Short Research Article

Research on License plate Recognition Method based on HALCON

ABSTRACT

With the rapid development and continuous improvement of image processing technology, the intelligent management of traffic management system for vehicles has accelerated the speed of road safety information, in which the car license plate as the identification of vehicle identity, the identification of its character information is the key to the license plate recognition system. In order to solve the problem of the traditional license plate recognition algorithm such as long development period, this study adopts the HALCON as a programming platform, the acquisition of image preprocessing to enhance image contrast, through the affine transformation to complete correction of tilt of the image, and at the completion of the design after character segmentation OCR based on neural network classifier to complete accurate recognition of Chinese characters, letters and Numbers. The experiment shows that the system has the ability to adapt to the environment and can recognize the license plate information efficiently and accurately.

Keywords: machine vision; character recognition; affine transformation; expansion processing;

1. INTRODUCTION

License plate recognition technology plays an important role in road safety management system [1]. It is widely used in highway automatic toll collection system, abnormal stop alarm system and residential area access control, etc. It is an important means to speed up road information management [2].

Foreign research on license plate recognition relatively early and achieves good recognition results, the domestic research institutions also carried on the related research and discussion, the current mainstream of license plate recognition methods are: using the projection features of license plate recognition method, suitable for layout structured sample figure, but plate wear or tilt will has a great influence on the identification results, poor anti-interference ability [3]; Based on wavelet, this recognition method can extract Chinese character features of license plate directly from gray image without binarization, which avoids the loss of Chinese character structure information caused by binarization, but the recognition effect is not ideal when the character location is not accurate [4].

HALCON is developed by the German company is relatively perfect package machine vision algorithms [5], including filtering, morphological analysis, geometric measuring and computing functions such as template matching, classification, and these functions are not designed for a specific object, most has the characteristics of general application, so almost related to image processing can be done by HALCON [6], This is why HALCON is widely used in various fields such as medical impact, automated detection, and monitoring.

In addition, to shorten the user's design cycle, HALCON includes H Develop, an interactive programming interface that allows users to write simple HALCON code and then directly output C, C++, VB code to be nested in their own programs [7].

This study constructs a license plate recognition system based on HALCON, and realizes the recognition of segmented characters by designing a classifier based on neural network [8]. The system avoids the recognition obstacle brought by the projection feature method by correcting the tilted image, and prevents the loss of character structure by expanding the acquired characters [9]. The system successfully applies the visual detection technology to the license plate character recognition, and realizes the recognition and display of license plate information efficiently and quickly.

2. EXPERIMENTAL DETAILS

2.1 The overall design

The image collected in natural environment often has a variety of adverse factors that affect the recognition results, so after reading the image file to be processed, the image should first be preprocessed by gray level, binarization and so on, so as to make the target features in the image more obvious. In addition, the pose of the license plate in the read image is not the same, which brings some difficulty to the positioning of the characters [10]. This study adopts the affine transformation method to adjust the pose of the image and obtains good results. Finally, OCR classifier based on neural network is trained to recognize the license plate character, and the recognition result is displayed on the original image [11].

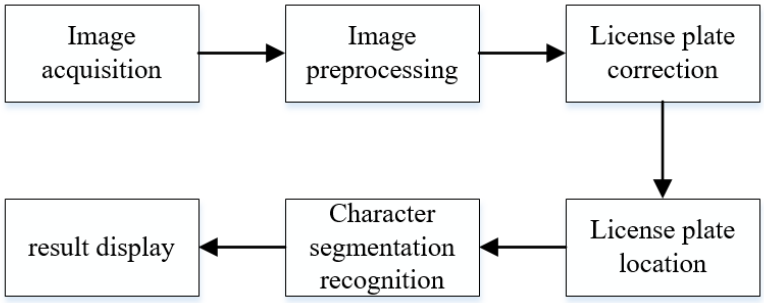

Fig. 1. System flow chart

2.2 Image acquisition

In this study, the read_image () operator is called in the HALCON programming environment to read the license plate image that has been stored in the computer (HALCON supports common image formats such as BMP, PNG, JPGE and GIF), and the reading result is shown in Figure 2. HALCON also provides access to hundreds of industrial cameras and image capture cards, allowing users to capture images of license plates in real time [12].

