# Research on license plate recognition based on video image processing

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**Abstract.** This paper researched the license plate recognition system based on video image processing. In the pretreatment process of license plate recognition, the paper uses image gray, gray stretch and a series of processing methods of image processing to process the license plate. In the license plate location, this paper introduces a new method which is based on the mathematical morphology and then uses the image binaryzation to locate the license plate location algorithm. This paper used MATLAB as a platform to achieve the design and implementation of the license plate recognition. Experiments show that the method proposed in this paper is effective and has practical value.

## 1. The significance and background of the study

Intelligent transportation system [1], referred to as ITS, is came into being in the background. Intelligent transportation system is composed of traffic information collection system, information processing, analysis system and information release system. It is widely used in the United States, Japan, Europe and other regions. Intelligent transportation system can be applied in the station, the airport passenger flow guidance system and highway intelligent scheduling system. In our country, the application of the vehicle license plate recognition system [2-3] has enormous development space and market prospect.

The research on vehicle license plate recognition technology [4] has started earlier on abroad. It was first appeared in 1980s. In the world, many countries have already applied it in real life. In China, the electronic eye of WELL Technology Company and "Han Wang eye" in the research of license plate recognition has achieved good results [5].

## 2. Preprocessing of license plate image

The main research contents of image preprocessing include the color image of license plate, the gray scale, the two values and the edge detection [6-7].

Gray processing's process is to process the color image into a gray image. The pixel color information of the gray image is represented by the gray value [8]. In this paper, the weighted average method is used to deal with the image of the vehicle license plate.

The aim of Gray stretch is to enhance the contrast, at the same time, it pulled all the gray value together, which makes the bright brighter and dark darker. The edge feature of the gray scale drawing [9] is more obvious, which is more favorable to the image processing in the later stage.

The aim of binary processing [10] is to select the appropriate threshold value, it makes the image remaining black and white, and meanwhile the characters and background can be separated.

Threshold algorithm can be divided into two categories; the first category is the global threshold method. The second category is the local threshold method. In this paper, the OTSU[11] method is used to deal with the license plate.

The edge of the image is the occurrence of gray mutations in the region, it is the most likely to produce the edge between the object and the background or between the object and the object. The significance of edge detection [12] is that if the edge of the image can be accurately identified, then all the objects can be accurately positioned. The commonly used method about first order edge

detection operator has Roberts operator, Sobel operator, Prewitt operator [13]. As shown in fig. 1 , it is the edge detection result which is after the effect of the gray scale and the two values .



Fig. 1.  This is the result of Prewitt operator, Sobel operator and Roberts operator..

## 3.   The initial location of license plate based on morphology

Mathematical morphology includes corrosion, expansion, opening and closing four basic operations [14].

### 3.1.   Corrosion, closed operation and remove small objects

The operational symbol of morphological [15] is $\oplus$; the operational symbol of erosion is $\Theta$.

The Symbol of corrosion is A $\Theta$ B, After the structure element B translation of the target A in a point, the maximum relative set of the reference point of the structural element B which satisfies the translation condition and the A of the target object is satisfied:

$$A\Theta B = \left\{(x，y)\middle| B_{(x,\ y)} \cap A^{c} \neq \varnothing\right\}$$

(1)

The symbol of expansion is A $\oplus$ B. Every point of a target object A is translated by a given structural element B. The operation of the pixel expansion of the target object is enlarged. Make a note of:

$$A \oplus B = \left\{(x，y)\middle| B_{(x,\ y)} \cap A \neq \varnothing\right\}$$

(2)

The function of expansion is expanding the pixel of the target object, and the function of corrosion is shrinking the pixel of the target object.

The process of corrosion which is after expansion is called closed operation. When it is used to fill the tiny holes in the object, connected with the adjacent objects and smooth the boundary, the area will not changed significantly. After the corrosion of the license plate image, then processing it to be closed.

