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An Improved Plate Recognition Method Based on Template Matching

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Abstract

This paper proposed an improved template matching method for fouled license plate recognition. Designed for smeared license plates and blurred license plate recognition, this method matches license plate with a given improved template to recognize characters. By utilizing the information obtained in the process of license plate location and character segmentation, the feedback will contribute to the process of license plate recognition. By enlarging the difference value between characters in template and plate, the match degrees can be compared, which could help determine the result of character recognition. The improved template matching method improves the accuracy of dirty license plate recognition and can be employed to identify license plate characters. Experimental results showed that this method offers strong environmental adaptability and robustness.

Keywords - *template matching, license plate recognition, fouling license plate, license plate character, fuzzy license plate, character matching recognition*

I. INTRODUCTION

The license plate recognition system is widely used in the transportation sector such as toll station, urban intersection and parking management and has become a popular topic in the field of image processing and pattern recognition. It comprises three parts: [1-4] license plate localization, license plate segmentation and license plate character recognition.

There is a variety of license plate character recognition methods, those major approaches based on neural network, character stroke feature, and fuzzy recognition can effectively identify the license plates that have high resolution and clear image. However, for those dirty license plates or low quality captured images, the above methods are not optimal choices. License plate recognition part has a license plate recognition method based on the analysis of the feature information of the license plate. For example, document [18] made full use of the information obtained in the process of license plate location and character segmentation to feedback the process of license plate recognition. It combines license plate location and character segmentation and pays attention to the separation between the license plate and the vehicle background image. Connected domain analysis is used as a character segmentation to improve accuracy. Literature [6]

Uses radial basis neural network (RBFNN) to identify the license plate, in which a hybrid structure optimization algorithm is employed; this uses non-full character input and multilayer identifier in recognition. The hybrid structure optimization algorithm reduces the structure of RBFNN and improves the generalization ability of RBFNN; the non-full character reduces the input of RBFNN and improves the speed of recognition; the multilayer recognizer can guarantee a high recognition rate of the non-full character input. Combining RBFNN's hybrid structure algorithm with non-full character input and multilayer recognizer allows improving recognition speed while keeping a high recognition rate. The simulation test in document [6] demonstrated that the method has a great advantage over the time complexity of the license plate recognition compared to the full character input. Compared with the RBFNN license recognition using K-means algorithm, this method has a certain advantage in the generalization ability.

An improved template recognition method is proposed in this paper, which divides each character separately then divided separated characters into small parts; Each part of the individual character will be compared with parts that constitute the template such that the different values will be obtained; the difference values of parts will then be accumulated to acquire the total difference between the character of the license plate character and the template character. Finally, the characters have the most significant matching degree / minimum difference value will be taken as the recognition result, and the flow chart is displayed in Figure 1 below. This method can identify the characters of the dirty license plate effectively and has good robustness and stability.

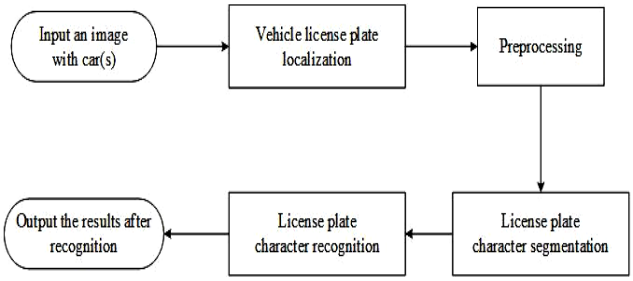

Figure 1 license plate recognition flow chart

II. LICENSE PLATE LOCATION

When observing a vehicle from a distance, the license plate area is mainly determined by the colour and brightness of the license plate and the texture formed on the edge of the license plate character. Therefore, making full use of this information is critical to locate license plates. Considering the license plate region can be different from other areas, the characters should include the characteristics of the domestic license plate, the contents of the license plate in the country consist of numbers, letters and Chinese characters. The first character is the Chinese character part, followed by one of the 24 English characters (except the letter O and I), and the remaining part is a combination of numbers and letters. According to the characteristics of Chinese license plate characters, a template is used to create templates, and the recognition rate is high. The grey level projection of images shows good continuity, and there are no large fluctuations, which are reflected in texture information; that means the distance between vertical edges is regular. The method of license plate location in this paper is based on the combination of the two features of the character position of the license plate and the regularity of the projection, in this case, the interference area is eliminated more effectively, and the localization of the license plate is more efficient and accurate.