Fig. 2. Read the original image

2.3 Image preprocessing

The quality of images acquired under natural conditions is often affected by factors such as uneven illumination, mechanical vibration, camera performance and so on. Even the license plate itself may have pollution, defects and other

factors that affect the recognition results [13]. Therefore, the license plate image should be preprocessed by image preprocessing before the location segmentation and recognition, to enhance the contrast between the license plate and the background environment so as to reduce the difficulty of post-image processing.

2.3.1 Gray level processing

Generally, a pixel is composed of the values of R, G and B channels, and the value of each channel is between 0 and 255, which makes the possible color values of each pixel 256*256*256. The gray image is a special color image with the same components of R, G and B, and there are only 256 color variation ranges for the computer. In addition to the reduction of the original data, RGB does not reflect the morphological characteristics of the image better than the gray image. Therefore, this study uses RGB1 () operator to gray process the image based on HALCON. The common gray-scale methods are component method, maximum method and weighted average method [14]. The weighted average method is adopted here, and the transformation relation is shown in Formula (1). The transformation result is shown in Figure 3:

$$gray = 0.299 * red + 0.587 * green + 0.114 * blue \quad (1)$$

Fig. 3. Image after gray-scale processing

2.3.2 Contrast enhancement

Due to the phenomenon that the image contrast after gray-scale may not reach the desired level, the operator scale_image () is further invoked in HALCON to enhance the image contrast by scaling the gray value of the image. Formula (2) describes the algorithm, where GMax and GMin are the maximum and minimum gray value of the image respectively [15]. Figure 4 is the processing result of contrast enhancement. Compared with Figure 2, 3 and 4, it can be seen that the image contrast is significantly enhanced after gray-scale and image contrast enhancement.

$$g\text{^}' = g * 255/(GMax - GMin) - Mult * GMin \quad (2)$$

Fig. 4. Image with enhanced contrast

2.3.3 Binarization processing

Binarization is to roughly select the position of the license plate to facilitate the subsequent calculation of license plate tilt Angle and the choice of character region [16]. The gray histogram (as shown in Figure 5) is used to determine the threshold, and all pixels whose gray values meet the threshold conditions are returned in the form of regions by calling the threshold () operator based on the Gaussian filter bimodal method. The binarization result is shown in Figure 6.

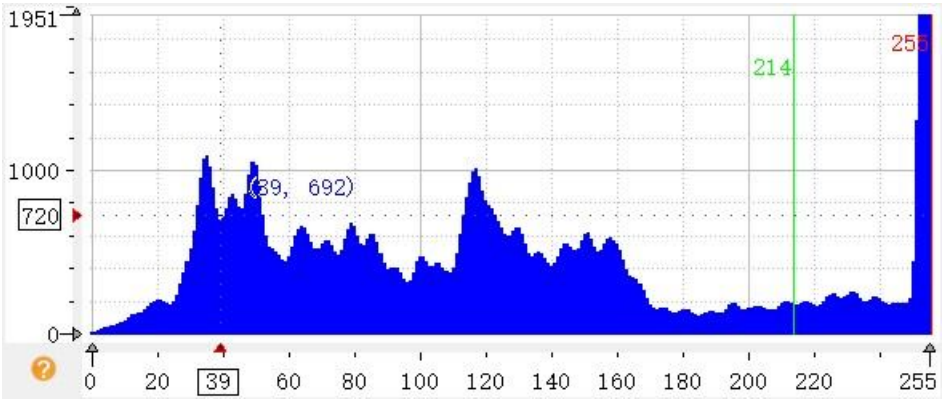

Fig. 5. Gray scale histogram

Fig. 6. The result graph after binarization processing

2.4 License plate image correction

After the above preprocessing, the image suitable for feature extraction with stronger contrast is obtained. However, this cannot guarantee that the license plate in the actual image is always in the same pose, especially the inclined image which is not conducive to the accurate positioning of the character position. Therefore, the license plate pose needs to be further corrected and positioned [17]. Common geometric transformation methods include affine transformation, projection transformation and polar transformation. This study uses affine transformation to adjust the pose of detected license plate.

