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Research on License Plate Location Method in License Plate Recognition System

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Abstract: License plate location is a key problem in the automatic license plate recognition system, and it is a hot research topic in recent years. Many domestic and foreign scholars have developed many license plate location algorithms, which can be divided into edge detection method, mathematical morphology location method and color image location method. In this paper, several commonly used license plate location methods are briefly introduced, and their respective advantages and disadvantages are analyzed and compared.
Keywords: License Plate Recognition System; Image Processing; License Plate Location; Edge Detection; Mathematical Morphology; Color Feature.

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1. INTRODUCTION

License plate recognition technology is an important research object of computer technology and pattern recognition in the concept of intelligent transportation. The license plate recognition system integrates image processing technology, data access technology, data processing technology and pattern recognition technology. Through image acquisition and recognition of passing vehicles, the license plate number is extracted and searched in the database to obtain the detailed information of the ownership and owner of the vehicle.

2. LICENSE PLATE RECOGNITION SYSTEM

The license plate recognition system is mainly composed of three subsystems: license plate positioning system, license plate character segmentation system and license plate character recognition system. When the vehicle enters the photographic range of the equipment, the appropriate angle is selected to collect the image of the vehicle, then the system processes the collected image, and then completes the location of the license plate. Finally, the characters in the license plate are segmented and recognized.

Image preprocessing: image is generally divided into color and gray image. Although color image will provide more color information, it will occupy more capacity and reduce the running speed when it is processed, so it should be grayed. Then, binarization and image denoising are performed on the gray scale image. Finally, corrosion expansion is carried out for further processing.

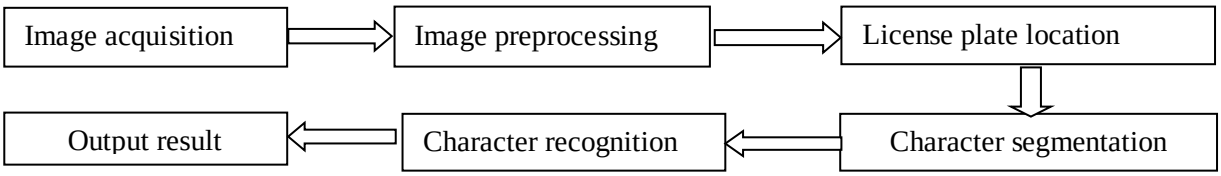

Fig.1: Block diagram of license plate recognition system

Character segmentation: Character segmentation divides the characters in the license plate into individual pictures. This step is also the link between license plate location and character recognition. The license plate format of each country is made according to the rules formulated by the country. Therefore, the space occupied by the characters in each license plate and the interval between each character are fixed distances. In this step, we usually use the vertical projection of the license plate to complete the character segmentation, supplemented by the lateral projection to determine the character width.

Character Recognition: Character recognition is the last door to check whether the license plate recognition technology is successful or not. The commonly used methods are template matching method and neural network recognition method. Template matching is a relatively simple method. It processes the characters after the last step of segmentation into the same format size as the characters in the template library, then compares and identifies them, and finally outputs the results.

3. LICENSE PLATE LOCATION

In the license plate recognition system, the license plate location is to extract the license plate area of the vehicle in the original image. This process must be accurate. Only after the precise location, the processing can proceed normally. Otherwise, it will bring unavoidable impact on the whole system, thus affecting the accuracy of license plate recognition. License plate location is affected by many factors, so it is very important to use which method to locate the license plate. The commonly used license plate location methods include edge detection, mathematical morphology, color feature and so on.

3.1 Edge Detection Method

The most basic characteristic of a complete image is to have edges. Generally speaking, it is also the edge of the image. It contains the plane edge information of the image. Edge detection is one of the important steps of image recognition and analysis, and is the main feature extraction method of image. Edge is an area of gray level change with jump level in image gray level, but it does not change dramatically in object. It mainly exists between subject and background, and the demarcation of each object. In the license plate location, the gray value of the license plate area is quite different from that of other areas, so we can use this point to locate the license plate and extract the license plate to achieve the original purpose.

