An Efficient Method of License Plate Location Based on Structure Features

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Abstract. License plate recognition system is an important part of intelligent transportation system, while the vehicle license plate location is the key of it. In this paper, a new method of license plate (LP) positioning is proposed. In this method, firstly, the input image is preprocessed. Then, the texture and color features are used to remove most of disturbance. After that, the regions which have the structure and texture that is similar to the license plate are extracted. Finally, pseudo-region is eliminated and true LP is precisely located. The working principle is taking full advantages of plate texture, color characteristic and structure features to choose candidate regions. Experimental results illustrate that the method is robust and can increase the location accuracy distinctly.

Keywords: Vehicle license plate location, texture, color, pseudo-region, structure features.

1 Introduction

Automatic license plate recognition system has already been used in traffic surveying and monitoring, automatic toll, etc. Of all these application areas, license plate location plays an important role, and also it is the most difficult step.

Nowadays, the main methods of vehicle license plate location are as follows: the method based on projective invariance [1], the method based on Hough transform [2], the method based on the color feature of the vehicle license plate [3], the method based on morphology [4], the method based on the texture feature of the vehicle license plate [5, 6], and so forth. The presently available methods turn out to be not effective enough in the case of complicated background, varying illumination, and low-quality images.

In order to improve the location accuracy, this paper presents a new approach for vehicle license plate location based on structure features. The rest of this paper is organized as follows. In section two, the license plate location method is discussed in detail. Experimental result and analysis are presented in section three. Concluding remarks are given in section four.

2 Method for License Plate Location

This method consists of four stages which will be discussed in the following subsections.

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2.1 Pre-processing

Original images often suffer from various types of degradation such as noises and low contrast. Therefore, the input images need to be preprocessed. In this proposed method, only the image brightness information is used. So, the original image should be converted into grayscale according to formula (1).

$$Gray = 0.299R + 0.587G + 0.114B \tag{1}$$

In order to filter out the small particle noises which maybe affect the positioning effect, median filter is chosen. Due to various reasons, the license plate is not prominent against the background, here, top-hat transform is employed to restrain the background and give prominence to the license plate region. Top-hat is a morphological operator. It can suppress the background of number plates and enhance plate regions, so it is very favorable to plate location.

2.2 Getting Candidate Regions

There is lots of texture information in the plate region, especially the vertical edge. This feature is employed for locating the plate in an image. The following steps which describe in details can get the candidate regions.

Step 1: Using the operator "sobel" to detect the vertical edge of the license plate, pay attention to choose the appropriate operator.
Step 2: Using the color feature to eliminate some disturbance of the edge detection image, because of the fixed color collocation of the license plate. Before using this feature, the gray image should be transformed into HIS image. After do that, the de-noise edge detection image is shown in Fig.1 (a), which will be based on to do mathematical morphology.
Step 3: Using mathematical morphology method to get the candidate regions. The structure element is 3*3, which must be selected appropriately; otherwise it will influence the final positioning accuracy. And the detail processes are: erosion, erosion, close operating, dilation, dilation, dilation. The results of these processes are connective regions. Fig.1 (b) shows these regions.

(a) (b)

Fig. 1. (a) The De-noise Edge Image (b) Results after Morphological Processing

2.3 Coarse Location

Chinese license plate has an obvious structure feature, namely the width height ratio is 3.14.Taking into account possible inclination of license plate, the width height ratio could be set between 1.5~5.The connected regions without the proper width height ratio are eliminated. If only one connected region remains, it could be regarded as the region of the vehicle license plate. Otherwise, the other three conditions which are listed as follows will be used.

Condition 1: Density, the density of the license plate is defined as follows:
From the vertical edge detection image, it shows that the density of the license plate region is bigger than that of non-plate region. The proportion of the white pixels (the character brackets after the edge detection) in the whole candidate region is defined as the density. Let N be the number of the white pixel in the whole candidate region, L is the width of the candidate region, H is the height of the candidate region, and D is the density, which can be calculated as the formula(2):

$$D = N/(L \times H) \tag{2}$$

The density (D) of the license plate is between two specific values, which can be a structure feature to exclude the pseudo-plate regions.

Condition 2: Using "ostu" threshold method to transform the gray image into the binary image *f(x,y)*.And then get the subtraction image *g(x,y)* according to the following formula(3):

$$g(x, y) = |f(x, y+1) - f(x, y)| \tag{3}$$

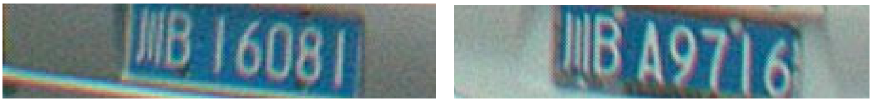
where, if $g(x,y)=0$, then $f(x,y)=0$, else $g(x,y)\neq 0$, then $f(x,y)=255$, x is the number of the row and y is the column. So the number of the white pixel of each row is equal to the gray level jump times in the gray image. The number of this gray level jump times is between two specific values when the area is the real license plate.

Condition 3: The variance of the plate region is smaller than that of pseudo-plate region in the image after edge detection. Calculating the variance (dF) of these candidate regions. The region that its dF is the minimal is the real license plate region. The formula (4) to calculate the variance is as follows:

$$dF = \sum_{i=1}^{L \times H} \frac{(X - a)^2}{L \times H} \tag{4}$$

where, X is the grayscale value of the candidate region, a is the mean of the grayscale value of the candidate region, L is the width of the candidate region, H is the height of the candidate region.