The affine transformation can modify the translation and rotation Angle of the object. The affine transformation consists of a linear part and a part, and the mathematical description is shown in Equation (3). This way of matrix column write need translation part separately, every time when the problem description is too cumbersome, so on the basis of the original coordinate this expression need to translation part separately, when the problem description is too trival, therefore on the basis of the original coordinate so as to realize the coordinates of the introduction of the third value is 1 only with simple multiplication of the affine transformation can be realized, The mathematical description is as in Equation (4). Where R and c respectively represent the column and row coordinates of pixels [18].

$$\begin{pmatrix} r' \\ c' \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \begin{pmatrix} r \\ c \end{pmatrix} + \begin{pmatrix} T_r \\ T_c \end{pmatrix} \quad (3)$$

$$\begin{pmatrix} r' \\ c' \\ 1 \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} r \\ c \\ 1 \end{pmatrix} \quad (4)$$

By calling the operator orientation_region () on HALCON platform, the region returned by the above binarization was fitted to the minimum enclosing ellipse, and the Angle between the major axis of the ellipse and the horizontal direction was taken as the inclination Angle phi of the image, as shown in Figure 7. The area_center() operator is used to calculate the center point coordinates and area of the region. The vector_angle_to_rigid () operator calculates the affine transformation according to the correspondence between points and two corresponding angles, and returns it as the homogeneous transformation matrix HomMat2D. The affine_trans_image () affine transformation is described by the homogeneous transformation matrix given in HomMat2D [19]. The corrected image is shown in Figure 8.

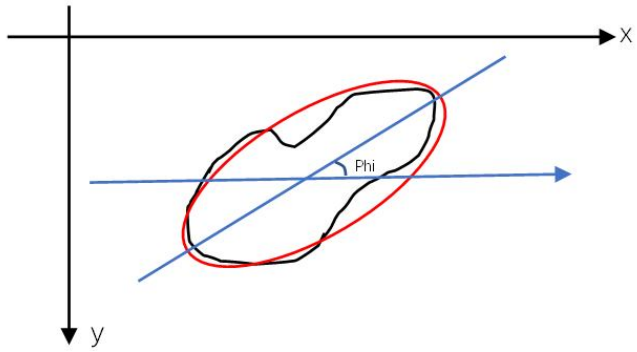

Fig. 7. Find the inclination Angle of the outer ellipse

Fig. 8. The result of image correction

3. RESULTS AND DISCUSSION

3.1 License plate location and character segmentation

After image preprocessing and image correction, a more suitable candidate area of vehicle license plate can be obtained. Next, the steps and methods of license plate location and character segmentation are introduced.

(1) The connected domain obtained by binarization is divided into several regions. The connection () operator is called in HALCON to split the disconnected regions into independent regions, and the result is shown in Figure 9.

Fig. 9. The resulting graph of the splitting of connected domains

(2) A number of connected domains of characters to be recognized are obtained by shape selection. The call select_shape () operator uses the region area feature and the column and column coordinate feature to extract the license plate character area precisely, which reflects the important significance of rotation correction for license plate. The selection results are shown in Figure 10.

Fig. 10. Select the character area

(3) Each character is separately processed as a connected domain by swelling processing. Most of the Chinese characters have stroke discontinuous phenomenon, which makes the shape of a simple choice does not make Chinese characters which connected domain, this study use dilation_rectangle1 () operator through a rectangular structure element to expansion of the selected area, makes the original broken parts connected together, expand the results as shown in figure 11.

Fig. 11. Connected domain expansion processing

Then, through Union1 () and connection (), several regions of each character that form a separate connected domain are regenerated, and the final segmentation result is shown in Figure 12.

