License Plate Detection and Segmentation for Goan Vehicles

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Abstract: ***This paper presents an approach to license plate localization and segmentation. Vehicle license plate identification and segmentation is an important part of the vehicle license plate recognition. In recent years the number of vehicles has increased drastically especially cars; which causes difficulty in tracking vehicles for the purpose of parking admission, traffic management and law enforcement especially at state borders. The proposed idea of work is based on image processing tool and helps in functions like vehicle license plate recognition. The proposed algorithm is based on a combination of morphological operation for license plate localization, extraction of plate region and segmentation of characters.***

Keywords: License plate, Pre-processing, License plate extraction, Character segmentation, Bounding box.

1. Introduction

In recent years, the standard of living has been increased and the willingness of people to buy new vehicles specially cars is increased. Because of this the numbers of vehicles are increased, and it is getting difficult to manually keep track of each vehicle to enforce law and traffic rules for smooth traffic flow. Toll-Booths are constructed on highways, boarders and parking structures, where the car has to stop and pay the toll or parking fees which is a time consuming process. All these have a scope of improvement. In order to automate these processes and make them more effective, a system is required to easily identify the vehicle [1]. Using the vehicle's license plate a particular vehicle can be identified.

An automatic license plate recognition system is an important area of research due to its wide application. The development of Intelligent Transportation System provides the data of vehicle license number which can be used for the purpose of security control in restricted areas, highway surveillance and toll collection. Since Vehicle license plate recognition (VLPR) contains four parts, license plate detection, extraction segmentation and recognition; segmentation of license plate characters plays an important role, which directly results on the recognition of characters.

The main purpose of this proposed idea is to detect a license plate from an image provided by a camera, to extract the license plate from an image and then to segment each character.

2. Literature Survey

In general, License plate recognition consists of four modules: image acquisition, license plate extraction, character segmentation and character recognition [1].

Various license plate detection algorithms have been developed in past few years. Each of these algorithms has their own advantages and disadvantages. And most of them use gradient edge detection. Shidore *et a*l described the method in which license plate extraction had been done using Sobel filter, morphological operations and connected component analysis [2]. Character segmentation was done by using connected component and vertical projection analysis. Character recognition was carried out Support Vector Machine (SVM). The drawbacks are deep shadows and reflection have an impact on number plate extraction work; failure in character segmentation and falls recognition. Anishiya *et al* proposed algorithm based on a combination of morphological operation with area criteria tests for number plate localization [3]. Segmentation of the plate characters was achieved by the application of edge detectors, labelling and fill hole approach. The character recognition was accomplished with the aid of optical characters by the process of Template matching. The drawbacks are recognizing the characters 'G' and 'C', 'I' and '1', '7' and 'T' due to similarities in their shape. Lazrus *et al* suggest a different approach in which they did not extracted the license plate form the entire image but they segmented the license plate after pre-processing of image [4]. Sobel filter was used to find out the edges, Bwlable to calculate the number of connected component and neural network for recognition. The drawbacks are failure in character segmentation and recognition due to noise different font style and size of the license plate. Mei-Sen *et al* developed Chinese Vehicle License Plate Character segmentation in their method they used Least Square Method (LSM) to correct the tilted image, Image Fusion Method to minimise noise, defined algorithm for boundary detection and projection method for character segmentation[5]. Drawbacks are: detects noise region with the actual character; some character is divided into two or more parts; two neighbouring characters are regarded as a single one. C

Paunwala *et al* described the technique for extracting license plate using Wavelet analysis [7]. First author performed preprocessing of image and license plate region is roughly detected using vertical gradient top-hat and horizontal projection analysis. For accurate detection Prolonged Haar wavelet transformation is used.

3. Proposed Technique

The proposed idea of work has three parts pre-processing of image, license plate detection, license plate extraction, and character segmentation. First of all the vehicle image is captured and pre-processed whose main function is to eliminate noise and enhance information contained in image for further processing by the system. Secondly license plate is detected and the actual license plate is extracted. In third part the characters from the extracted license plate are segmented.