The most commonly used method of edge extraction is to detect the gray level changes of each pixel in an area of the image, and to obtain the edge points of the image by first-order and second-order derivative methods. The most commonly used differential operator algorithms are:

Robert operator uses local difference to get the edge of the target area in the image. It locates the edge accurately, but the image processing effect of dense and noisy points is not very good, and the obtained edge lines are rough.

Sobel operator is a convolution kernel composed of horizontal edge and vertical edge information. It combines directional difference operation with local average. The convolution operator of Sobel edge detection is:

$$\begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \quad \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix} \tag{1}$$

Each pixel in the image is convoluted by the above cores, and edge detection is carried out in vertical and horizontal directions respectively, and convolution is done by taking the most influential values in two directions. This method can make the noise point smoother, but it has low accuracy in edge detection and location.

Prewitt operator is similar to Sobel operator and consists of convolution kernels in two directions. The difference between Prewitt operator and Sobel operator is that it calculates its difference by averaging first. Its convolution kernels are as follows:

$$\begin{bmatrix} 1 & 0 & -1 \\ 1 & 0 & -1 \\ 1 & 0 & -1 \end{bmatrix} \quad \begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{bmatrix} \tag{2}$$

Compared with Sobel operator, they all have better processing effect on images with more noise points, but Sobel operator carries out weighting operation on each pixel, and the performance on vehicle edge detection will be more accurate.

Canny operator is more accurate in edge detection, but it will consume more computing time, which obviously does not meet the requirements of real-time license plate recognition. At the same time, it can not suppress too many noise points, which will bring many unnecessary troubles to license plate recognition.

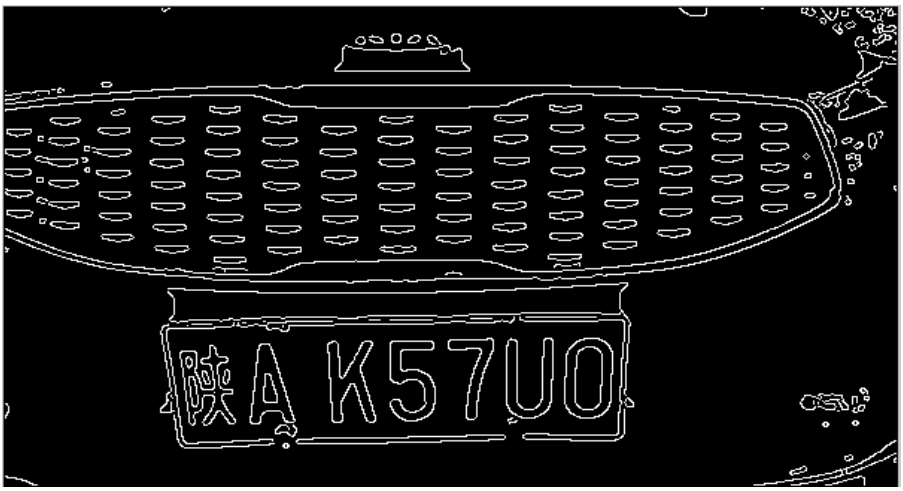

Fig.2: Effect of edge detection

3.2 Mathematical Morphological Location Method

The principle of mathematical morphology location method is to embed a structural element into the image, so that the structural element can be integrated with the whole image, and the structural information of the image can be obtained by moving the structural element in the image. Mathematical morphology consists of corrosion, expansion, open and closed operations. Based on

these basic operations, more mathematical morphology algorithms can be derived, which can be applied to image segmentation, feature extraction, filtering and noise reduction. The following four basic operations are introduced:

(1) Expansion

The essence of expansion operation is to add pixels to the boundary of the target area, so that the boundary of the target area can be expanded from inside to outside, so that the target area, i.e. the small gap and void of the license plate, can be filled to the maximum, eliminating unnecessary troubles and never turning the target area into a connected area. The expansion operation is as follows:

$$D(x,y)=(I\oplus T)(x,y)=\underset{i,j=0}{\overset{m}{OR}}[I(x+i,y+j)\&T(i,j)] \tag{3}$$

Among them, I is the image after binarization and T is the binary template of structural elements.

