Car License Plate Location Based on Mathematical Morphology

Hongping Hu, Zheng Zhang, and Yanping Bai

School of Science, North University of China, Taiyuan, Shanxi, 030051
hhp92@163.com, 844067343@qq.com, baiyp@nuc.edu.cn

Abstract. The car license location is the foundation of the whole car plate recognition system, whose efficiency will directly affect the veracity of license recognition.

In this paper, the car license location is adopted on the base of mathematical morphology. Turn the inputted color car license image into gray image and detect the edge by using the Roberts operator. Eliminate the noise in the obtained binary image by using the erosion operation, and then the close operation of the mathematical morphology is used. Some connecting areas are formed. According to the area preparations and the marked connected regions, the license plate location are obtained. The results show that the method is simple, the location accuracy rate is higher, and it can meet certain real-time requirements.

1 Introduction

License plate recognition(LPR) plays an important role in many system, such as road traffic monitoring, parking lots, access control, highway electronic toll collection, red-light violation enforcement, finding stolen cars, gathering traffic flow statistics and so on([1]). In particular, license plate location is an essential and important stage in LPR and directly influences the accuracy of license plate recognition. In this paper, the mathematical morphology is used to locate the car license plate, which shortens the selected region of car license plate and lessens the complexity. Thus the license plate location prepares for the character segmentation and the recognition of car license plate.

2 The Gray Transformation

Currently, the images obtained by the equipments such as television cameras, numeral camera were the color images and generally were the 24-point color images. Every pixel of the color image has three different color components R, G, B that influence the accurate location of car license plate. Therefore, it is necessary that the color images are transformed into the gray images. And the gray value of the corresponding pixel point is g . The formula on the gray value adopted in this paper is the following:

$$g = 0.2989 * R + 0.5870 * G + 0.1140 * B. \quad (1)$$

Z. Qian et al. (Eds.): Recent Advances in CSIE, LNEE 128, pp. 415–420.
springerlink.com

There are four RGB images in Figure 1. The images shown in Figure 2 are the gray images of the images shown in Figure 1.

3 Edge Detection

There are four kinds of car license plates on the colors of the background and the characters in our country: blue background and white characters, yellow background and black characters, black background and white characters, white background and black characters. Although car license plates are different on the color, their same characteristic is that there is a bigger comparison among the background, the characters and the boundary of the license plate on color. This characteristic is advantageous to the edge detection. The Robert operator, Sobel operator, Prewitt operator and Canny operator on the edge detection operators are in common use.

In this paper, the Robert operator is use to detect the edge of the gray image of the license plate with blue background and white characters. The Roberts operator is the operator that seeks the edge by use of the local difference operator, whose definition is the following:

$$R(x, y) = \sqrt{[f(x, y) - f(x+1, y+1)]^2 + [f(x, y+1) - f(x+1, y)]^2}. \tag{2}$$

In order to be convenient to calculate, the formula (2) is simplified to be

$$R(x, y) = | f(x, y) - f(x+1, y+1) | + | f(x, y+1) - f(x+1, y) |, \tag{3}$$

where $f(x, y)$ is the input image with the integer coordinates of the pixel and subduplicate operate makes this operation similar to the process in the human visual system. The Roberts operator has more accuracy and the best on the image with abrupt low noise in particular. According to the pattern of the image processing, two 2×2 convolution operators are used in this paper, shown in Figure 3. The edge detection images of the images shown in Figure 2 are shown in Figure 4.

Fig. 1. The original images

Fig. 2. The gray images

$$\begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix} \quad \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$$

Fig. 3. Robert convolution operator

Fig. 4. The image of edge detection

4 Mathematical Morphology

The essence of mathematical morphology is that the important image information is obtained by the interaction between the image set and the structural elements([2][3][4]). Different structural element can pick up the image information of different layer. The basic operations of mathematical morphology have four kinds: corrosion operation, expansion operation, open operation and close operation.

Some noise is eliminated in the edge detection image filtered. The main affection in this step is to avoid the noise outside the license plate region to form the connectinged region which becomes the false plate region in the follow-up processing. In this paper, the corrosion operation of mathematical morphology are used to filter and the 3×1 structural element is use to do the corrosion operation. The images obtained by the corrosion operation to the images in Figure 4 are shown in Figure 5.

On the base of the images shown in Figure 5, the close operation of mathematical morphology is used. The expansion operation is firstly used by 25×25 rectangular structural element to make the region with the ample edge information close. Then the corrosion operation is used by the same structural element to make the car plate region and the false plate region cleavage so that the connected region is formed in the plate region. The operation results are shown in Figure 6.