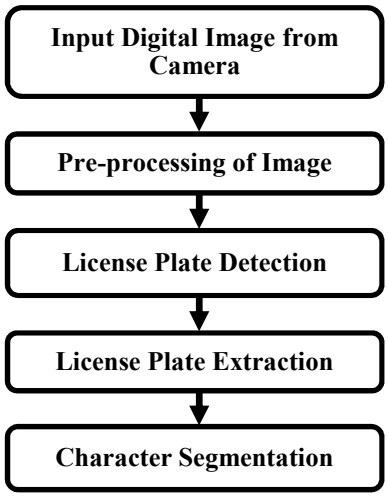


Figure 1: Block diagram of Car Number Plate Detection

3.1. Acquisition of image

In this proposed work different resolution cameras are used ranging from a high resolution digital camera to VGA camera to acquire an image Figure 2a. Images are taken in different background and illumination and a distance between one to two meter from the camera to vehicle. Images are normalised to size of (640 X 480).

3.2. Pre-processing of image

Pre-processing of image is done to reduce the noise in the image, improve the contrast of the image and to increase the processing speed.

First RGB image is converted to gray scale image Figure 2b. By converting RGB image to gray scale hue and saturation information is suppressed, while still maintaining the luminance component in image. After this, the intensity of the image is adjusted and contrast of the image is reduced. For this purpose histogram equalisation is used. Histogram equalisation enhances the contrast of images by transforming the values in an intensity image, or the values in the colour map of an indexed image, so that the histogram of the output image approximately matches a specified histogram [9]. Histogram adjusted image is shown in Figure 2c.

$$p_{n=\frac{number\ of\ pixels\ with\ intensity\ n}{total\ number\ of\ pixels}} \quad n = 0,1,\ldots l-1 \qquad \text{Eq. 1}$$

Let n be a given image pixel intensities ranging from 0 to L − 1. L is the number of possible intensity values, often 256.

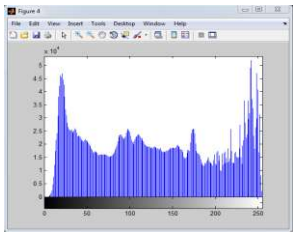
Let p denote the normalized histogram of gray scale image for each possible intensity.

The histogram equalized image g will be defined by

$$gi.j = floor((L-1)\sum_{xn=0}^{fij} pn) \qquad \text{Eq. 2}$$

Figure 2: (a) Original Image

Figure 2: (b) Gray Scale Image **(c)** Histogram Adjusted Image



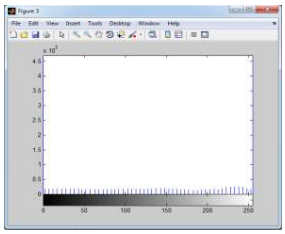


Figure 2: (d) histogram of fig.2b **(e)** Histogram of fig.2c

The gray scaled image is then converted to binary image by setting the threshold value. The binary image is shown in Figure 2d

$$G(i,j) = \begin{cases} 1 & if\ g(i,j) \geq T; \\ 0 & if\ g(i,j) < T; \end{cases} \qquad \text{Eq. 3}$$

Here, G (i, j) =Binary Image; g (i, j) =Gray Scaled Image; T= threshold.

Figure 2: (f) Binary Image using Threshold

Binary image is useful as the information needed can be obtained from the silhouette of the object [8].

3.3. License Plate Extraction

License plate extraction is the key step in license plate recognition, which influences the accuracy of the system significantly [1]. Its purpose is to produce a number of candidate regions in given input image, with high probability of containing number plate and validate the true number plate.

3.3.1. Candidate Regions Detection

For candidate region detection various morphological operations are performed on the image for specifying the plate location. Morphological operator can be build that is sensitive to specific shape in the input image. In our system opening, filling and closing are used to detect candidate region in image as shown in Figure 3a and Figure 3b.

First opening is performed on the image, opening is basically erosion followed by dilation. It is used to eliminate all the pixels in regions that are too small to contain structural element. For these morphological operations to be performed structuring element has to be defined first. Structural element is a matrix consisting of zeros and ones that has arbitrary shape and size. The size of structuring element is smaller than image. Center pixel of structuring element being processed identifies pixel of interest.

