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An Improved License Plate Location Method Based On Edge Detection

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Abstract

License plate location as one of the key steps in license plate recognition system, the positioning accuracy is direct impact on the effect of license plate recognition. In this paper, for the plate image that is under different backgrounds and lighting conditions，a license plate location method based on an improved prewitt arithmetic operator was proposed. Firstly，do improved prewitt operation on the preprocessed plate image. Then, use the characteristics of vehicle license , adopt the horizontal and vertical projection method to determine the location of the upper and lower edge around the edge position, in order to achieve the positioning of vehicle license. The experiments results show that the algorithm with high accuracy, positioning speed and have good practical value.

Keywords—License plate location, edge detection, projection, prior knowledge

1. Introduction

License plate location as one of the key steps in license plate recognition system, the positioning accuracy is direct impact on the effect of license plate recognition. In practice, due to complexity of image background license plate, vehicle type and variety color, and change as a result of different weather conditions and other factors in different light, making accurate positioning difficulty [1].

Some methods have been used in the License plate location. This includes different approaches such as based on the HSI color model [2], [3], based on the textures of the license plate [4], base on edge statistics and morphology [5]. Segmenting the plate region by neural network [6], based on Hough transform [7].and based on mathematical morphology [8].

In this paper, for the plate image that is under different backgrounds and lighting conditions，a license plate location method based on an improved prewitt operator was proposed. do improved prewitt operation on the preprocessed plate image. Then, use the characteristics of vehicle license, adopt the

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horizontal and vertical projection method to determine the location of the upper and lower edge around the edge position, in order to achieve the positioning of vehicle license.

2. License plate location

The proposed method includes four stages as follows: The proposed method which include Image preprocessing as Image gray and strctch, edge detection via eight templates of Prewitt operator, extracting the candidate regions based on horizontal and vertical projection, and locating the plate region exactly with prior knowledge and texture character.

The flowchart of this algorithm is schematically depicted in Figure.1.

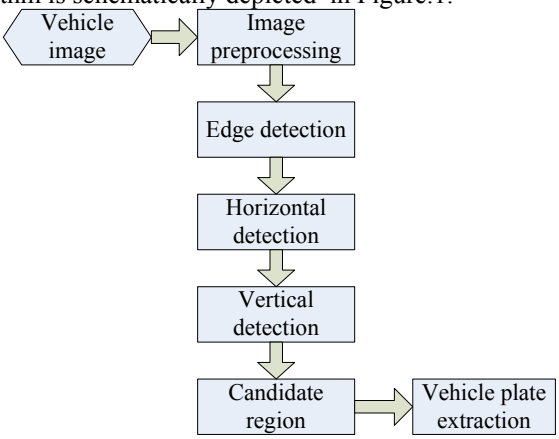


Figure.1 The flow diagram of license plate location

2.1 Prepreocessing of license plate location

a) Gray: Being real-time capture images of vehicles containing 640 * 480 24-bit true color chart, be converted to grayscale, on the one hand to facilitate a more rapid follow-up image processing, on the other hand is dealing with a variety of colors vehicle license for a uniform. Gray used the current standard of the average method, with g that after the gray of gray value, R, G, B, respectively, stand for the original true-color image of the red, green and blue components. Therefore

$$G = 0.11*B + 0.59*G + 0.3*R \tag{1}$$

b) Gray stretch: the graying of the image contrast stretching to the edge of the image is more prominent, so that the stroke characteristics of the license area is more obvious and more beneficial to the next step of edge detection.

$$G' = \begin{cases} 0 & G < MIN \\ \dfrac{(G - MIN)}{(MAX - MIN)/255} & G > MIN \,\&\&\, < MAX \\ 255 & G > MAX \end{cases} \tag{2}$$

Where min, max can be set dynamically in the program, you can also experience the value of the experimental set. Then needs to be done after contrast stretching from the edge detection of gray image.

（a） （b）

Figure.2 a-- Original image, b-- Image after preprocessing

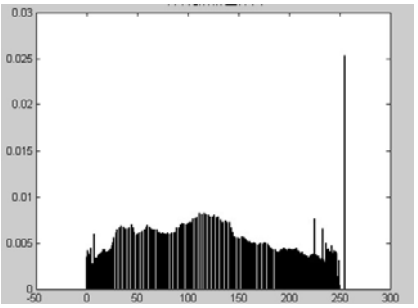


Figure.3 Histogram after gray stretch

2.2 Edge processing algorithms

At present, the vehicle plate's size is 440mmxl40mm in China. License generally dispose from seven characters which is 45mmx90mm are level arranged. Plate region of characters and background large in contrast, has rich edge information. According to the license plate's features, the following location algorithm design is show. [9]

(a) Prewitt operator

Prewitt operator is shown in Fig.5, the formation of two convolution. In processing, the image of each point are carried out with these two nuclear convolution, the vertical edge of a nuclear response is usually the largest, and the other on the level of the maximum edge response. Two convolution is taken as the point of the output bit. The result is a range of computing the edge of the image. Figure.4 is the template within the template of figure coefficient, the middle point of said central element[10].

$$\begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix} \qquad \begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{bmatrix}$$

Figure.4 Prewitt operator

Prewitt operator using pixels from top to bottom, left and right adjacent point difference of gray, in the extreme edges to detect. It has a smoothing effect on noise, but its position accuracy is not enough. Prewitt operator, basically lost the corner information, it is not isotropic. To solve the above problem, this paper presents a modified Prewitt operator –eight templates of prewitt operator.

