Intelligent license plate recognition system based on digital image processing

Yulong Zhang
Wuhan University of Technology. Wuhan. China
1470147128@qq.com

Abstract. With the rapid development of China's economy, intelligent transportation system has gradually become an inevitable trend in the development of modern traffic management. As an important part of intelligent traffic system, license plate recognition system plays an important role in the management and control of modern traffic. This paper uses digital image processing technology to study the license plate positioning technology of color automobile images. Through image preprocessing, license plate positioning, character segmentation and character recognition, the image is processed to realize the recognition of license plate under different environments.

1. Introduction
For picture 1, we first preprocessed the image, improved the image quality through image graying, image Roberts edge detection, image binarization and other technologies, [1-2] removed interference factors in the image, and highlighted useful license plate information, so as to facilitate subsequent recognition operations. Then, we conduct character segmentation and normalization processing on the processed image. Since the character segmentation can only process the image of white words on a black background, while the image processed by binarization is black words on a white background, we realize the transformation of the background by inverting the binarization image matrix. After the correct background conversion, each character of the license plate is segmented by the projection partition method, and the license plate character is unified with the character features in the standard template block by the normalization processing. Finally, OCR algorithm based on template matching was adopted to recognize the segmented license plate characters. The characters were successively matched with Chinese characters, letters and Numbers in the template, and the license plate in picture 1 was identified as 京 AF0236.

In view of picture 2, we first adopt image clustering method to locate the license plate, and capture effective license plate information by removing the part whose gray value is less than 2000. Then, Radon transform is used to correct the tilt Angle of the license plate so that the image of license plate is rotated horizontally. Due to the blurred image after rotation, the nonlinear filtering algorithm, image sharpening, image contrast enhancement, histogram equalization and other operations were carried out successively to enhance the clarity of the image. [3] Finally, we conduct character segmentation and recognition on the processed image, segment the license plate characters through the transverse and longitudinal projection method, and normalize the segmented characters. The processed characters use template matching algorithm to read the license plate name, so as to realize the recognition of license plate in video. The license plate in the second image of the picture is identified as: e F9Y007.
For video, first of all, we combined the features of video images and used the inter-frame difference method to detect the sequence images of video, so as to judge and extract the key identification frames containing the information of moving vehicles.[4] Secondly, we locate the position of the license plate by a method based on mathematical morphology and geometric features of the license plate. Accurately extract the license plate area from the vehicle image. The tilt Angle of license plate is corrected by using Radon transform.[5] After defining the position of the license plate, we make the blurred license plate image clear, and enhance the clarity of the license plate image by means of image denoising, image contrast enhancement and image sharpening, so as to prepare for the subsequent character recognition. [6] And then, we processed the processed image according to the method of picture 1 and identified the license plate in the image 3 of video as Beijing FR4563. Finally, we randomly select license plate images to check the accuracy of the established license plate recognition system and improve the unreasonable places.

2. The analysis

2.1. Analysis of question 1

we are requested to give the license plate recognition in the figure, after a lot of literatures, we found that establish a steam car license plate automatic recognition system mainly includes seven modules, respectively is: trigger photographs, image acquisition, image processing, license plate location, character segmentation and character recognition, the output unit, is one of the most important part of the image preprocessing, license plate location and character segmentation and recognition of the three modules. The whole license plate recognition system is the core of image processing and character recognition, due to the system long time outdoor work, vulnerable to lighting, camera Angle and distance, vehicle head their own conditions and the influence of vehicle speed, and take pictures is not ideal, so we need to take the photos by cameras for processing, mainly on the image gray scale and image edge extraction. At the same time, the location of license plate and the segmentation of license plate are also very critical. It is to determine the specific location of license plate in the gray image after image preprocessing and to segment it accurately. The precision of segmentation directly affects the recognition rate of the whole license plate character recognition system. After splitting the characters, we match the split characters with the character template library to identify the license plate number.
Table 2. The license plate is further processed

