RESEARCH ARTICLE   OPEN ACCESS

Analysis and Comparison of License Vehicle Number Plate Recognition   Technique

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ABSTRACT
Number plate recognition system recognizes the characters from license vehicle number plate. It becomes a difficult task to recognize the number plate characters of swiftly moving vehicles manually or the blurred images of the number plates. A number of techniques have been used to recognize the characters of the number plate from their images. These techniques used different methods such as Morphological operations, edge detection, character segmentation, character recognition using template matching and character extraction. In these techniques various algorithms are used such as sobel algorithm and local Otsu segmentation method. Various image noises like salt and pepper are added to obtain the desired results. This paper reviews various techniques and their results on the number plate character recognition. This paper also reviews the level of accuracy of number plate detection and recognition of various techniques in terms of percentage.
Keywords: - Number Plate Recognitions, Morphological, Salt & Pepper, Local Otsu, Sobel algorithm

I. INTRODUCTION

 The number of vehicles in our country increases day by day. Which causes increase in crimes, traffic on roads, traffic laws violations, hit and run cases and heavy rush on toll plazas installed at various places for toll tax collection[2]. Traffic police can't solve all the crime cases because police is unable to detect the vehicle involved in crime. To detect the vehicle accurately, police should have a good automatic vehicle recognition system. The major problem in accurate number plate recognition is bad quality of vehicle image captured by CCTV cameras. Due to bad weather conditions such as fog and rain, bad light effects , different fonts and background colors of number palates, the image got noise. Due to noisy image, the characters can't be recognized accurately. There exists a number of vehicle recognition systems based on various techniques to recognize the characters from noisy images. The existing techniques used various edge detection algorithms and Optical Character Reader (OCR) method to recognize number plate images[1].These methods work on different types of image noises such as Salt & Pepper[3]. These number plate recognition systems can also be used for traffic management, online parking management , automatic toll collection and congestion control[2]. When number plate is detected accurately, police or toll authority can easily get information about the owner of vehicle. The Indian number plate has ten characters. First two letters gives the state information, next two digits gives the district information,   next two letters are optional and last four numbers are the unique registration number of vehicle[2]. For example number is HR11ME1111.

HR	11	ME	1111
State code	District code	Optional	Unique License Plate number

Table 1: Description of Indian number plate

This paper includes four sections. First section includes Introduction about number plate recognition system and its uses. Second section includes existing techniques of number plate recognition. Third section includes result and discussion. Forth section includes conclusion and future scope.

II.   TECHNIQUES OF NUMBER PLATE RECOGNITION

The existing techniques used for number plate recognition are as following:

A. Histogram based technique

 This technique utilizes image processing and pattern recognition methods for Open Road Tolling. This is used for Open Road Tolling (ORT) using number plate recognition. This Number Plate Recognition (NPR) technique consist of two modules: histogram based number plate localization and number plate recognition using template matching. This approach has an advantage of being simple & faster and will be used for images size more than 700×700 pixel. To make it faster all the operations are performed on gray scale image not on RGB image. Open Road tolling has come up in a large way in foreign countries, but not in India to that extent here it is still at the level of idea[2][6].
Steps for NPR (Number Plate Recognition):-
   1. Colour to gray scale image conversion
   2. Image dilation
   3. Horizontal edge detection
   4. Vertical edge detection
   5. Segmentation
   6. Number plate extraction
   7. Character segmentation

8. Number plate recognition
9. Final license number

Histogram based techniques has applied on 50 vehicles number plates and recognize 45 number plates accurately which gives 80% accuracy rate.

Recognition Accuracy (%) = 100 * (1-E/T)

E=Total error in character recognition

T= Total number of characters in the number plate

B. Sobel edge detection and contrast enhancement technique

This number plate recognition approach based on efficient morphological operation and sobel edge detection method. It also presents a simple approach to segmented all the letters and numbers used in the number plate. After reducing noise from the input image it try to enhance the contrast of the binarized image using histogram equalization. It mainly concentrates on two steps; one is to locate the number plate and second is to segment all the number and letters to identify each number separately. Number plate is a pattern with very high variations of contrast. If the number plate is very similar to background it's difficult to identify the location. Brightness and contrast is changes as light fall changes to it. In this the technique morphological operations are used to extract the contrast feature within the plate[4][7].