In the license plate location stage, rough location [7] horizontal positioning and vertical positioning is employed to locate the license plate area roughly. First, it is necessary to determine the upper and lower boundaries of the license plate by horizontal projection. Although there is a massive grey level change in the horizontal direction of the license plate area, the horizontal grey projection in the license plate range will not be greatly undulating due to the good continuity of the grey level in the vertical direction. The projection value of the body or the background is significantly different in the upper and lower regions outside the license plate. Then a similar method is applied to determine the left and right sides of the license plate by vertical projection. The rectangular area is identified as the license plate area.

In this paper, the license plate area in the image is located at first, then move to the process of the stained license plate image. The picture below is the original picture of the license plate, as shown in Figure 2.

Figure 2 a picture containing a stain on the license plate

The smeared license plate area is extracted from the image containing a dirty license plate, as shown in Figure 3 below.

Figure 3 defiled license plate

III. LICENSE PLATE IMAGE PREPROCESSING

The complete license plate recognition process includes four steps: image preprocessing, license plate location, license plate segmentation and license plate recognition [8]. In the above section, license plate localization has been discussed and in following sections license plate preprocessing, license plate segmentation, and license plate recognition will be covered in detail.

A. Image preprocessing

In a practical case, license plates are not always clear due to vehicle motion. Besides, the difference in the road conditions and the actual environment such as strong light, shielding, pollution and blur will have a great impact on the capturing of the camera, which would then affect the quality of segmentation and recognition of the character. The most important step in the early stage is the preprocessing of the image [9]. In the preprocessing, the first step is the grey scaling, and the resultant image is greyscaled, as shown in Figure 4 below. Then a Gauss filter is used to remove Gauss noise to smooth the image.

Figure 4 a greyscale map

a) Gauss filter

Gauss filtering is a linear smoothing filter, which is applied to eliminate Gauss noise and is widely used in the noise reduction process of image processing. Generally speaking, the Gauss filter is the process of a weighted average of the whole image, and the value of each pixel is obtained by the weighted average of its own and other pixel values in the neighbourhood. The specific operation of Gauss filter is to use a template (or convolution, mask) to scan every pixel in the image, and to replace the value of the template centre pixel with the weighted average grey value of the neighbourhood pixels in the template. The image after Gauss filtering is shown in Figure 5 below:

Figure 5 image after Gauss filtering

Gauss smoothing filter is used to remove blurred images, which has a similar function with mean filter. However, unlike the mean filter, the kernel is different. The elements of the mean filter kernel are identical, while the elements in the kernel of Gauss smoothing filter present Gauss distribution.

For the two-dimensional Gauss distribution:

$$G(x,y)=\frac{1}{2\pi\sigma^2}e^{-\frac{x^2+y^2}{2\sigma^2}} \quad ;$$

b) Edge detection

Image edge detection [19] greatly reduces the amount of data and exclude irrelevant information, retaining important structural properties of images. There are two kinds of methods for edge detection: search-based and zero crossings. Based on the lookup method, the boundary is detected by finding the maximum and minimum values of the first derivative in the image, usually locating the boundary in the direction of the maximum gradient. Based on the zero-crossing method, it is found that the two order derivative of the image and zero crossings to find the boundary, usually Laplacian zero crossing or nonlinear zero difference zero crossings.

The Sobel edge detection algorithm is relatively simple, and it is efficiency in practical application is higher than Canny edge detection; however, the edge is not as accurate as Canny detection. For many practical applications, the edge of Sobel is the first choice, especially when the efficiency is high, while the fine texture is not concerned.

The Laplacian operator is a second-order differential operator in n-dimensional Euclidean space. It is defined as the divergence div of gradient grad. Operation templates can be used to compute this theorem. Since the Laplacian operator is sensitive to noise, the image is usually smoothed first. Due to the fact the template also uses the smoothing process, the usual segmentation algorithm combines the Laplacian operator and the smoothing operator to generate a new template.

In this paper, more accurate edge detection is required since it is the license plate is fouled; the texture should be concerned, and the noise should have some anti-interference. As a result, Canny edge detection is selected in this research. The Canny edge detection algorithm has the characteristics of low error rate, high location and minimal response. The following figure is the effect diagram after edge detection, as displayed in Figure 6.

Figure 6 map after edge detection

B. license plate segmentation

The quality of the license plate directly affects the result of license plate recognition. After license plate localization and image preprocessing, two-valued characters are segmented one by one. Common character segmentation methods include template matching, clustering analysis [11], projection segmentation. The effective region is found before segmentation, and the effective area is intercepted as the segmentation area. In the detection of effective area, the method of row-column scanning is used to find the upper and lower boundaries by statistical jumping times: by scanning from the left and right, the whitest boundary is considered to be the starting edge as shown in Figure 7:

Figure 7 the valid area detected

After detecting the effective area, the next step is to intercept the effective area detected. The following figure 8 is the effective area to intercept.