The closed operation plays a role in smoothing the boundary. After the image is processed, the white connected domain is mainly concentrated in the license plate region, but there are still some small objects scattered outside the license plate area. So it is necessary to remove the white connected domain erase to make the license plate region more clearly. As shown in fig. 2, there is the license plate image which is removed the small object after the effect diagram.
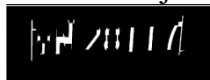


Fig. 2.  The result of remove the small object.

### 3.2.   Initially cut out the license plate area

Scan the white pixels in the license plate image, and put it into an array of storage, then operating it. Add the horizontal and vertical coordinates of the array, and find the minimum value and maximum value of the added value. The minimum and maximum values are respectively the upper left and the lower right of the vehicle license plate. Use the pair of diagonal points; we can extract the whole rectangle plate.

### 3.3.   Tilt correction

Radon transform [16] is commonly used to detect the tilt angle of the method of license plate. The idea of the tilt image correction is that to computed the projection of the image in all directions, and then finds the direction of the maximum projection to determine the angle of the image tilt.

### 3.4.   Relocation of license plate

In the initial location of the license plate, a part of the license plate with the border and rivet. And the license plate frame and rivet will bring some interference to the character segmentation of license plate, which makes the recognition rate of license plate is not accurate. Therefore, we must remove the license plate of the horizontal frame and rivets, so need further precise positioning.

In the binaryzation image, there is a distinct difference between the black and white jump variables in the horizontal direction of the character and non character area. License plate contains 7

characters, each character has 2 black and white jump variables, so the character region of the black and white jump variables more than 14 times. However, in the non character area, in addition to the left and right borders and rivets, there are no other factors can change the jump variables; two frames and two rivets will have 8 black and white jump variables. Therefore, the set of black and white jump variables which is less than the 14 is part of the non character area. Next, the effective area of the character is determined in the horizontal direction, and the upper and lower frame and rivet are removed.

License plate initial positioning and precise positioning of the comparison chart as shown in fig. 3.

Fig. 3. The License plate initial positioning and precise positioning of the comparison chart.

## 4. License plate character segmentation

After the license plate location, the next step is to separate the seven characters one by one and lay a good foundation for the subsequent recognition. In this paper, a method of character segmentation based on black and white is adopted, which is more simple and easy to calculate.

### 4.1. License plate image segmentation

In the image binaryzation of the license plate, the black and white jump variables in the vertical direction are obviously different from the character region and the non - character region. There are 7 characters in the vehicle license plate, the left and the right of each character jump once, a total of 14 times. In the license plate location, although the upper and lower edge of the rivet removed, some of the license plate in the positioning is still with the left and right border. Every black and white jump two times, two border jump 4 times. In the license plate, there is a dot between two to three characters, it also jump 2 times. Therefore, the entire license plate will jump 20 times; the array will be stored in 20 horizontal coordinates. Two coordinates will be cut out of a character, a total of 10 out of the map. The 10 figure includes 7 characters; there is the left border, right borders and a dot. Because of the interception of the left and right borders and dot length values than 7 characters is too small, so we can set a threshold, it will be removed.

The results of license plate character segmentation shown in fig. 4. The first picture is the binaryzation of the license plate, the second picture is 7 characters extracted.

Fig. 4. The results of license plate character segmentation.

## 5. License plate character recognition

The last part of the license plate recognition system is the license plate character recognition. License plate character recognition can accurately identify the real characters of each character image obtained by character segmentation, and thus determine the unique ID of the vehicle.

The character to be recognized has a standard character. The process of the Template matching algorithm [17] is to compare with the image of the character which is to be recognized and the standard template, then to find the smallest difference between the match and the best match for the character template. Finally, you can determine the characters on the template are the character recognition results.

### 5.1. License plate recognition algorithm based on template matching

5.1.1. Create template library

Template library include Chinese character template, letter template and digital template. In order to save system costs, the size of the template is neither too big nor too small. In this context, it is prescribed that the size of the binaryzation template is $16 \times 32$ (pixels).

