Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
May-June 2022 Page No. 2177-2184
Article History: Received: 24 February 2022, Revised: 05 April 2022, Accepted: 08 May 2022, Publication: 30 June 2022

Vehicle License Plate Recognition Algorithm Based on Deep Learning

Qiaojun Li
Henan Polytechnic Institute, Nanyang, Henan, 473000, China

Abstract:

With the gradual increase of car ownership in China, license plate recognition plays an important role in intelligent vehicle control system. The existing vehicle number recognition algorithms have slow recognition speed and low accuracy, and are easy to be affected by the light, the position angle of the license plate and the relative fixed position of the camera. The Faster-RCNN based on pattern analysis method locates the license plate, generates the license plate extraction frame and extracts the license plate; Use VGGnet network model to recognize characters, and finally complete the recognition of car license plate. Training and testing are carried out in a great quantity of data sets. The simulation results show that the network model combining fast RCNN and VGGnet can recognize the license plate with an accuracy of 99.2% in a complex environment, and the recognition accuracy is better than other algorithms.

Keywords: *License plate detection, Artificial intelligence, Faster-RCNN, VGGnet, Feature identification.*

I. INTRODUCTION

As one of the significant external identity information of the vehicle, the license plate can get the driving path, form, driver and other information of the vehicle by the license plate. License plate recognition has a wide range of applications and is widely used in smart parking, highway vehicle monitoring, urban number restriction and so on. But the current license plate recognition method has high requirements for license plate images, and can not be applied to the recognition requirements of complex light, multi-scale, high recognition rate and fast speed. License plate recognition includes license plate extraction, feature fragment and feature recognition. The traditional methods of license plate location mainly rely on the manually designed features: location method based on morphological features [1-2], location method based on color image [3], location method based on neural network [4-5], location algorithm based on texture features [6], etc. Traditional license plate recognition algorithms have high requirements for license plate images, while there are many factors affecting the quality of license plate images, such as light, distance and angle between license plate and image acquisition equipment. Current segmentation algorithms include template based character segmentation algorithm [7], clustering algorithm, character segmentation [8,9]. Feature recognition is the most important part of license plate recognition, and its accuracy directly affects the accurate recognition of license plate. Using machine learning algorithm to recognize character calls, but there is still a lot of room to improve the recognition time and recognition rate. With the emergence of deep learning, feature extraction does not need to rely on

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
May-June 2022 Page No. 2177-2184
Article History: Received: 24 February 2022, Revised: 05 April 2022, Accepted: 08 May 2022, Publication: 30 June 2022

artificially set features, and the accuracy and speed of character recognition have been greatly improved. However, this paper uses the license plate recognition algorithm based on the combination of deep learning fast RCNN [10] and VGGnet (Visual Geometry Group network) model to extract, segment and recognize the vehicle license plate.

II. LICENSE PLATE RECOGNITION BASED ON FAST RCNN AND VGGNET

The target detection algorithm based on deep learning, so it can be divided into One-stage and Two-stage by the principle. The Faster-RCNN model belonging to Two-stage is used in this paper. Faster-RCNN is a convolutional neural network applied to target detection and recognition [11-15]. It is improved from fast RCNN to realize end-to-end detection. Using this model for target detection task can realize the accurate positioning of detected objects, predict the types of objects in the picture, and overcome the recognition shortcomings of multi angle, multi-scale, multi category and multi scene. The fast RCNN process is shown Figure 1.

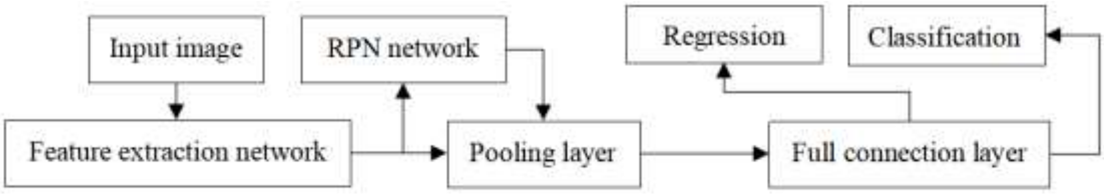

Figure 1 Fast-RCNN flow chart

III. LICENSE PLATE LOCATION

Faster-RCNN model is used to extract the license plate. Faster-RCNN network model first uses the basic characteristic extraction network to extract the characteristic vector of the detected image. The characteristic extraction network includes 13 convolution layers and 5 pooling layers, and the characteristic vector is shared by RPN (region proposal networks) network and fully connected network. The RPN network is used to generate the region proposals of the target. The network structure includes a 3 × 3 convolution layer and two 1x1 convolution networks. The network structure is shown in Figure 2. Activate the function through Softmax and correct an by using Bounding box regression to correct anchor box and obtain the exact position of the target. The ROI (region of interest) pooling layer is used to obtain the corresponding classification, and the probability vector is also obtained. The comprehensive proposals of feature weights output by the feature extraction network are received. Through a full connection layer and a Softmax layer, the probability vector is obtained to determine the target category.