Figure 8 the effective area intercepted

The vertical projection method is used to segment characters. It is noticed that the interval between the second and third characters when it is segmented. Figure 9 is the result of segmenting the effective region after an interception.

Figure 9 character after segmentation

The seven characters in the segmented effect diagram are segmented separately and standardized together, and the results after segmentation are as follows:

Figure 10 after the standardization of the character segmentation

IV. LICENSE PLATE RECOGNITION

A. Traditional method of license plate recognition

At present, the technology of license plate recognition is relatively mature, and there are a variety of license plate recognition methods. The recognition rate of the license plate recognition using the traditional template matching method is high in case the plate is clear. In Figure 11, in the traditional license plate recognition method, the first character obtained from the license plate (the first 6 in the following figure) is compared with the characters in the template library (the second number 6 and 8 in the following figure), and then the recognized character is output with the smallest difference value.

Figure 11 traditional character alignment

B. Improved template matching method

License plate character recognition is the process of recognizing Chinese characters, numbers, letters and other information on the license plate. The first process of character recognition is character extraction such that a character feature library can be built. Then character recognition is conducted by comparing characters in a character feature library. License plate recognition is commonly used in template matching and neural network. Different from the traditional template matching method, it only matches the template recognition character. In the improved template matching method, the characters and templates to be identified are processed first and then compared one by one after processing. After comparing the travel value, output the smallest value in the comparison value and use it as an output result. The figure shown below is the character extracted from the license plate [14] of a dirty license plate. Since the license plate is stained, conventional template matching methods are not suitable.

An example of the proposed method using single character comparison to demonstrate the principle is offered: Figure 12 is a comparison of the single character of the licens**e** plate and the single character in the template library. The character in the graph from left to right is respectively the license plate character, the damaged license plate character, the successful character in the template library, and the other characters in the template library.

When a character is being proceeded, a single license plate character is extracted and divided into 100 equal elements. At the same time, the characters in the template are equally divided into one hundred equal elements. Then the number of white pixels in each small grid of the damaged character is compared with the corresponding small grid in a template and the difference is obtained. The difference value is then superimposed on the difference values in the 100 grids. Then one of the least difference values is selected as the recognition result and output.

Figure 12 single character alignment

Assume there is a threshold 0<X<255, S is the pixel value of the current point, U is a counter, and V is the number of total pixels in a single grid. Since the pixel value of the two-valued image is only 0 and 255 two values, when the total pixel value of a small grid in the 100 small grids is traversed, the counter U is added to the S>X when it is encountered, until all the pixels in the complete small grid are traversed. The sum of non-zero pixel values in this small grid is U, set a1=U/V, same to the remaining small meshes A2, A3... A100, total sum M can be obtained.

$$\mathrm{M} = \sum_{i=1}^{100} a_i \ ;$$

The cumulative character of the template character is N., and the difference between the dirty character and template character is L , $L = |M - N|$.

Seven characters in the license plate were located at a fixed position. When the fouled character is compared with the template character, if the fouled character is in the first place, the fouled character is compared with the Chinese character template. If the fouled character is in the second bit, the character is compared to one of the 24 English characters in the license plate (except for the letter O and I), if the fouled character is the later five, because The five-number is the combination of numbers and letters, matching the stained characters with the templates of numbers and

letters. After comparisons, the seven positions of the license plate characters take the template character, which corresponds to the minimum L value and output the recognition result for this method.

The following figure is the result of identifying the plate as shown in Figure 13

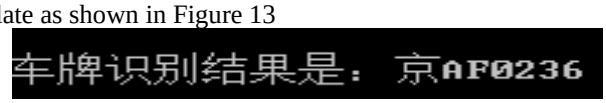

Figure 13 license plate character recognition results

V. CONCLUSION

Due to the high recognition rate of template matching method[15], it is used in this paper to identify the contaminated plate and make full use of the local and whole information of the character of the license plate. Because the difference of the local character of the license plate character is not very large, the difference of each small part of the license plate character is superimposed such that the differences of the local elements are transformed to global difference. Based on the above information, an improved template matching method is proposed to identify the license plate character of [16]. The method divides the damaged characters into many small parts. The difference values are calculated between each small part and corresponding parts of the template; the difference values of each small part are added to obtain the final total difference between the character and the template. Then each template is compared with the fouled character; once the difference value is obtained the template characters with the minimum difference value of the fouled character is selected to be output, and it is identified as the result of recognition. Experimental results showed that this method could detect and identify dirty character plates effectively, and has a high recognition rate for dirty license plates. However, the effect of image recognition is not accurate enough for a contaminated area, or the recognition rate is not too high. Therefore, on the basis of the algorithm in this paper, the next step should be focusing on the situation that the pollution area is larger or the image recognition rate is not too high, and it is expected to get a better effect on the identification of the contaminated plate.

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