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Research on Image Preprocessing Algorithm of License Plate Recognition System

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Abstract: ITS (Intelligent Transport System) can not only be used in public transport fields such as expressway ETC lanes and traffic guidance, but also can be used in fields such as car theft prevention, community guards, parking fees, etc. For cars, the license plate is the only sign to prove their identity, so in traffic management, obtaining a license plate can successfully solve various problems. Therefore, people have paid more and more attention to the automatic license plate recognition technology. License plate location, character cutting, character recognition and post-processing are the key technologies of the automatic license plate recognition technology.

1. Introduction

In recent years, with the development requirements of transportation modernization, the demand for cars has grown rapidly. At the same time, the pressure faced by urban traffic management systems is also growing. People's demand for a perfect ITS Intelligent Transport System is also growing. The emergence of the ITS concept is mainly to solve the problems that people have in transportation and are difficult to solve manually. License plate recognition system is an intelligent technology widely used in traffic field, vehicle management and safety monitoring. With the rapid development of China's economy and the advancement of urbanization, the number of vehicles has increased dramatically. License plate recognition system plays an increasingly important role in maintaining traffic order, ensuring traffic safety, promoting intelligent transportation, etc. However, in practical applications, license plate recognition systems face many challenges, such as uneven lighting, license plate contamination, tilt, blur and other image preprocessing problems. Therefore, the research on image preprocessing algorithm of license plate recognition system has important theoretical and practical significance[1].

2. Principle of license plate recognition

The process of license plate recognition is mainly divided into the following steps: image preprocessing, license plate positioning, license plate character segmentation, license plate character recognition [2]. The flow chart of the current license plate recognition system is shown in Figure 1.

The license plate used in this paper is mainly divided into six steps: image input, license plate area location, denoising of license plate area, character segmentation, character recognition, reading and storing recognition results. The flow chart is shown in Figure 2. The difference from the mainstream

method is that it is convenient and easy to directly locate the license plate area of the collected RGB color image. The basic working process is as follows[3]:

(1) When the moving vehicle passes by, the sensor buried in the fixed position will be triggered, and the system will be awakened to work; Once the photoelectric sensor connected to the optical shutter of the camera is triggered, the camera set at the front, rear and side of the vehicle simultaneously captures the vehicle image;

(2) The image with the vehicle license plate taken by the camera or CCD camera is input to the computer through the video card for pre-processing. The image pre-processing includes image conversion, image enhancement, filtering and level correction[4];

(3) The license plate is searched and detected by the retrieval module, and the rectangular area containing the character number of the license plate is located and segmented;

(4) The license plate characters are binarized and separated into single characters, which are input into the character recognition system for recognition after normalization[5].

(5) Read the recognition results and store them in the database.

Figure 1: Current License Plate Recognition System Flow Chart

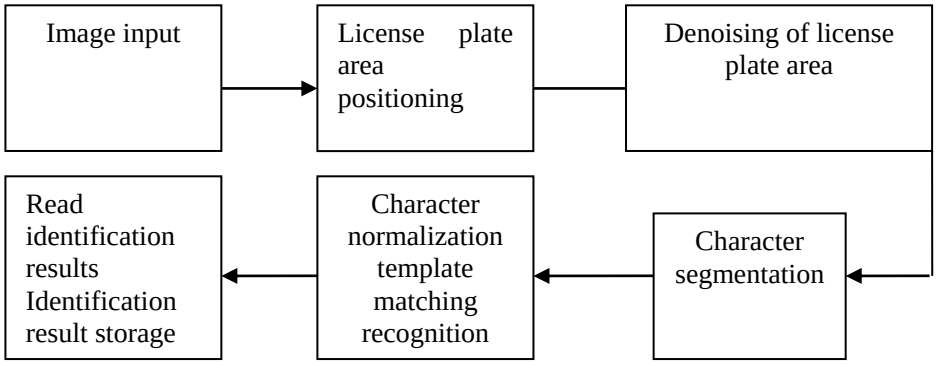

Figure 2: Flow chart of license plate recognition system based on RGB image

3. License plate recognition algorithm based on image processing

License plate recognition first needs to accurately locate the position of the license plate in the existing vehicle pictures, and then carry out a series of corrective operations to identify the number. However, it is very difficult to accurately identify the license plate, because the vehicle models in the image are mixed with the background, and the image quality is also easily affected by various external factors. So experts at home and abroad have carried out a lot of research to solve the problems in license plate recognition and improve the recognition accuracy[6].