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
May-June 2022 Page No. 2177-2184
Article History: Received: 24 February 2022, Revised: 05 April 2022, Accepted: 08 May 2022, Publication: 30 June 2022

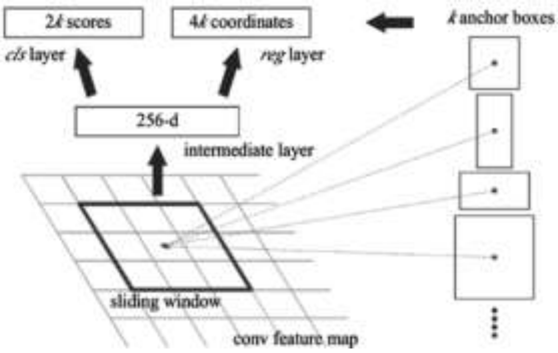

Figure 2 RPN network

IV. Character Segmentation

There are many types and complex types of license plates in China. Take the license plate of ordinary cars as an example, the white characters on the blue background for small cars, the black characters on the yellow background for medium and large vehicles. According to GA36-2007 standard, the license plate is composed of one character plus six characters, of which the first character is the abbreviation of the province where the license plate is located, a total of 31 kinds, and the rest characters are composed of letters (excluding I and o) and numbers. Firstly, the license plate extracted by Faster-RCNN network is preprocessed [16-19]. Image preprocessing includes image gray image processing, filtering and denoising, image enhancement, gray image binarization and so on.

4.1 Image Graying

The license plate image is stored with three channel components of red, green and blue. The process of image graying is to convert three channels of color image into a picture with only one gray channel.Average method, maximum method and weighted average method are the common license plate image graying processing methods. Because there are many kinds of license plates, this paper selects the weighted average graying method through the comparison of the experimental results shown in Figure 3, which has good robustness.

Figure 3 Graying methods

4.2 Filtering and Denoising

License plate image information is easy to produce noise in acquisition. The commonly used image filtering algorithms include Gaussian filtering, bilateral filtering, mean filtering and so on. Although these

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
May-June 2022 Page No. 2177-2184
Article History: Received: 24 February 2022, Revised: 05 April 2022, Accepted: 08 May 2022, Publication: 30 June 2022

methods can remove the noise better, they can make the license plate character image

The edges become blurred. The bilateral filtering can maintain the edge features of the contour and eliminate the noise at the same time. Figure 4 shows the comparison of denoising results by different methods. In this paper, bilateral filtering is used to denoise the license plate.

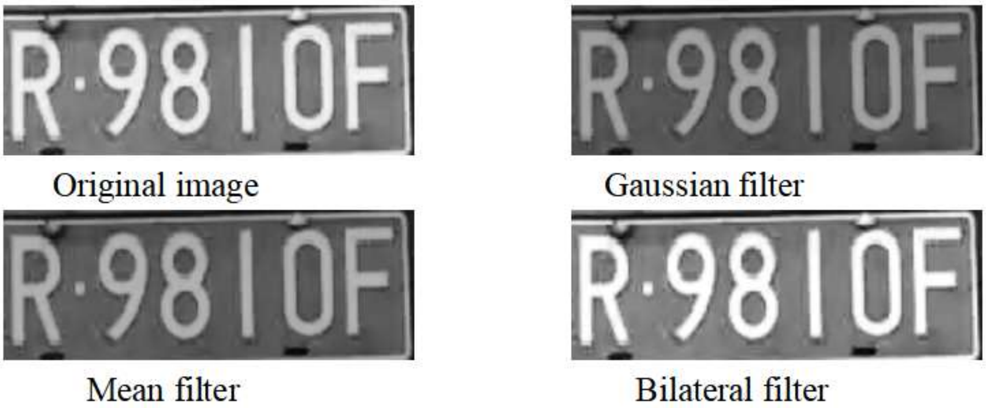

Figure 4 Filtering methods

4.3 Image Enhancement

Image enhancement mainly solves the problem of low gray contrast caused by the small gray level range of the image. The purpose is to enhance the gray contrast of the image and make the detail contrast in the image more clear. Several common methods are linear transformation, piecewise linear transformation, histogram normalization, local adaptive histogram equalization and so on. In this paper, a gamma transform algorithm is used to enhance the contrast of license plate image, which has good effect and is helpful for subsequent processing.