Dilation is performed by laying structural element on the image. If starting point of structuring element coincides with white pixels in the image the pixel remains unchanged, it moves to next pixels. If starting point of the structuring element coincides with black pixels in the image than it makes all the pixels black in the image covered by the structuring element. Dilation allows object to expand, fill small holes and connect disjoint objects.

Erosion is similar to dilation but here pixels are turned to white. If starting point of structuring element coincides with white pixels in the image there is no change, it moves to next pixels. If the starting point of structuring element coincides with the black pixel than all the pixels are converted to white which are covered by the structuring element. Erosion shrinks the object boundaries and disconnects joint objects depending on size of the structuring element.

Then filling operation is performed, which fills the hole in binary image. It changes pixels in background to foreground and will stop to fill once reached object boundary. Later closing operation is performed on the image, closing basically is dilation followed by erosion. It is used to fill holes and small gaps. Closing and opening generates different result even though both consist of erosion and dilation therefore order of operation is important [12]. This morphological operation results in smoothening object boundaries for sharp image and removes noise

The number plate is detected by multiplying image obtained from closing of image with filled image for identifying the required area.

$$A \circ B = (A \ominus B) \oplus B \qquad \text{Eq. 4}$$

$$A \bullet B = (A \oplus B) \ominus B \qquad \text{Eq. 5}$$

Structure B open aggregates A in (4) and structure B close aggregates A in (5).

Figure 3: (a) Opened Image

Figure 3: (b) Filled Image **(c)** Candidate Plate Area

3.3.2. Actual License Plate Extraction

After the detection of candidate plate area, unnecessary area which has lesser probability of containing license plate are eliminated by using a threshold as shown in Figure 4a.

To extract the actual license plate from image, centroid of the area is marked and depending on this license plate is extracted as shown in Figure 4b. For marking centroid the number of connected component are found out. Depending on the connected component centroid is found out.

Once the centroid is found, area is marked and the unwanted area from left and right side is eliminated. Then the area above and below the centroid which does not contain the license plate is eliminated automatically by using predefined values, in this way the desired number plate is cropped.

The equation for the centroid are given by,

$$C_x = \int \frac{xdA}{A} \qquad \text{Eq. 6}$$

$$C_y = \int \frac{ydA}{A} \qquad \text{Eq. 7}$$

The distance from the y-axis to the centroid is C_x
The distance from the x-axis to the centroid is C_y
The coordinates of the centroid are (C_x , C_y)

Figure 4: (a) Removal of unwanted Area

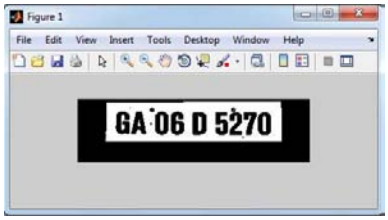


Figure 4: (b) Extracted License Plate

3.4. Character Segmentation

Segmentation of license plate characters plays an important role, which directly results on the accuracy of character recognition significantly. In character segmentation the characters on the extracted license plate are isolated from each other without losing features of the characters.

There are some widely used methods for character segmentation like static bounds, vertical projection, bounding box and connected component [6]. We have used bounding box to separate individual character from the license plate. By using bounding box the respective row and column indices of the license plate area are found out and depending on these indices the characters are segmented as shown in Figure 5.