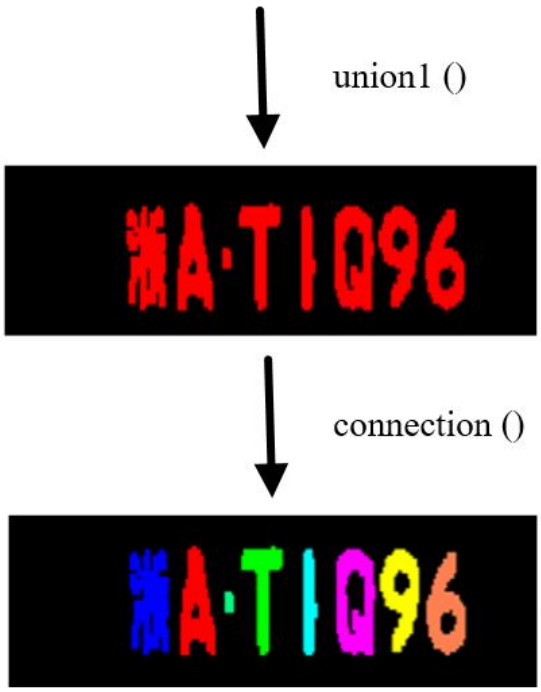

Fig. 12. The result of character segmentation

3.2 Character recognition

Based on the HALCON platform, this study uses the learning and memory functions of neural networks to match the segmented character regions with the previously obtained samples to identify characters. The classifiers commonly used in HALCON include GMM (Gaussian mixture Model), Netural Nets(Neural network), SVM (Support Vector Machine), etc. In this study, multi-layer perceptron (MLP) is used to create an MLP classifier with manually selected features by adding feature vectors, and then the classification file of the trainer is read to recognize and classify the selected characters.

Multi-layer perceptron (MLP) is also known as deep neural network. The connection between layers is shown in Figure 13 as a fully connected neural network, and each neuron represents a kind of excitation function as shown in Figure 14 (the excitation function is composed of linear function and activation function).

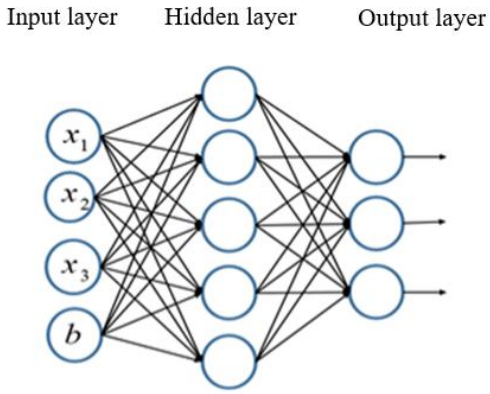

Fig. 13. multilayer perceptron

The deviation between the output y of the neural network and the true value y is denoted as:

$$Loss = \sum_{i=1}^{n} \left(Y_i - (w_i + b_i)\right)^2$$

The whole training process is the process of shrinking Loss. By backpropagating the residual, the gradient descent method is used to continuously update the weights and biases so that the output of the network approximates the true weights.

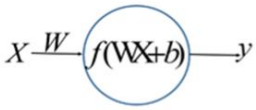

Fig. 14. neuron model

The steps on the HALCON platform are as follows: The first step is to sort the segmentation characters in HALCON and count the number of connected domains (characters) by count_obj() operator. Then the append_ocr_trainf () operator is called to write the feature vectors of a single character region, a single character image, and the corresponding character text into the TRF TrainFile file. Then the create_OCR_class_MLP () operator is used to create an OCR classifier using multi-layer perceptrons. According to the character sequence saved in the TrainFile file, the character picture is saved as the OCR classifier in OMC format, and the classifier assigns class labels to the data points for identification and use to complete the creation of the classifier. In the second step, the trainf_OCR_class_MLP () operator is used to train the newly created OCR classifier, and then the write_OCR_class_MLP () operator is used to write the OCR classifier into a file for saving. Finally, the trained OCR classifier is invoked to recognize and display the characters. The result is shown in Figure 15.

Fig. 15. License plate recognition result

4. CONCLUSION

The built-in classifier of HALCON cannot recognize Chinese characters, so this study trained its own OCR classifier according to the needs. In the process of Chinese character recognition, expansion processing was used to process the corrected Chinese characters into independent connected domains in view of the ‘character disconnect’ of Chinese characters. After testing, the license plate recognition system designed in this study is simple and effective, and has a certain sense of use value.

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