Table 3. After the character segmentation

2.2. analysis of picture ii

In practical application, the vehicle image may be blurred due to various noise pollution, or it may be affected by the shooting Angle, resulting in the image being tilted. Picture 2 asks us to set up a license plate recognition system to locate and identify the license plate in the given picture. First of all, we need to remove the redundant information in the image, carry out positioning and image capture for the license plate, cluster the image through the binarization processing idea based on clustering analysis, and capture the effective license plate information. Secondly, the Angle tilted image in the captured image increases the difficulty of character recognition, so Radon transform method is adopted to rotate the image of license plate to transform it into horizontal direction. Then, we use nonlinear filtering to remove noise, and image sharpening and enhancement of specific degree, to increase the clarity of license plate image, and finally use the same method as the picture to identify the license plate in the image, to complete the establishment of license plate recognition system.

Table 5. License plate image denoised and sharpened after the image

Table 6. License plate recognition results
2.3. video analysis

Table 7. The original image selected in video
We set up license plate recognition system to recognize car license plate in video. First, we combined with the characteristic of video images, using interframe difference method to test the video image sequences, judge extract contains the key to the motor vehicle information recognition frame, then we have to locate the license plate location, adopted based on mathematical morphology and license plate positioning method of geometric features, roughly extract license plate location area.[7][4] The Angle picture taken by video leads to a tilt Angle between the license plate direction and the horizontal direction, so we use Radon transform to correct the tilt Angle of license plate. After determining the position of the license plate, we make the image of the blurred license plate clear, and enhance the clarity of the license plate image by means of image denoising, image contrast enhancement and image sharpening. Finally, we conduct character segmentation and recognition on the processed image, segment the license plate characters through the transverse and longitudinal projection method, and normalize the segmented characters. The processed characters use template matching algorithm to read the license plate name, so as to realize the recognition of license plate in video [8]

Table 8. License plate rough location map

Table 9. Fine plate location map

Table 10. Noise removal, sharpening and other processing after the effect diagram
Table 11. License plate recognition results

3. Model hypothesis
1. Assume that the image license plates in the three pictures all conform to the actual situation of license plates in use in China;
2. Assume that there is no damage to the license plate in the three pictures;
3. Assume that there is no intentional blocking of the license plate in the three pictures.

4. Model evaluation

4.1. Evaluation of picture-1 model
Advantages:
1. A picture we use recognition algorithm based on template matching the character recognition in the field of classical method, as a result of the license plate recognition required less kinds of characters, shooting image quality is not too bad, character deformation degree is not big, this algorithm has good recognition performance to its, Jane was low due to the complexity of algorithm calculation at the same time, in terms of time performance is better than other algorithms.
2. The Roberts operator is used for edge detection, which is simple and fast. As a conventional edge detection operator, the Roberts operator is based on the first derivative of the image function. In addition, the actual operation of the Roberts operator is to find the differential of rotation degree in both directions, which is a method for calculating the gradient of oblique deviation. The gradient direction is perpendicular to the edge, and its size represents the edge strength. For license plate edge detection, the positioning accuracy is high and the result is good in horizontal and vertical direction.

Disadvantages:
1. The disadvantage of using the template matching method is easily due to ignore the detail characteristics of the characters in the recognition of similar characters, such as the 0 s/O of license plate character similar characters, moreover in the actual application scenario, because the reason such as image acquisition perspective, license plate wear, prone to deformation, adhesion, fracture characters and details such as fuzzy severe situation, which greatly increase the difficulty of the accurate identification characters, namely poor anti-jamming capability of the proposed algorithm, in the application may have its limitations.
2. Roberts operator is sensitive to noise and cannot eliminate local interference. The Roberts operator is used to detect the edge of the license plate, according to the difference of gray value of the four adjacent pixels in the diagonal position in the part of the license plate image. In addition, no special smoothing operation is carried out, so it cannot suppress the influence of noise and is relatively sensitive to noise.