5 Area Preparations and the Marked Connected Regions

After the edge image is processed by mathematical morphology, the character region in the plate region is a big block of connected region. And the background and other regions is many small blocks of connected regions. Thus the goal regions that are called license plate candinates are obtained.

The plate area is the number of nonzero pixels in every white candinate region. When the license plates are photographed and gathered, the distances and angles between television cameras and the cars are the same. That is, the sizes of the car image are generally fixed and the varied regions is smaller, so the areas of the license plate candinates are fixed and a suit threshold value T is determined by many

experiments(for example, $T_1 = 2000$ and $T_2 = 7000$ are selected by experiments in this paper). When the license plate area S is far more than the threshold value T_2 or is far less than the threshold value T_1, the license plate candinate region is not obviously the real license plate region. Thus once the threshold value T belongs to the suit region, the license plate candinate region is the real license plate region. According to the area preparations, we obtained the less license plate candinate regions. Thus the calculated amount is lessened and the location speed and the location precision are improved.

In this paper, the function bwlabel in MATLAB tool is used to mark the connected regions of the images. The specific usage of the function bwlabel is

$$[L,num]=bwlabel(BW,n), \tag{4}$$

where BW is a binary image, n is 4 or 8 and denotes the n-connected regions found, L is a category label matrix with the same size as the size of BW and marks every connected region of BW, the label value is 1,2,…,num, and num is the number of the connected regions. In this paper, 8-connected region is adopted in the function bwlabel. Then we can find all the connected regions, and all the pixel points of the same connected region has the same mark. Thus num marked connected regions are obtained. The pixel value of the ith connected region is marked as i(i=1,2,…,num).

The license plate candinate regions are obtained by area preparations and the marked connecting regions, shown in Figure 7 on the base of Figure 6.

Fig. 5. The corrosion operation on the edge detection image

Fig. 6. The enclose operation of the mathematical morphology

Fig. 7. The license plate candidate regions by area preparations and the marked connecting regions

6 The License Plate Location

The scope of white foreground is set on the license plate candidate regions by area preparations and the marked connecting regions. Seek the row and the column with the maximum white pixels in the x axis and y axis, respectively; recycle to seek the scope of the up-down-left -right white region on the obtained row and column, and the height and the width are obtained; Then the constant is added up and the white region is obtained as the license plate region. The license plate image is obtained after the location, shown in Figure 8 on the base of Figure 7.

Fig. 8. The color plate images after the location

7 The Experiments and Analyses

In this paper, the location method is adopted to complete the artificial experiments by Matlab R2009a under Windows 7, 2.0GHz CPU, 1G internal hardware. All the original images are the color images with the 640×480 pixels. In the experiments, we take 100 license plate images test and succeed in 94 images. The location accuracy is up to 94%. The false location is mainly owing to the bigger roll angle or the inadequate exposure. We will enhance the image and adjust the roll angle to improve the location accuracy rate.

8 Conclusions

In this paper, the license plate location method based on the mathematical morphology is put forward. Turn the inputed color car license image into gray image and detect the edge by using the Roberts operator. Eliminate the noise in the obtained binary image by using the erosion operator, and then the close operator of the mathematical morphology is used. The better license plate candinate images are obtained. Then for the candinate images, the license plate locations are obtained by area preparations and the marked connecting regions. The experiments show that the proposed method is simple and the location accuracy rate is higher, and it can meet certain real-time requirements.

Acknowledgments. This research was supported by Postdoctoral granted financial support from China Postdoctoral Science Foundation(20100481307), Natural Science Foundation of Shanxi(2009011018-3), National Natural Science Foundation of China(60876077) and School Foundation of North University of China and High level talent research starting foundation item of North University of China(20090714).

References

1. Jia, W., Zhang, H., He, X.: Region-based license plate detection. Journal of Network and Computer Applications 30, 1324–1333 (2007)
2. Wang, W., Ma, Q., Du, P.: Based on Edge Detection and Mathematical Morphology of License Plate Location. Journal of South Central University for Nationalities 27(4), 83–87 (2008) (in Chinese)
3. Lu, J.-H.: License Plate Localization Algorithm Based on Mathematical Morphology and Line Scanning. Computer Era 11, 51–54 (2009) (in Chinese)
4. Liang, D., Gao, J., Cao, W., Fu, Q., Zhao, J.: The location algorithm of the inclined license plates based on mathematical morphology and orientation field. Chinese Journal of Electronics 12(2), 163–166 (2003)