(2) Corrosion

Corrosion process is actually erosion process. Comparing the small objects in the target area with the structural elements, when the objects are smaller than it, the area of the objects will be reduced or even eliminated. Finally, the unrelated areas of the system will be separated. Corrosion calculation is as follows:

$$E(x,y)=(I\oplus T)(x,y)=\underset{i,j=0}{\overset{m}{AND}}[I(x+i,y+j)\&T(i,j)] \tag{4}$$

Among them, I is the image after binarization and T is the binary template of structural elements.

(3) Open operation

Open operation is the process of eroding and expanding the binary image. Its purpose is to eliminate small objects, extract a clean license plate as far as possible, reduce the interference objects to the minimum, and smooth the edges of larger objects.

(4) Closed operation

Closed operation is the process of expanding the binary image first and then eroding the image. Its purpose is to fill the small vacancies in the target area and smooth the gaps between objects.

3.3 Color Feature Location Method

The color feature location method is different from the first two methods. The first two methods are based on the gray image after image preprocessing to locate the license plate area. This method converts the original RGB image into HSV color vehicle image, which can locate most of the brightly colored license plates quickly. Its basic principle is to find the threshold value of each component of R (red), G (green) and B (blue), so as to determine the color range of the license plate. Sometimes when we encounter the special color of a special license plate, we need to consider redefining the threshold of RGB. HSV images are derived for this purpose.

The three letters of HSV mean hue, saturation and brightness respectively. The conical coordinates of HSV space are shown in the following figure:

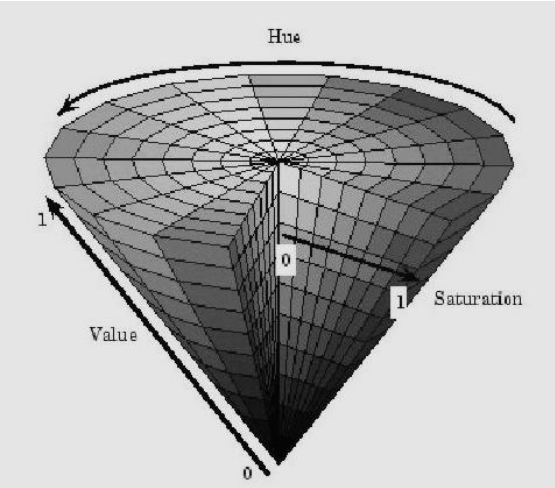

Fig.3: schematic diagram of HSV space

H is the component representing the color in the spatial model. As shown in the figure, H ranges from 0 to 360. S is the saturation of color, ranging from 0 to 1. The smaller S is, the lower the saturation is. V is the brightness information of color , ranging from 0 to 1. The smaller V is, the darker the brightness is. The relationship between them is as follows:

$$\begin{cases} H/2 = H_E \\ S \times 255 = S_E \\ V \times 255 = V_E \end{cases} \tag{5}$$

The conversion formula between RGB and HSV is as follows:

$$\max = \max(R, G, B) \quad \min = \min(R, G, B)$$

$$H = \begin{cases} (G-B)/(\max - \min) \\ 2 + (B-R)/(\max - \min) \\ 4 + (R-G)/(\max - \min) \end{cases}$$

$$V、S \in [0,1], \quad H \in [0,360] \tag{6}$$

Tab.1 Threshold ranges of three components in HSV space for several main colors of vehicles (-indicating that the color is independent of components):