3.1 Common algorithms for license plate location

The image environment may contain a large number of irregular images, such as trees, sky, streets, etc., or some rectangular interfering objects, such as banners, which make the vehicle images different[7]. Moreover, outdoor cameras are vulnerable to environmental factors, so it is particularly difficult to extract license plate areas from the collected images. The current license plate positioning methods are as follows:

1) Location method based on gray feature

Because the license plate area contains 7 characters arranged regularly, when we scan the gray image of the number using the horizontal scanning line, we can get a continuous wave crest image. Barroso accordingly created a license plate location method based on horizontal line scanning [8]. At the beginning, the overall image of the vehicle is placed in the horizontal scanning line in the set gray change threshold. When the gray level of a certain part is greater than the set threshold, we think that this area may be the required license plate area. This positioning method can roughly determine the position of the license plate edge, but its limitation is still great, because it can not perfectly find the left and right edges of the license plate after using this method, which brings great trouble for further operation.

2) Location method based on geometric features

This method uses edge detection in the image to find a rectangular area to determine the position of the license plate. The obvious disadvantage of this method is that it generally has poor accuracy in the tilt direction, and its advantage is simple and convenient.

3) Positioning method based on wavelet analysis

This method is usually combined with the next method. Firstly, this method is used to locate the small area of the suspected license plate, and then the mathematical morphology method is used to detect and find the correct license plate area. This method will produce a large amount of data and consume a lot of time when it is actually used.

4) Location method based on mathematical morphology

This positioning method is generally used together with the previous method or edge detection algorithm.

5) Positioning method based on RGB/HIS image

The previous algorithms are all based on the positioning algorithm of gray image, which requires image pre-processing to convert the license plate image into gray image and perform gray stretching operation, which is more complex. Of course, you can also directly identify the horizontal and vertical blue pixels on the RGB image to find the area with the most blue pixels and the shape meets the requirements. This paper will use this direct location method based on RGB images. The obvious disadvantage of this method is that when using color pictures for operation, it will produce a large amount of calculation, and it is easy to fail to locate on a background with more blue color blocks or on a blue vehicle.

3.2 The method and results of license plate location in this paper

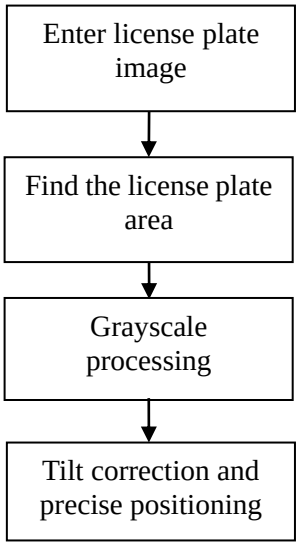

Figure 3: Color information extraction and license plate area location

Whether the license plate can be accurately located will seriously affect the accuracy of character segmentation and character recognition. Its main purpose is to determine the specific location of the license plate in the original gray image after image preprocessing. This system uses the positioning method based on RGB image for positioning. The main process is shown in Figure 3.

1) Image acquisition and rough location of license plate area

After the license plate image is input, the color image is now converted to the double precision floating point type, because in general, the image is stored in uint8 data. When performing data operation on a picture, data greater than 256 will overflow and the result will be distorted. So far, the rough location of the license plate has been completed, and this area will be intercepted for the next operation. As shown in Figure 4.

Figure 4: Locating License Plate Area

2) Gray processing and tilt correction of license plate image

The located license plate area is converted into a gray image for tilt correction. As shown in Figure 5.

Figure 5: License plate area after tilt correction

3) Noise removal of license plate area

Because each license plate character occupies the same space, it can be determined that the width of the first two characters and the last five characters accounts for a fixed proportion in the whole license plate width. According to the measurement, the first two characters account for about 0.27 of the width of the license plate, and the first two characters and white dots account for about 0.32 of the width of the license plate. The first 0.27 and the last 0.68 parts of the license plate image are intercepted respectively, and then the two parts are merged to obtain the license plate image without dots. Even if the dot is not completely cut and there are some residues, only a small part will be left. Later mathematical morphology operations can be easily erased without affecting the quality of other characters. As shown in Figure 6.

Figure 6: License plate area after removing dots

4) Precise separation of license plate area

Since the following character recognition template is black characters on a white background, we first take the image of the license plate area as non, that is, reverse the color of the image. As shown in Figure 7.

Figure 7: Precisely located license plate area

4. Character cutting

The effect of character recognition will directly affect the accuracy of character recognition later. If the 7 characters in the license plate cannot be segmented correctly, it will mark the failure of license plate recognition. When segmenting license plate characters, the whole system should not only be able to match different picture quality and different shooting environment, but also be able to prevent interference factors such as spots or reflective spots on the license plate that may cause segmentation errors.

Based on the binary image of license plate region, this paper uses projection method and clustering analysis method to segment the characters of the image. The specific segmentation algorithm is as follows shown in Figure 8.