Various steps to recognize the number plate:

1. Input raw image
2. Image binarization
3. Reduce noise using mid-filtering method
4. Enhance contrast using histogram equalizer
5. Plate localization
6. Character segmentation

This technique emphasize on contrast enhancement of binary image using histogram equalizer as shown in figure 1&2.
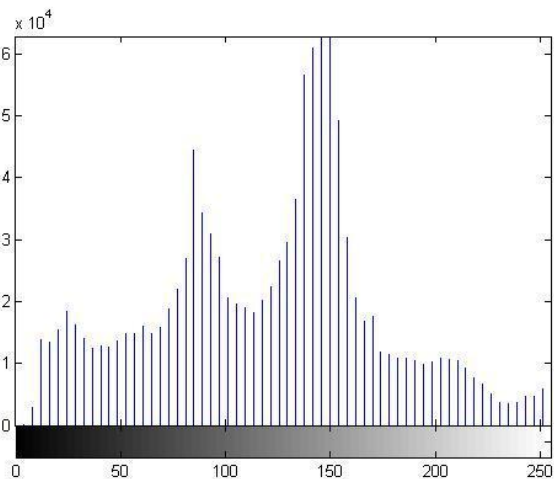

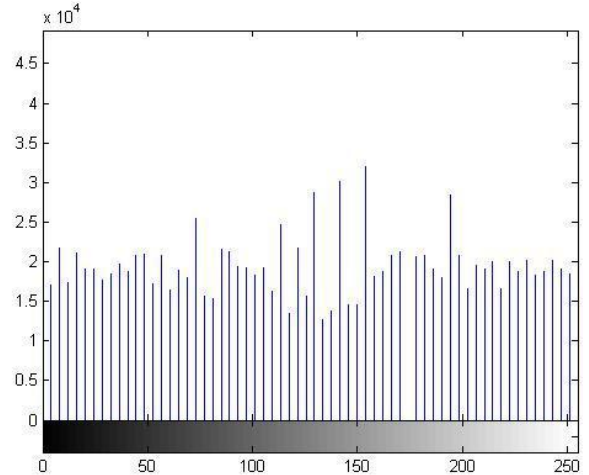Figure 1: Before contrast enhancement

Figure 2: After contrast enhancement

Plate localization is done by using Sobel Edge Detection algorithm. Using Sobel edge detector it used to high light regions with a high edge magnitude and high edge variance are identified as shown in figure 3 & 4. Depending upon the threshold value edge will be detected from the input image. It is an efficient less time consuming vehicle number plate detection method which performed on complex image. By using, Sobel edge detection method here detects edges and fills the holes less than 8 pixels only. To extracting the license plate this removes connected components less than 1000 pixels. This algorithm is mainly based on Indian automobile number plate system. Extraction of number plate accuracy may be increased for low ambient light image[4][7].

Figure 3: Gray scale image after contrast enhancement

Figure 4: After applying Sobel Edge Detection

C. Number plate detection with Salt and Pepper noise.

This technique is able to tolerate noise level up to 20% with recognition rate of 85%. The system utilized a combination of filters and morphological transformation for segmenting the number plate. It then uses resilient back propagation neural networks for recognition. The system is composed of detection sub-module and recognition sub-module. Detection module filters the image and identifies region that contains number plate. In this detection module, there is an important step that pre-processes the image in order to detect region of interest in ambient illuminating condition. The pre-processing step converts the image from RGB domain to grayscale so as to eliminate the hue and saturation formation while retaining the luminance. To further enhance the picture, it attempts to minimize luminance and noise factors by using appropriate filers. Median filter is first used, it calculates the neighbouring pixels values and store in an array. The array is then sorted in numerical order. After which, the median from the array is chosen as pixels value. The next step in detection module is morphological transformation. There are four types of operations: dilation, erosion, opening and closing. Dilation expands the image. Erosion is the shrinking of the object. Opening consists of erosion and dilation. Closing perform dilation first then erosion. We use opening and closing pre-process the image first, then locate the number plate within the image, and finally extract the relevant features for subsequent processing. It processes the image by adding in salt and pepper noise. As shown in Figure 5. Top left corner first image is the original image, the top right image is the resultant image after salt and pepper noise is introduced. With the introduction of salt and pepper noise, it significantly degrades the readability of number plate. The images from second to third tows shows the characters being segmented out from image. The system is able to extract out the character from image with salt and pepper noise. The system can recognize up to 20% distortion by noise. The hit rate is 85% with 30 images tested. Under

