An Efficient Method for Indian Vehicle License Plate Extraction and Character Segmentation

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***Abstract*— Automatic License Plate Identification (ALPI) has many applications in traffic systems (highway electronic toll collection, red light violation enforcement, border and customs checkpoints, etc.). In this paper, a smart, simple and efficient algorithm which is mainly designed for Indian license Plate Recognition is presented for vehicle's license plate recognition system. The proposed algorithm consists of three major parts: Extraction of plate region, segmentation of characters and recognition of plate characters. For extracting the Plate region, edge detection algorithm and vertical projection method are used. In segmentation part, filtering, thinning and vertical and horizontal projection are used. And finally, chain code concept with different parameter is used for recognition of the characters. The performance of the proposed algorithm has been tested on real images.**

***Keywords*— License Plate Recognition, plate region extraction, segmentation, thinning, vertical and horizontal projection**

I. Introduction

AUTOMATIC License Plate Identification is an essential stage in intelligent traffic systems. Nowadays vehicles play vital role in transportation. Also the use of vehicles has been increasing because of population growth and human needs in recent years. Therefore, control of vehicles is becoming a big problem and much more difficult to solve. Automatic vehicle identification systems are used for the purpose of effective control. Automatic License Plate Identification (ALPI) is a form of automatic vehicle identification [1]. It is an image processing technology used to identify vehicles by only their license plates. Real time LPR plays a major role in automatic monitoring of traffic rules and maintaining law enforcement on public roads [2]. Since every vehicle carries a unique license plate, no external cards, tags or transmitters need to be recognizable, only license plate.

Lotufo, Morgan and Johnson [3] proposed automatic number-plate recognition using optical character recognition techniques. Johnson and Bird [4] proposed knowledge-guided boundary following and template matching for automatic vehicle identification. Choi [5] and Kim [6] proposed the method based on vertical edge using Hough transform (HT) for extracting the license plate. E.R. Lee, P.K. Kim and H.J. Kim [7] used neural network for color extraction and a template matching to recognize characters. S.K. Kim, D.W. Kim and H.J. Kim [8] used a genetic algorithm based segmentation to extract the plate region. Tavsanoglu and Saatci [9] proposed an approach to form orientation map as recognition feature using a Gabor filter for recognizing characters. Yoshimura and Etoh [10] used Gabor jets projection to form a feature vector for recognizing low resolution gray-scale character. Hontani et.al. [11] Proposed a method for extracting characters without prior knowledge of their position and size in the image. Park et. al. [12] devised a method to extract Korean license plate depending on the color of the plate.

In this paper, the proposed algorithm is based on extraction of plate region, segmentation of plate characters and recognition of characters. Extraction of plate is a difficult task. Essentially, the difficulty can be due to the following reasons:

1. License plates normally, occupy a small portion of the whole image.
2. The difference of license plates in formats, styles and colours from country to others.
3. In most cases, the detecting is performed without prior knowledge of the license plate's location in the image.
4. Probability of facing some common drawbacks which could influence the efficiency of the extraction, such as, blurry image, uneven or low illumination, vehicle motion, low resolution of the image, distorted characters, dirty plate, shadows or reflection…etc.

In addition to the reasons above, the license plate extraction becomes more difficult in real time systems, where the fast processing as well as accuracy is required. In this paper, a simple license plate extraction method is presented. The method is basically based on the morphological algorithms and connected components analysis, including four major stages, which are, RGB to gray-scale conversion, image binarization and filtration, analysis and dilation, and extracting the accurate location of the license plate.

This paper is organized in VI section. Section II explains various phase of proposed algorithm. Plate candidates rectangles filtering are explained in III, Experimental result is made in section IV. Conclusions are given in Section V, Reference in section VI.

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II. The Proposed License Plate Extraction Method

The proposed method is designed for real-time Indian license plate extraction. Input to the system is an image which contains the license plate, acquired from about 4 meters away by a digital camera of the front or rear of the vehicle; and its output is the license plate region. The method comprises the following major stages, which are: RGB to gray-scale conversion, vertical edge detection and image binarization, analysis and dilation, vertical projection and thresholding, extracting the accurate location of the license plate, filtration and image enhancement, binarization and smoothing process, and Character segmentation for horizontal and vertical as shown in the Figure 1.