The advantages of the template matching method is that the algorithm implementation is simple and its fast processing speed, but its anti-interference ability is poor, especially when the characters to be recognized is dirty, the character collection is not clear, more noise and characters of some

deformation, the recognition rate will be reduced.

The solution is for any one character; insert multiple templates into the template library.

5.1.2.  License plate character image normalization

After the vehicle video capture, then extract the key frame, the license plate image obtained in the license plate position is different, and the size is inconsistent. Therefore, in the template matching method for license plate recognition, the character image should be normalized to the same size and consistent with the template size in the template library. After normalization, template matching can be started to recognize the characters of license plate.

5.1.3.  License plate character recognition

The first character of the license plate is Chinese character; the second characters are capital letters; the rest of the characters are the mixed arrangement of numbers and letters. In this paper, the most classical template matching method is used to recognize the characters of license plate.

Take the first character to identify, then compared with the template in the template library Chinese characters one by one, scanned the Chinese character template which are the character to be recognized and the template library. Then count the same number of black and white pixel values for the same coordinates, and output the largest number of Chinese characters template. In the same way, the second character and the third to seventh character is also can be recognize.

Finally, output the recognition result of the seven segmented license plate characters

**5.2.  Analysis on the reasons of inaccurate license plate recognition**

In this paper, there are 1 picture recognition errors, and the reason for the failure is as follows.

As shown in fig. 5, due to the shooting angle and some other reasons, some of the license plate vertical frame has a tilt phenomenon after processing. As shown in the figure of the last character 7 and the right border of the vertical coordinates overlap, there is no black and white jump between the characters and the license plate border, so the character 7 and the right border can not be successfully cut. Finally affect the recognition results.

Fig. 5.  The last character 7 and the right border of the vertical coordinates overlap.

## 6.  Software interface design

Through research on the related theory and algorithm of video image processing and based on all of the above algorithms, this paper designs a license plate recognition software system based on MATLAB GUI. According to the previous introduction, the license plate recognition system is the first to read the image, and then the initial license plate location, tilt correction, license plate re location, license plate, license plate recognition, and exit system.

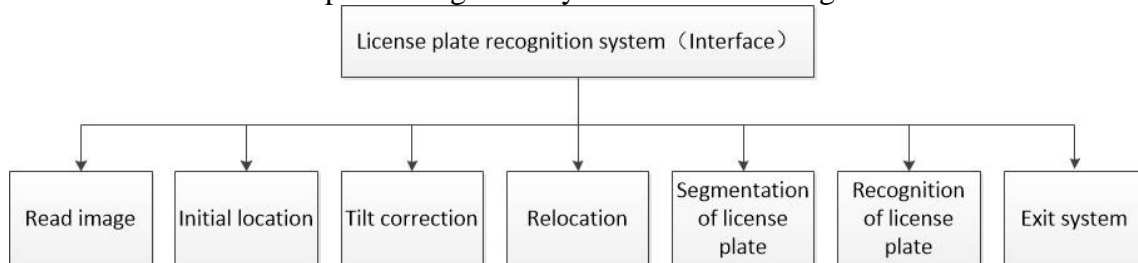The function of the license plate recognition system is shown in fig. 6.

Fig. 6.  This is the license plate recognition system.

## 7.  Conclusions

This paper introduces the development of license plate recognition technology on the first, and then summarizes the domestic and foreign research status and related products. On the basis of studying a large number of existing techniques, the vehicle identification is deeply studied. Using MATLAB to achieve the image preprocessing, license plate location, license plate character segmentation and license plate character recognition, the algorithm is validated in the license plate

recognition.

Based on all of the above algorithms, this paper uses MATLAB7.0 to achieve the function of the license plate recognition system. The effectiveness of the method is verified, and it has practical functions.

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