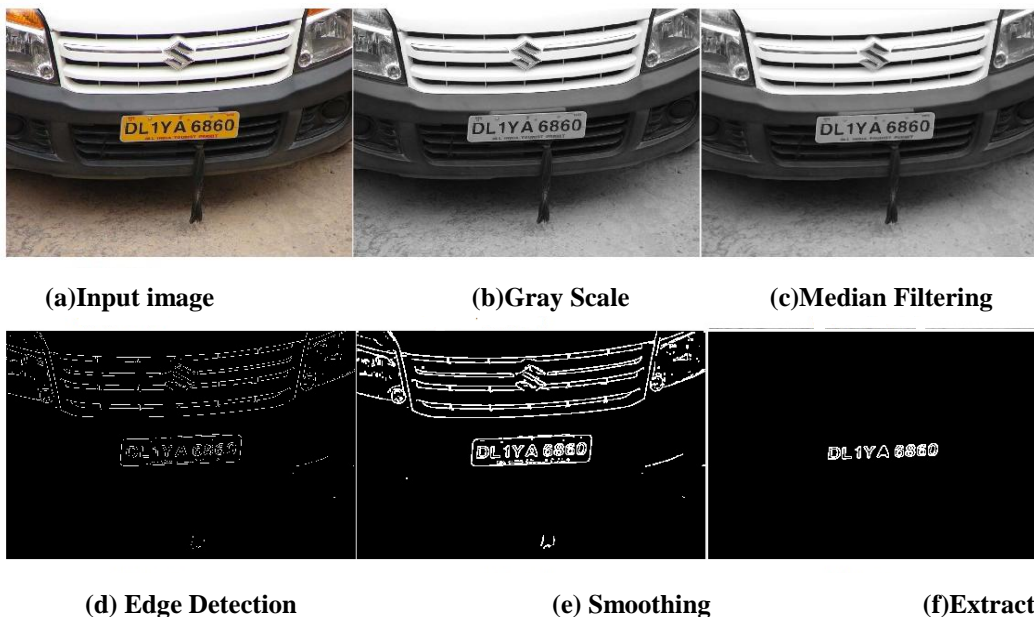


Figure 3: Proposed Technique

$$\text{Rejection Rate} = \frac{\text{Rejected characters}}{\text{Total characters}}$$

$$\text{Error Rate} = \frac{\text{Incorrect Characters}}{\text{Total characters}}$$

The above mentioned characteristics of vehicle number plates helps us recognize the number plates with more accuracy and makes the proposed system faster to recognize number plates using fuzzy logic. We tested the proposed system for 100 images of license plates. The system could not recognize 10 of these images due to bad camera angles, bad illumination and blurred images. The common misconceptions during character recognition can be seen in Table 1 and the common misconceptions that have been eliminated through our characteristic analysis are shown in Table 2. As a result, the images showed recognition rate of 95.1%, error rate of 1.3%, and rejection rate of 3.6

Character on the number plate	Character Recognized as
D	O
M	H
6	8
8	0

Table 1: Common misconceptions that exist

Characters on number plate	Correct output found with no confusion with characters below
B	8
O	0
Z	2
S	5
Z	7

Table 2: Misconceptions removed through characteristic analysis and table holds true vice versa.

4. Conclusion

In this paper we introduced a method of extracting specific features of the national number plates and increase its accuracy and speed in recognizing number plates. We have covered numerous number of the vehicle number plates in this paper but other type of number plates exist where such a character analysis cannot be applied using our fuzzy logic of character analysis. For such systems we have to make a few changes to our system. Hence we have focused our system on producing more accurate results and with lesser response time to the most common specifications of Indian vehicle number plates.

Acknowledgement

Authors are very thankful to C.S.E. Department of Amity University(Noida) for granting us the permission to carry out the work and providing necessary facilities during the progress of the work.

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