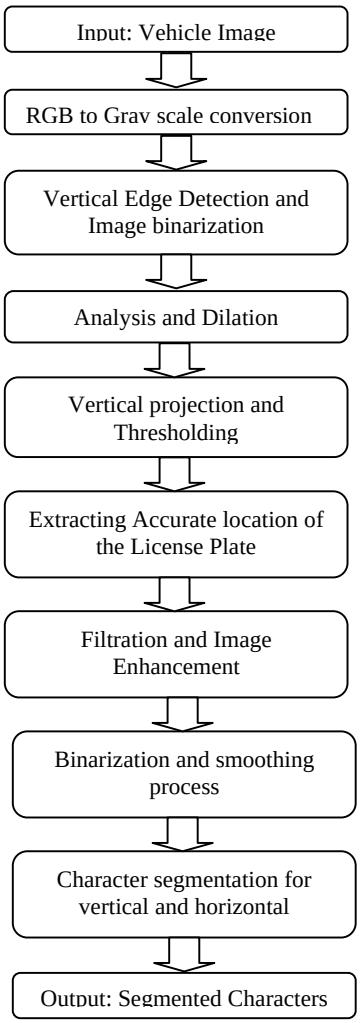


Figure 1. Flowchart of Proposed Method

2.1 RGB to Gray-Scale Conversion

In this method, RGB to gray-scale conversion is adopted, in order to facilitate the plate extraction, and increase the processing speed. Color image (RGB) acquired by a digital camera is converted to gray-scale image based on the RGB to gray-scale conversion technique. The basic idea of this conversion is performed by eliminating the hue and saturation information while retaining the luminance. The following equation shows an optimal method for RGB to gray-scale conversion, as follows [13]

$$Lu = 0.299 * R + 0.587 * G + 0.114 * B \quad (1)$$

2.2 Image Binarization and Filtration

The gray-scale image resulted by the previous stage is converted to binary image (Black & White). This conversion is the most important stage in all phases of the LPR system, and more specifically for plate extraction phase. As known, the foreground and background colours of vehicle license plates are quite distinct. However, input images to the LPR system, often contain unevenly distributed gray intensities, or all the intensity values could lie within a small range, such as the images with poor contrast, or poor illumination. Therefore, the crucial point is to use an effective technique for binarization; otherwise, the method would fail to extract the license plate region from the vehicle image correctly. In order to overcome the illumination problems, our method performs this task. As a result, the plate characters are appear clearly after binarization.

The next step removes any object contiguous to the border of the image. Thus, we can get rid of unnecessary objects, while the plate characters will not be affected because they are surrounded by a black background. After removing the unwanted objects, a specific filter is used for illuminating the very small objects based on the size of each one

2.3 Analysis and Dilation

The principal objective of this stage is to find out the rough location of the license plate. This is achieved by the connected components (objects) analysis, which looks for objects having an appropriate size and aspect for each connected component in the image, the height and width values are calculated. According to the height values, for instance, only the objects with a height greater than *T*min_*h* and less than *T*max_*h* are retained, and eliminate the other objects. After that, if the width values of the retained objects are greater than *T*min_*w* and less than *T*max_*w*, the objects are retained; otherwise, the objects are removed, and so on. Where:

*T*min_*h* : Minimum height of the object.
*T*max_*h* : Maximum height of the object.
*T*min_*w* : Minimum width of the object.
*T*max_*w* : Maximum width of the object.

Afterwards, the result of this step is an image containing only the plate characters and few small objects.

The resulted objects almost share the same size with the plate characters. The morphological operation (dilation) therefore, is used for combining the closed objects, by using a structure element (SE) value equals to 7×28 pixel. The purpose of using the dilation process is to obtain the rough

location of the license plate region. As indicated previously, Indian license plates are composed of single or double row(s) of characters. For this reason, the first value of the SE is used for joining the two sets of characters in license plates with double rows style; and the second value is used for joining the sets of characters in license plates with a single row style

2.4 Accurate Location of License Plate and Extract the Plate Region

The aim of this stage is to obtain the accurate location of the license plate region. It is proceeds as follow:

a) Find out starting and ending position of the plate region by means of counting no. of ones in each row.
b) Extract that region only from the image.

III. Plate Candidates Rectangles Filtering

After identification of plate candidates we must realize some special filters before optical character recognition stage. Below we give a short description of filtering with real plate candidate example Plate candidate

Step 1. Apply low frequency filter with convolution matrix. The result of this filter given in Figure 2.

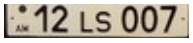


Figure 2 Plate region

$$H = 1/10 \begin{pmatrix} 1 & 1 & 1 \\ 1 & 2 & 1 \\ 1 & 1 & 1 \end{pmatrix}$$

The result of this filter given in Figure 3

Figure 3. Result of filtering

Step 2. Apply image enhancement filter using convolution. The result given in Figure4.