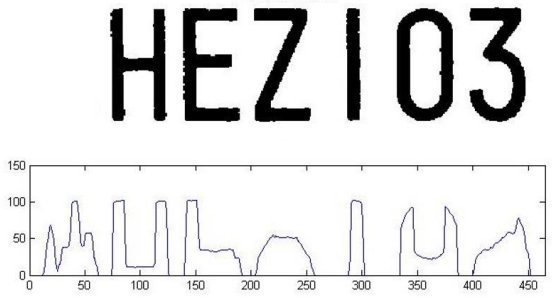

Figure 8: Binary image of license plate area and its vertical projection

Then is the official segmentation of license plate characters. Generally, the starting point of the first wave crest of the vertical projection map is the starting position of the first character of the license plate. Scan each wave crest and wave trough of the vertical projection map and count their positions. The starting point of each wave crest is the left boundary of each character of the license plate, and each end point is considered the right boundary of each character. At the same time,

according to the threshold value obtained previously, the X axis of the image is detected. If the cutting width is equal to this threshold value, cut and separate seven characters. For example, the word 'Jin' is often used to separate Sandianshui from the word 'Yu' on the right. To solve this problem, the system compares the width of the segmented font with the width of the whole license plate, and merges the misoperation characters. The characters after segmentation are shown in Figure 9.

Figure 9: Characters after segmentation

5. License plate character recognition algorithm and results

After character segmentation of license plate image, we get 7 separate character images. Then we need to use character recognition algorithm to recognize and display these individual characters. Due to the effective processing in the early stage, the sharpness and integrity of the segmented font can be kept at a high level. It is conducive to improving the success rate of template matching. As shown in Figure 10.

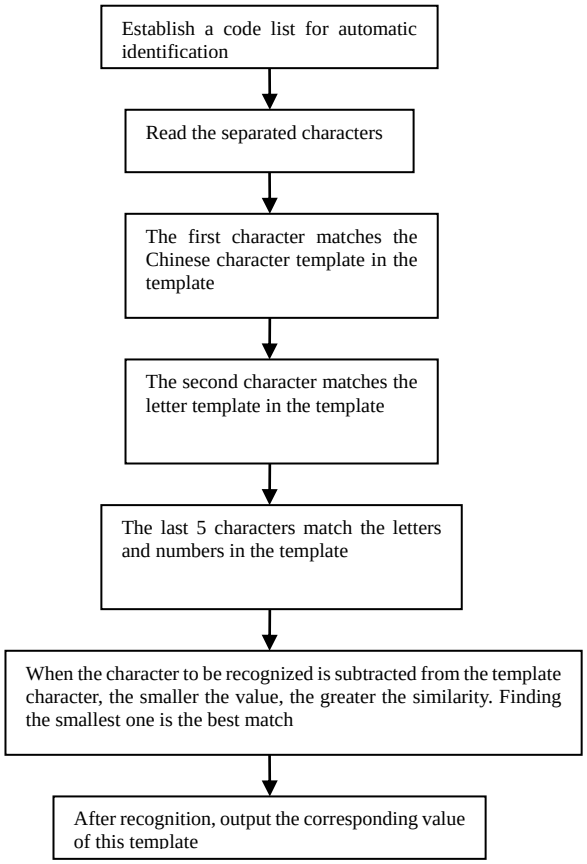

Figure 10: Character recognition process

The identification result is shown in Figure 11. Through inspection, the accuracy rate of license plate recognition under normal weather conditions is 98%, and blue cars cannot be recognized.

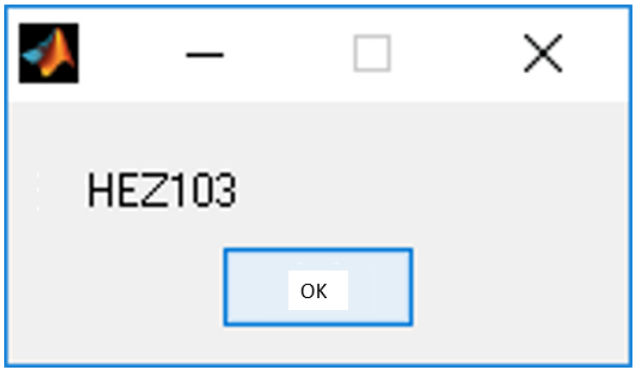

Figure 11: Character recognition results

6. Conclusion

License plate recognition system is an important research direction in the field of computer vision, and its image preprocessing algorithm is one of the key steps to achieve license plate recognition. With the continuous development of computer technology and the continuous expansion of application scenarios, the research and analysis of image preprocessing algorithms of license plate recognition system also need to be deepened and developed. By adjusting the brightness, contrast, color space and other parameters of the image, the visibility and clarity of the license plate can be enhanced. Common image enhancement algorithms include filtering, denoising, edge detection, etc. In the future development, the image pre-processing algorithm of license plate recognition system will face some challenges, such as image noise, illumination change, license plate color change, etc.

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