(b) Eight templates of prewitt operator

There are many edge directions in the vehicle images. In addition to horizontal and vertical direction, there are other edge directions, such as 45 °, 35 °, etc. This article will consider the Prewitt operator to increase 6 templates.

–1	–1	–1		–1	–1	0		–1	0	1		0	1	1		1	1	1	
0	0	0		–1	0	1		–1	0	1		–1	0	1		0	0	0	
1	1	1		0	1	1		–1	0	1		–1	–1	0		–1	–1	–1	

Figure.5 Eight templates of Prewitt operator

Basic principle of Algorithm:

As the brightness changes larger in the edge of image, so it can put those pixels which Neighborhood gray-scale changes over a suitable threshold as edge points.

The main steps of Algorithm:

step1: Template with eight directions were along the image from one pixel to another pixel，and the center of the template image pixel and a pixel location in coincidence;

step2: The coefficient and the template image pixel values corresponding to multiply;

step3: Add all products, Convolution of the two maximums, assigned to the center of the image pixel corresponding to the template, as the new gray value of the pixel;

step4: Take the appropriate threshold Th, if the new pixel gray value> Th, then the pixels is the image edge points.

(a) (b)

a-traditional prewitt operator; b-eight prewitt operator

Figure.6 The result of edge detection

The Fig.6 listed out after the traditional Prewitt operator and the improved prewitt operator to operation of the vehicle image. From the figure, it is shows that the improved detection of prewitt operator, the edge feature in the more complex cases is better than traditional Prewitt operator.

2.3 Rough positioning plate

After the vehicle image is preprocessed, plate region in the horizontal, vertical directions, the texture information is more abundant than the other regions. Coarse location method based on the principle of gray image texture features to achieve the process was divided into two steps: horizontal position and vertical positioning.

1) horizontal position

The image is to do Horizontal projection operation, the level projection value Ph is defined as follows:

$$Ph = a * \frac{\sum_{i=0}^{width-1} Hgraysum(i)}{width} \tag{3}$$

In above equation, $Hgraysum(i)$ means the summation of the I-rows of each points of the pixel, $width$ is the number of columns in the image, a equals constant coefficient. The physical meaning of the Ph is the average position in a row projection of a vertical line, more than some characteristic value that corresponds to two strip regions is the level of information includes license plate bar. Then separate it from the original image.

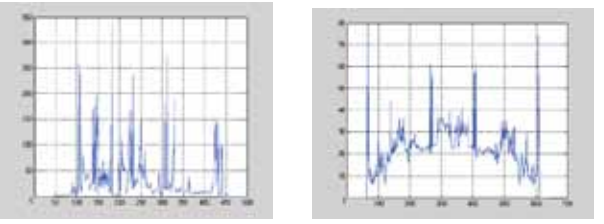
2) Vertical Position

After a series of horizontal positioning operation to find the level of the image, the next position to the vertical direction to determine the general area include license plate. Vertical projection of the characteristic values such as (6) shows:

$$Pv = a * \frac{\sum_{j=0}^{Pheight-1} Vgraysum(j)}{Pheight} \tag{4}$$

In above equation, $Vgraysum(j)$ means the summation of the j- column of each points of the pixel, $Pheight$ means the height of Strip image ,the value of a equals 1 / 2. The physical meaning of the Pv is the average position in a column projection of a horizontal line, more than some characteristic value that corresponds the average position in a column projection of a straight line.

Then separate it from the original image.



(a) (b)

a-- horizontal projection b--vertical projection

Figure.7 The gray statistical of graph

2.4 Vehicle plate extraction

After using the above approach does not always have a single vehicle license plate region, this is because the car license and the license area with the similar background information. When there are multiple candidate regions, it needs to remove some false car license area, and get the true vehicle license area. In practice, vehicle license plate has a strong texture and geometric shape of the rules. According to Vehicle license's characteristics, design rules to remove false car license.

(1) The candidate regions as rectangular, length and width ratio of R, this value is about 3.14 in China. Vehicle license plate region serves $R \in [R\min, R\max]$, therefore, it can delete candidate regions

by $|R-3.14| \le N$, N is pre-set threshold. In this paper, Because of factors such as shooting and tilting, N=0.5.

(2) From the global perspective, the entire image area and the vehicle license plate area ratio changes in a range that will not meet the requirements of the region is also set to the background pixel value.

The specific method is to mark the candidate regions, the marking value shall be the value of pixels in the region. Projection obtained by the four coordinates of the region, and then by the above two rules to remove false car license, get car license area, that is the successful positioning.Figure.8 is respectively denote under the approval of the rules locate vehicle plate area and the area under the segment of the vehicle license plate. The result of license plate location is as follows:

Figure.8 The candidate regions and the extraction plate

3. Analysis and conclusion

For the proposed method, multiple images for the License Plate Location in a variety of weather conditions and different background is tasted. Experimental result shows that this algorithm has high accuracy, reaching 96.75%. And that the positioning identification time is short. Identification of all the images of times within the 0.2 sec, is a real time and accuracy.

The algorithm based on the vehicle license to carry out the regional character gray feature detection. Combined with improved prewitt edge detecting operator to design a scan location algorithm. Enter the vehicle images generally have all kinds of disturbances. The proposed method solves the license plate extract problems due to a variety of outside interference and the human factor. The algorithm not only has high accuracy, and positioning speed, feature detection interference effective, to meet the needs of real-time systems, with good prospects.

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