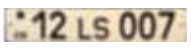


Figure 4. Result of Image Enhancement filter

Step 3. Apply image binarization filter. I.e. Find out average of minimum and maximum pixel in the image. The result is given in Figure 5

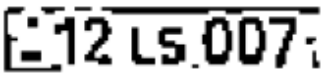


Figure 5. Result of Binarization

Step 4. Apply the contour of the binary image to obtain the contour with one pixel thickness.

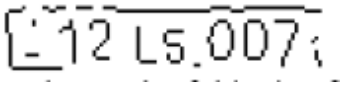


Figure 6 Result of thining using contour

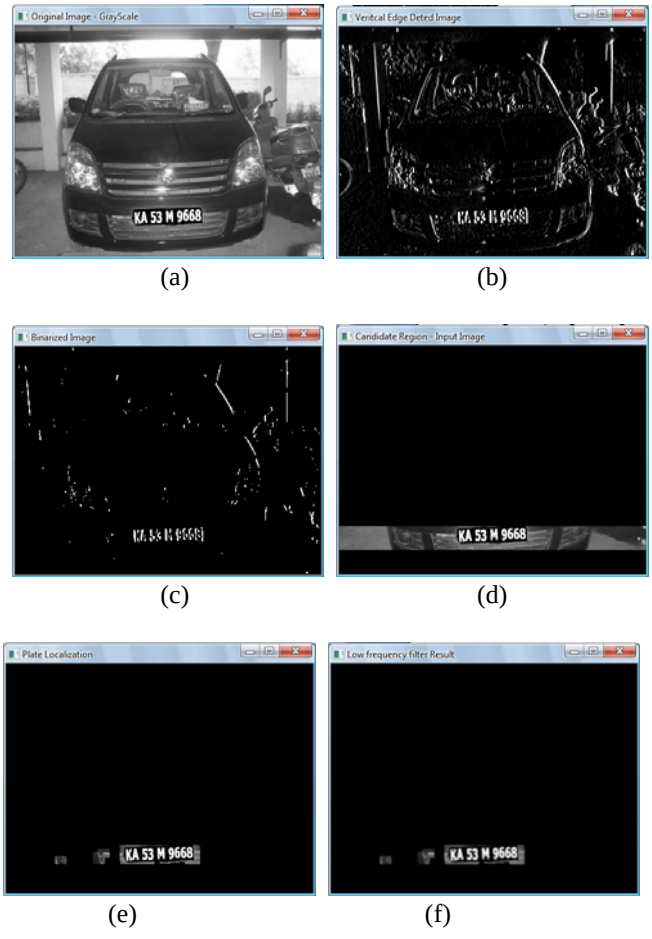
Step 5. Using the vertical and horizontal projection removes the false piece on the plate and defines also the number of rows and symbols in the plate.

Figure 7 Result of Horizontal and Vertical projection

Step 6. Defining the chain code of symbols and its recognition. To create chain code of symbols first symbols are approximated by linear segments

IV. Experimental Results

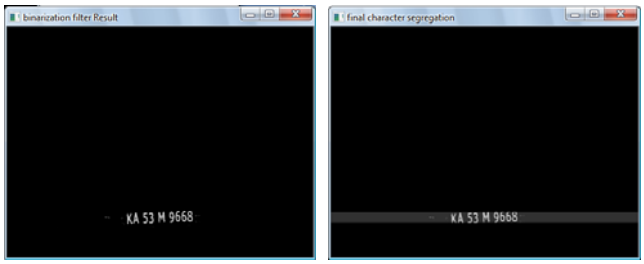
This method has been tested over a large number of images with size of 368 x 254 pixels in order to analyze its performance. It segregates character in 95% accuracy. It is implemented in IDL 7.0. The performance of the test results demonstrate that the proposed method is efficient to be used for the license plate recognition system.



(a) (b)

(c) (d)

(e) (f)



(g) (h)

Figure 8 a) Original Image b) Edge detected Image c) Binarized Image, d) Candidate Region image e) Plate Localization f) Low frequency filter g) Binarization h) Final character segmentation

TABLE 1: The results of license plate extraction

Total Vehicles images	Extracted license plates	Unsuccessful extraction
150	147	3
Percentage	98%	2%

V. CONCLUSION

A simple but efficient license plate extraction method is presented in this paper. The proposed method is mainly designed for real-time Malaysian license plate, and can be readily extended to cope with license plates of other countries, especially those using Latin characters. Our method is based on the morphological algorithms and connected components analysis, comprises four major stages, which are, RGB to gray-scale conversion, image binarization and filtration, analysis and dilation, and extracting the accurate location of the license plate and character are extracted in efficient way. To measure the efficiency, our method has been tested over a large number of images acquired under various illumination and weather conditions (sunny, cloudy, daytime, nigh time, rainy days...etc), and achieved a satisfactory results.

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