4.2. Evaluation of picture ii model
Advantages: in the image enhancement of the second picture, the filtering method is median filtering, which can be used to preprocess the license plate to eliminate the pepper and salt noise of the image. The noise of the license plate image is mostly isolated points, and the corresponding pixels are few. Moreover, the license plate image is composed of blocks with larger area and more pixels, and the median filtering effect is very good. On the other hand, median filtering method can prevent the blurring of license plate edge, avoid the image blurring similar to the image blurring created by mean filtering, and overcome the detail blurring caused by linear filter to some extent. In addition, the
median filter has a small amount of computation and a fast computation speed, which is suitable for the image with few details such as license plate in this figure.

Disadvantages: in the process of using standard median filter to denoise license plate image, we did not fully utilize the statistical knowledge of image model, which has certain blindness. Median filter has better denoising effect on salt and pepper noise, while it may not have ideal denoising effect on other noises, such as gaussian white noise. In addition, some of the signal interfered by the pulse may have the phenomenon of edge displacement after median filtering. And is that median filtering is only applicable to less disturbance pixels, if the pollution of vehicle image point is more, even more than sliding window sample 1/2, basic no filtering effect, we cannot simply increasing the size of the sliding window to improve the denoising effect, because to do so despite the image quality has improved to some extent, but can cause blurred edges.

4.3. Evaluation of figure 3 model

Advantages: in picture 3, we used the frame difference method to detect the video sequence images and judge and extract the key identification frames containing the information of moving vehicles. At the same time, it has a strong adaptability to the environment. Due to the short time interval between adjacent frames, the background light in video does not change significantly, so it is less affected by the light and has a high stability. Moreover, this method has strong adaptability and robustness to dynamic environment, and is suitable for extracting image frames from video.

Disadvantages: the disadvantages of the inter-frame difference method are mainly caused by the difference between the speed of moving target and the time interval between adjacent frames. If the moving speed of vehicles in video is slow and the time interval between adjacent frames is small, there will be almost no difference between the two adjacent frames, and the target vehicle will be misjudged as the background area. After binarization, it will be integrated into the background, resulting in the loss of target information and the formation of "void".

5. Conclusions and future work

In this paper we presented an intelligent license plate recognition system through image preprocessing, license plate positioning, character segmentation and character recognition. The image is processed to realize the recognition of license plate under different environments. The next phase, we plan to improve this algorithm to apply the large crane structure inspection, which can be used to automatically detect the metal structure surface cracks, rusts, plastic deformation and other defects, and determine whether there are wear, deformation, defects and other problems in the main parts such as spangles, wire ropes, pulleys and connecting parts.

Acknowledgements

This project is supported by the National Key Technology R&D Program of China (No.2017YFC0805703).

References

[1] guan ruining. Symbol recognition in natural scenes based on multi-scale segmentation [D]. Fudan university.2012.50-56

[2] wang lei. Coordinated development and traffic practice -- proceedings of the 2015 China urban traffic planning annual meeting and the 28th academic seminar [C]. Academic committee of urban traffic planning of China urban planning association: urban traffic research institute of China urban planning and design institute, 2015:15-19

[3] lie Siyan and li aiming. Research on license plate location under complex illumination [J]. Electronic measurement and instrumentation bulletin, 2005,19 (06): 92-97

[4] Zhao handle, lie jury, jiang lei et alto-line license plate segmentation algorithm based on convolutional neural network [J]. Journal of computer aided design and graphics, 2019,5 (08): 1320
[5] Yue Peng, Peng jinee. A practical fast locating system for multiple license plates [J]. Computer engineering and applications, 2011,47 (17): 217-220

[6] Arvin Ebrahimkhanlou, Salvatore Salamone. A probabilistic framework for single-sensor acoustic emission source localization in thin metallic plates [J]. Smart Materials and Structures, 2017,26 (9) :24-26

[7] lin jingo, zhug Xinmin, we Yue et al. almost-vehicle license plate online detection based on neural network and support vector machine [J]. Journal of automation, 2016,8(08): 42-45

[8] S.an, B.W. Li. Impact Localization of Thin Plate Structures Using pat-array Based Passive Wave Method[J]. IOP Conference Series: Earth and Environmental Science, 2019,283 (1): 56-59