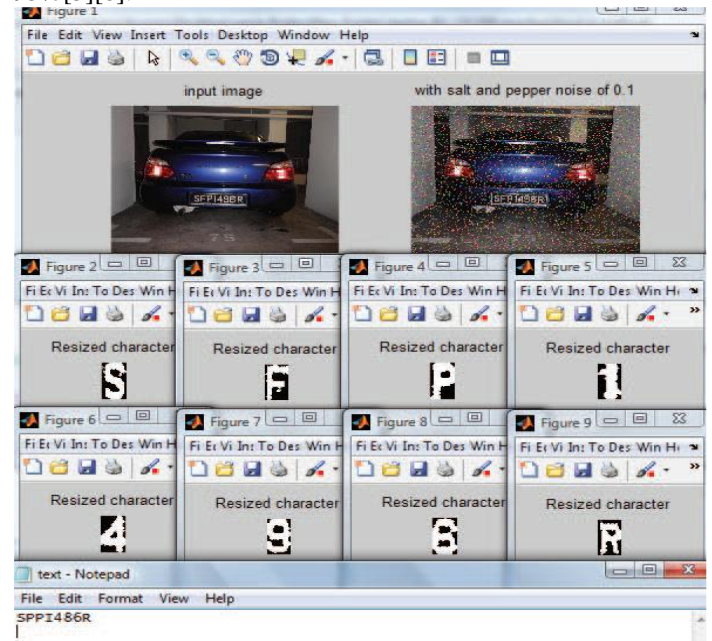good condition original image, the recognition rate is above 95%[3][8].

Figure 5: Image before after salt and pepper noise

D. Number plate detection with Local Otsu Segmentation Method

This algorithm is an efficient method for recognition for Indian vehicle number plates. The algorithm aims at addressing the problems of scaling and recognition of position of characters with a good accuracy rate of 98.07%[5][9]. Number plate detection consists of following modules:-

1. Input original image
2. Convert to gray scale image
3. Denoise the image using median filter
4. Image segmentation by Local Otsu Method
5. Convert to binary image
6. Crop the region of interest
7. Find and label connected components
8. Reorder labelling
9. Resize templates
10. Template matching by normalized cross correlation
11. Final output image

Generally, the image obtained contains some irrelevant information or impurities such as holes, dirt particles and the background which must be removed. The noise is removed using median filter. Segmentation is performed using local Otsu's method. The initial threshold is set to zero. By calculating the size of input image, n window frames of equal size were found representing the overall image. A window frame moves on the input image and its local threshold is being calculated, the task is carried out for n window frames. Finally the average of n threshold values is calculated. This weighted threshold value is used to

convert the image to binary scale. By using Otsu Method of segmentation ,this system gives high detection and recognition accuracy i.e 98.07% as shown in Table 2[5][9].

No of sample images taken for testing	52
No of images correctly detected	51
No of images correctly recognised	51
Rate of accuracy	98.07%

Table 2: Accuracy data using sobel edge detection method

III. RESULTS AND DISCUSSION

All the four already existing Vehicle number plate recognition techniques discussed in section II used the different methods of denoising the image, segmentation of number plate and extracting characters from number plate. Each method has its own level of accuracy of detection and recognition of number plate. Lets have a look at results of each technique discussed above.

Histogram based technique is used for On Road Tolling(ORT). This technique use histogram based method for number plate localization. It is very simple and faster because all the operations are performed on gray scale images. Its rate of accuracy of plate recognition is 80%[2][6].

Sobel edge detection based method used Sobel edge detection algorithm for segmentation. It enhance the contrast of the binarized image using histogram equalization method. It gives high accuracy of number plate detection specially in low ambient light images[4].

Number plate detection with salt and pepper noise first add salt and pepper noise to original image up to extent of 20%. By adding noise the image become less readable. It uses different filters for noise removal and use template matching for character recognition. The rate of accuracy with 20% noise level is 85% and in original image without noise is 95%[3][8],

Number plate detection with local Otsu Segmentation method used local Otsu method for segmentation of image. After cropping region of interest it find and label the components. For character recognition template matching is used by normalized cross correlation. Its rate of accuracy is 98.07%[5][9].

Table 3 shows the comparison of four techniques on the basis of technique used and rate of accuracy.

S.No	Method used	Outcomes
A.	Histogram based technique	Accuracy rate of image detection is 80%
B.	Sobel edge detection method	High rate of accuracy in low ambient light images
C.	Number plate detection on image with Salt and Pepper noise	a. Accuracy rate is 85% with 20% noise b. Accuracy rate is 95% with original image
D.	Local Otsu segmentation method	Accuracy rate is 98.07%

Table 3: Comparison analysis of all four techniques.

IV. CONCLUSION AND FUTURE SCOPE

As shown in table 3, all techniques already used for number plate recognition used different methods and give different accuracy rates. Out of these four techniques, Local Otsu method gives the highest accuracy rate of image recognition. All techniques have their own advantages and disadvantages and all are good at their own levels. But on the basis of accuracy rate Local Otsu method is the best technique which gives 98.07% accuracy rate. In future we can compare these techniques practically on the basis of some different parameters.

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