License Plate Localization Based on Edge Detection and Morphology

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Abstract. This paper presents a new method based on edge detection and morphology for the license plate localization, in this method ,first pre-processing of license plate image, then using Sobel operator for edge detection, and then using mathematical morphology processing image, then according to the priori knowledge and license plate aspect ratio to get the exact location of the license plate, and finally use horizontal projection and vertical projection to accurate positioning of the license plate. Simulation results show that the algorithm speed, high accuracy, to achieve the desired effect.

Keywords: Edge detection, license plate localization, morphology.

1 Introduction

With the development of social economy, the car has increased dramatically, the number of traffic control, safety management, charge management requirements also is increasing day by day, using electronic information technology to realize safe and high intelligent transportation become the main development direction of traffic management . Car license plate number is the only vehicle "status" logo, license plate recognition technology can not make any alterations in car to realize "identity" registration and verification, the technology have been used in road charges, parking management, traffic induction, traffic law enforcement, a road check, vehicle scheduling, vehicle testing and other various occasions. Position the image and character segmentation is the key to license plate recognition.

2 License Plate Location Method

According to the different characteristics of the license plate,we can use different positioning methods. The most common positioning technologies are mainly based on edge detection [1,2],based on color segmentation [3,4,5], based on genetic algorithm approach[6],basedonneural network[7,8],based on mathematical morphology[9],based on gray degree of image texture feature analysis[10] etc. But the method based on mathematical morphology, plate area location can not accurately determine the location of the border around the plate, it must be combined with other positioning methods for accurate positioning. Analyze the advantages and disadvantages of

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various positioning methods, this approach based on edge detection and mathematical morphology for the license plate localization.

3 License Plate Localization Process

3.1 Gray Image

Color images contained a large color information, not only in the storage, and dealing with them will reduce the execution speed of the system, so in the image recognition color image often change to gray image, so as to speed up the processing speed. The color conversion for gray process called gray processing. the standard of the choice is after gray transform, the dynamic range of pixels increases, the image contrast expansion , make the image become clearer, exquisite, easy to recognize. In the color image, the color of each pixel decisions by the R, G, B components, each byte for 8 bit, says different brightness values between 0 to 255 , the three bytes combination can produce 16.7 million different colors.. In the gray image, pixel gray level with 8 bit said, so each pixel is one of the 256 kinds of gray between black and white . The description of the gray image reflect the same with color images , still reflects the local color and brightness level of the distribution and characteristics in the entire image.Gray image, the processing methods are the following three:

Maximum method: R = G = B = Max (R, G, B),
Average method: R = G = B = (R + G + B) / 3,
Weighted average method: R = G = B = (0.299R +0.588 G +0.113 B) / 3.

This paper used the weighted average method for gray-scale image processing, gray-processed image shown in Figure 1.

Fig. 1. Gray image

3.2 Binary Image

Graying later, there are 256 separate colors in image, to reduce pixels interference, further enhance the processing speed, should be converted grayscale to binary image,

binary image is only have black and white two color pixels, the license plate area character can be a clear distinction to background . This paper uses a global threshold binarization method. Set the original gray image is f (x, y), after binarization the images is g (x, y), binarization processing as follows:

$$g(x,y)=\begin{cases}0 & f(x,y)\le T\\ 1 & f(x,y)>T\end{cases}$$

Here, T is called the binarization threshold (Threshold), in gray-scale image ,pure black is 0, pure white is 1. After binarization processing, the foreground and background colors separated by the black and white, choose a different threshold may be different separation. Image binarization show in Figure 2:

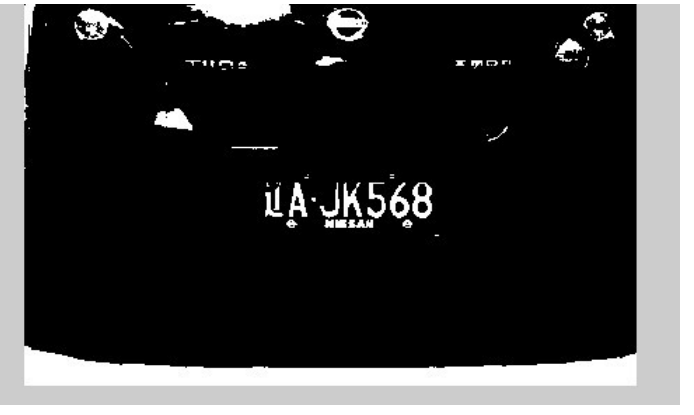

Fig. 2. Binary image

3.3 Edge Detection

There are many edge feature extraction method, commonly used edge detection algorithms can be divided into the first derivative and second derivative algorithm categories. First order differential algorithm main have gradient operator、Roberts operator、Sobel operator、prewitt operator、Krisch operator, etc, the second order differential algorithm is Laplacian operator and Wallis operator for representative. in several classic operators of edge detection , Sobel operator is simple, fast processing speed, and the edge after process is smooth and continuous. This article chooses the Sobel operator on edge detection, Sobel operator is the form of filter operator, used for edge extraction, can use the fast convolution function, simple and effective, so widely used. Usually use the following two convolution nuclear (h1 and h2)respectively on the horizontal and vertical image edge detection.