	H	S	V
Yellow	hy1~hy2	sy1~sy2	vy1~vy2
Blue	hb1~hb2	sb1~sb2	vb1~vb2
Red	hr1~hr2	--	--
White	--	sw1~sw2	vw1~vw2
Black	--	--	vk1~vk2

This method classifies the color to see which class it belongs to, and distinguishes the license plate from the vehicle itself and the background environment of the vehicle. The location of color mainly depends on the component range of H, S and V. The formulas used for the specific test are as follows:

$$G(x,y)=\begin{cases}255 & hb1<H<hb2\,\&\,sb1<S<sb2\,\&\,vb1<V<vb2\\ 200 & hy1<H<hy2\,\&\,sy1<S<sy2\,\&\,vy1<V<vy2\\ 150 & sw1<S<sw2\,\&\,vw1<V<vw2\\ 100 & vk1<V<vk2\\ 50 & hr1<H<hr2\\ 0 & else\end{cases} \tag{7}$$

Each element of the HSV color model is transformed into a gray image with six gray classes according to the range defined by the graph, so that the desired target area can be separated from other external environments to complete license plate location.

4. CONCLUSION

For the license plate location part of the license plate recognition system, this paper introduces the current classical location algorithm, including edge detection method, based on mathematical morphology, color characteristics and other methods, and compares the advantages and disadvantages of each algorithm. How to synthesize the advantages of these algorithms, put forward more advanced recognition concept, so that the system can be processed faster and more efficiently, which has become a more in-depth research topic.

REFERENCES

[1] Gong Shenglong, Liu Chunping, Wang Qiang. Digital Image Processing and Analysis [M]. Beijing: Tsinghua University Press, 2006.

[2] Zhu Xiuchang, Liu Feng, Hu Dong. Digital Image Processing Course [M]. Beijing: Tsinghua University Press, 2011.

[3] Wang Yaonan. Computer Image Processing and Recognition Technology. Beijing Higher Education Press [M], 2001.

[4] He Tiejun, Zhangning, Huang Wei. Research and Implementation of License Plate Recognition Algorithms on Highway Traffic Technology [N], 2006.

[5] Xie Weisheng. Pre-implementation of license plate location and character segmentation algorithm [D]. Southwest Jiaotong University, 2010.

[6] Zhang Yujin. Course of Image Processing and Analysis [M]. Beijing: People's Posts and Telecommunications Press, 2009.

[7] Xu Hui. Automated License Plate Recognition System Based on MATLAB [J]. Computer Knowledge and Technology, 2010.

[8] Jiang Chaoyou. Research and Implementation of Key Technologies for Vehicle License Plate Recognition [D]. Heilongjiang: Northeast Petroleum University, 2017.

[9] Chen Ding. Research and implementation of license plate recognition system based on MATLAB [D]. Guangxi: Nanchang University, 2017.

[10] Li Wei. A New Practical License Plate Location and Recognition System [D]. College of Information Science and Engineering, 2008.

[11] Suze. Involvement and Implementation of License Plate Recognition System Based on Color Digital Image [D]. Jilin University, 2014.

[12] Huang Xiangxing. Research and Implementation of Key Technologies of License Plate Recognition System [D]. Beijing: Beijing Jiaotong University, 2008.

[13] Li Zhiqiang, Li Yongbin. Development and research status of license plate recognition technology [N]. Frontier of science and education, 2012.

[14] Hu Tao. Applied Research of Mathematical Morphology Algorithms in License Plate Recognition System [D]. Anhui: Anhui Engineering University, 2013.

[15] Zhu Xinzhong. Research and Implementation of Automatic License Plate Recognition Technology [D]. Hunan: University of National Defense Science and Technology, 2005.

[16] Zhao Juan. Image Acquisition and Location in License Plate Recognition System [D]. Hubei: Wuhan University of Engineering, 2016.