After using these structure features and the three conditions, it can exclude the pseudo-regions which not fit above features and get the coarse location of the license plate. The results are shown in Fig.2.



(a) (b)

Fig. 2. Results of Coarse Location

2.4 Precisely Location

The results show that the coarse location is not precise. So the images need to be further processed. Using Hough transform to detect the tilt angle and make them paralleled before the precisely location. This precisely location method is divided into two parts, horizontal location and vertical location.

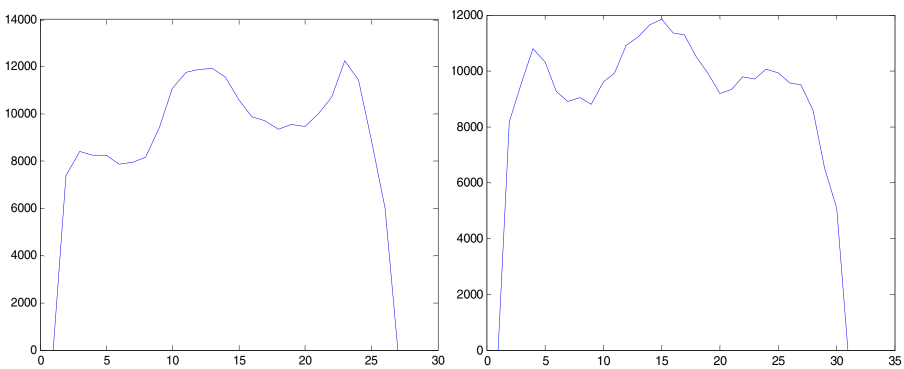
1) Level Location

In this paper, using the formula (5) below for the level projection, which is

$$T_h(i) = \sum_{j=1}^{n} f(i, j) \tag{5}$$

where, n represents the number of the column of the binary image *f(x,y)*, i is the row and j is the column.

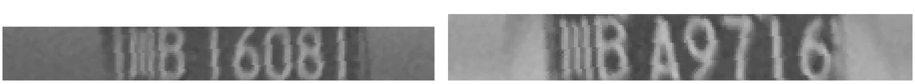
The results are shown as follows (Fig.3):



(a) (b)

Fig. 3. Level Projection of the Image

From the level projection of the image, setting a threshold and using the first row that its level projection is bigger than the threshold as the up and down border of the license plate, so candidates of the license plate can be got. The level precisely location results are shown in Fig.4.



(a) (b)

Fig. 4. Candidates of the License Plate after the Level Location

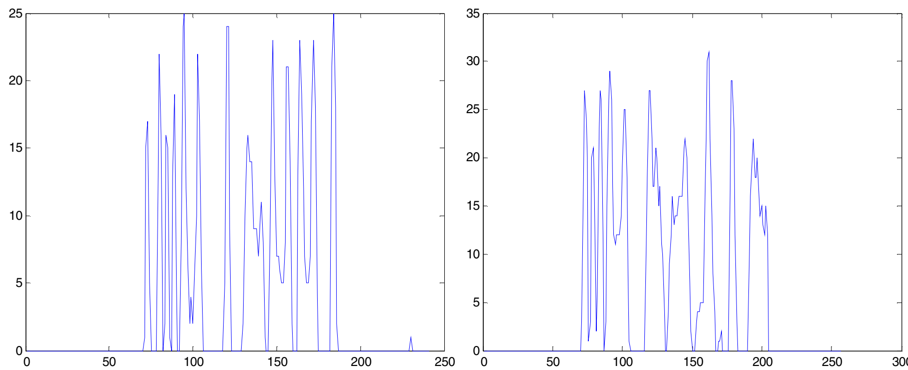
2) Vertical Location

During the vertical location, the integrated location method based on edge detection and vertical projection is taken. When converting the gray-scale image into binary image, selecting the "ostu" method and taking the formula (6) below to calculate the vertical projection, which is:

$$T_v(j) = \sum_{i=1}^{m} f(i, j) \tag{6}$$

where, m represents the number of the row of the binary image *f(x,y)*, i is the row and j is the column.

The results are shown as follows (Fig.5):



(a) (b)

Fig. 5. Vertical Projection of the Image

As the result, the left and right border of the license plate can be got that using the first column which its vertical projection is bigger than the specific threshold that we set according to different plate images. The finally located images are shown in Fig.6.

(a) (b)

Fig. 6. Final Location of the License Plate

3 Experiment Result and Analysis

A data base of 250 images, which are taken from many kinds of conditions, such as different angles and different lightening conditions, corrupted and stained license plates is used in the experiment. The experiment is oriented to Chinese LPs, and the result is illustrated in Table 1.

Table 1. Experimental result

Different condition	Total image number	Location number	Location rate
day	150	146	97.3%
night	100	95	95.0%

This experiment result reveals that the proposed method is robust and has high accuracy.

4 Conclusions

As indicated above, we can get good result using this method. It fully uses the special structures of the license plate and employs the fixed structure features of the license plate, which is very stable, so comparing to other method, it has a good performance. As a whole, our experiment shows that we can get good location accuracy with this method in different conditions, and the time for location is very short. So, this method can be applied to high real-time requirements of intelligent system.

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