$$h1=\begin{bmatrix}1 & 2 & 1\\ 0 & 0 & 0\\ -1 & -2 & -1\end{bmatrix} \qquad h2=\begin{bmatrix}-1 & 0 & 1\\ -2 & 0 & 2\\ -1 & 0 & 1\end{bmatrix}$$

The results shown in figure 3:

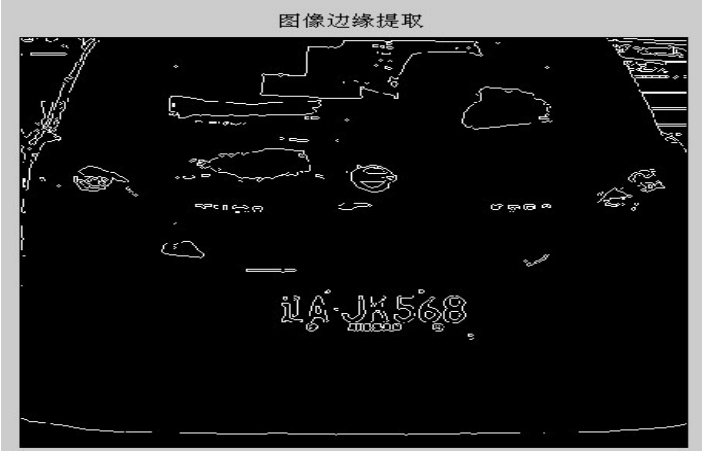

Fig. 3. Sobel operator edge detection

3.4 Morphological Processing

Mathematical morphology, there are four basic operations: dilation, erosion, opening operation and closing operation. Dilation and erosion is the most basic morphological transformations, they are each dual relationship.Morphology of erosion is the basic arithmetic. Its implementation is based on the filling structure element concept.one of the most simple use is eliminate irrelevant details according to size of the binary image.The erosion of A by B can be expressed as:

$$A\Theta B=\left\{Z\middle|(B)_Z\subseteq A\right\}$$

Dilation is the dual operation to erosion , dilation has expanded the role of the image, The dilation of A by B can be expressed as:

$$A\oplus B=\left\{Z\middle|(\hat{B})\cap A\neq\varnothing\right\}$$

The morphological opening of the image A by element B, denoted $A\circ B$, is simply erosion of A by B, followed by dilation of the result by B:

$$A\circ B=(A\Theta B)\oplus B$$

Opening operation generally make contours becomes smooth of the object, disconnect the narrow piece, eliminate fine protrusions.

The morphological closing of A by element B, denoted $A \bullet B$, is dilation followed by erosion:

$$A \bullet B = (A \oplus B) \Theta B$$

Closing operation is similar to make contour more smooth, but in contrast with the open operation, it is usually to eliminate a narrow discontinuous and long thin gap,eliminate small holes and fill the fracture of the contours.

Selection structure elements to operator is the key of morphological operations, the different size and shape of structural elements produce different results in the image morphological operations.Common structural elements generally shows the square, quasi-circular and rectangular.This algorithm selected 2×1 rectangle structure element, first, make erosion operations with binary image , de-noising processing. After denoising the binary image also contains many other areas outside the region in addition to containing the license plate, then use 25×25 structuring element to make closing operation and opening operations with image. See fig 4 and 5:

Fig. 4. Image closing operation

Fig. 5. Image opeing operation

3.5 License Plate Tilt Correction and Accurate Positioning

According to the prior knowledge, analysis the image after morphological processing, to compare whose aspect ratio is closer to the actual license plate aspect ratio, then extraction and display it.After treatment the location of the license plate can be initially determined, as shown in Figure 6, then make local analysis with the basic orientation of the license plate images to further define the range of characters, this paper use the Hough transform to get the license plate tilt correction, and then use the level projection and vertical projection to process the image, to reduce the license plate of the left, right and bottom margins to determine the specific location of a car license. The end result shown in Figure 7.

Fig. 6. Initial positioning plate

Fig. 7. Precise positioning plate

4 Experiment Results

This paper presents a new method based on edge detection and morphology for the license plate localization,make simulation with 200 vehicles images of different background and light conditions on MATLAB, the experimental results shows that the method speed and recognition rate are ideal.

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