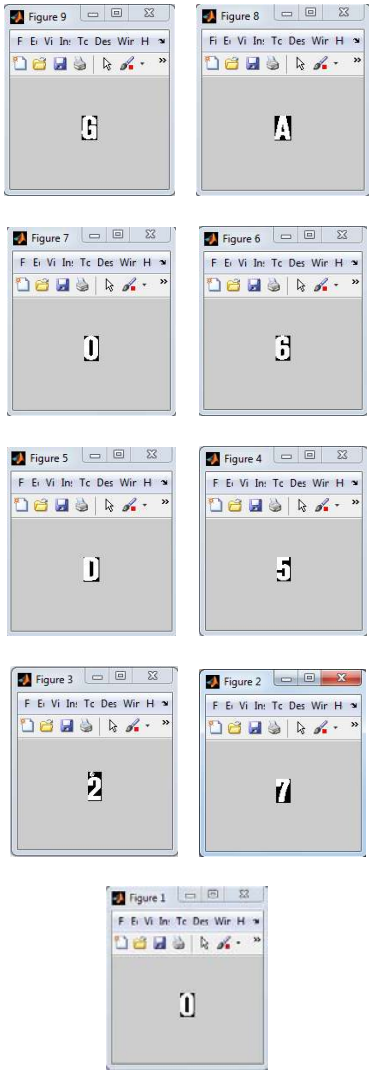


Figure 5: Segmented Characters

4. Result

Various images of different sizes are captured and resized to the size of 640 X 480. The proposed system is also tested with images taken with improper illumination, different angles and varying distance. Total 50 images were used to test the algorithm. The proposed system works well for images taken within the range of 1mt-2mt and angle up to 55º. Out of 50 images 49 images were extracted and 47 images were segmented successfully.

TABLE 1. Experimental results

Angle	Extraction	Segmentation
90	98%	97%
80	98%	97%
65	98%	92%
30	0%	0%

For stained number plates, lower illumination and high reflections, actual license plate could not get correctly extracted.

5. Conclusion

An algorithm for vehicle license plate detection, extraction, and character segmentation is designed and implemented. To measure efficiency, this method has been tested over a number of images captured at day time, with varying angle and distance and with different camera resolution and achieved satisfactory results. The drawback in this proposed idea is that the performance degrades if the illumination reduces substantially. The result shows that, number plate is extracted success full with success rate of 94%.

6. Acknowledgement

We wish to thank Prof. (Dr.) R. B. Lohani, principal and head of Electronics and Telecommunication Department, of Goa College of Engineering for constantly motivating us in our journey through this project and for his support and encouragement.

We would like to thanks our parents who taught us the value of hard work by their own examples. They rendered us enormous support during the whole period of our life.

Reference

[1] Manisha Shirvoikar, Ramesh Kudaskar, Vinay Mirashi and Jairam Parab, “Vehicle Identification and Authentication for Goan Vehicles”, Recent Trends in Computer science and Application and Computational Mathematics, ISBN 978-93-5097-319-6, 2012.

[2] Shidore, Narote,”Number Plate Recognition for Indian Vehicles”, IJCSNS International journal of Computer Science and Network Security, VOL. 11 no.2, Feb.2011.

[3] P.Anishiya, Prof. S. Mary Joans,” Number Plate Recognition for Indian Cars Using Morphological Dilation and Erosion with the Aid Of Ocrs”, 2011 International Conference on Information and Network Technology IACSIT Press, Singapore, vol. 2011.

[4] Anish Lazrus, Siddhanrtha Choubey, Sinha G.R, “An Efficient Method of Vehicle Number Plate Detection and Recognition”, International Journal of Machine Intelligence (IJMI) ISSN: 0975-2927 & E-ISSN: 0975-9166, Volume 3, Issue 3, 2011, pp-134-137

[5] Mei-Sen Pan, Jun-Biao Yan and Zheng-Hong Xiao, “Vehicle License Plate Character segmentation”,

International Journal of Automation and Computing 05(4), October 2008, 425-432.
[6] Chetan Sharma and Amandeep Kaur, "Indian Vehicle Licence Plate Extraction and Segmentation", International Journal of Computing Science and Communication Vol 2, No. 2, July-December 2011.
[7] Chirag N. Paunwala, Suprava Patnaik and Manoj Chaudhary, An Efficient Skew Detection of License Plate Images Based on Wavelet Transform and Principal Component Analysis, 2010 International Conference on Signal and Image Processing,page.17-22.
[8] Wong Eng Yong U1260238,"Vehicle License plate registration recognition system", SIM UNIVERSITY, July 07/BSTE/05.
[9] R. Gonzalez and R. Woods, "Digital Image Processing", 2nd ed., Prentice-Hall, New Jersey, 2001.

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