4.4 Image Binarization

Binarization is mainly to reduce the amount of calculation. Its principle is: set a value t as the threshold, compare the pixel gray value of the binarized image with T, if it is less than t, the pixel value point is set to 0, that is, white, otherwise the pixel value is 255, that is, black. The whole image presents both black and white effects. The selection of threshold is the key to the binarization effect. Otsu method counts the histogram of the whole image to realize the automatic selection of global threshold T. the algorithm is simple and stable,

Is a common method. In this paper, Otsu method is used to binarize the license plate image after image enhancement. The process is shown in Figure 5.

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
May-June 2022 Page No. 2177-2184
Article History: Received: 24 February 2022, Revised: 05 April 2022, Accepted: 08 May 2022, Publication: 30 June 2022

Figure 5 Image binarization process

4.5 Character Segmentation

This paper adopts the character segmentation algorithm based on vertical projection. Its principle is to scan the preprocessed license plate image from left to right, count the number of pixels in each column of license plate characters, and get a vertical projection image. According to the statistical characteristics of license plate character pixels: trough is character projection, crest is character gap projection, and select the center position of all peaks, the license plate image is segmented into a single independent character image. This method is simple, fast and efficient.

V. CHARACTER RECOGNITION

The traditional methods of license plate character recognition are template matching and traditional BP (back propagation neural network) neural network. Convolutional neural network can automatically extract features and classify complex images. It is less disturbed by the external environment and has good robustness and adaptability. Therefore, VGGnet network model based on convolutional neural network is used for license plate character recognition in this paper. The model includes 13 convolution layers, 5 pooling layers and 3 full connection layers. The model is shown in Figure 7. By adding dropout layer to the model, the direct function is to reduce the number of intermediate features in proportion, so as to reduce the redundant weight value, increase the orthogonality between the features of each layer and improve the generalization ability of the model. Based on the CCPD data set, this paper counts and classifies the character pictures after character segmentation, and makes the data set of character recognition. The data set contains 31 kinds of characters. After removing the remaining 24 letters and 10 numbers of I and O, the problem of license plate recognition is transformed into 65 kinds of character classification. The data set contains 3100 Chinese character pictures, 2400 alphabetic pictures and 1000 digital pictures. In keras platform, VGGnet neural network model is built by using deep learning theory for training. The length and width of the segmented binary image are unified as 224, and the image is sent to the input layer. The loss function uses relu. The optimizer selects Adam and epoch as 200 for training and recognition. Figure 6 (a) shows the relationship between the training accuracy and the number of iterations. It can be seen from the figure that the accuracy rate reaches 99.2% at the 100th iteration; Figure 6 (b) shows the relationship between the loss rate and the number of iterations. It can be seen from the figure that when the iterations reach about 100 times, the loss rate decreases to the lowest and tends to be stable. When the iterations reach 200 times, the recognition accuracy is 99.2%.

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
May-June 2022 Page No. 2177-2184
Article History: Received: 24 February 2022, Revised: 05 April 2022, Accepted: 08 May 2022, Publication: 30 June 2022

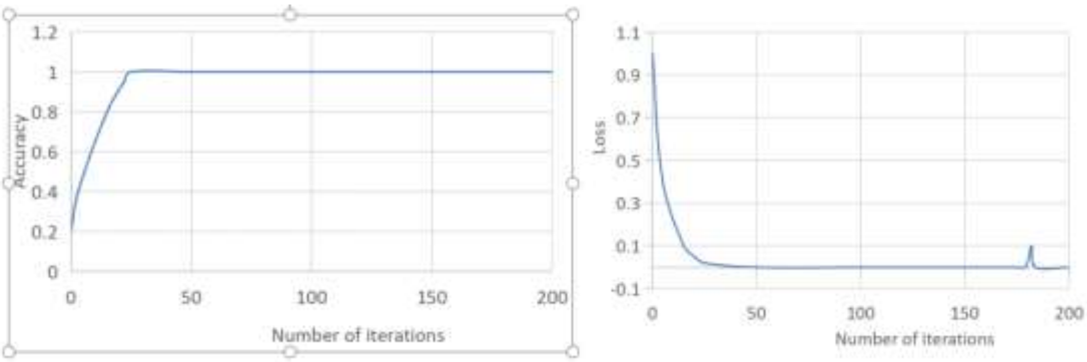

Figure 6 Training and Recognition

Windows are generally represented by four-dimensional vectors (x, y, W, H), which represent the coordinates of the center point and the width and height of the window respectively.

$$\begin{cases} t_x = (x - x_a)/w_a \\ t_y = (y - y_a)/h_a \\ t_w = \log(w/w_a) \\ t_h = \log(h/h_a) \end{cases} \tag{1}$$

In order to minimize the predicted value (TX, ty, TW, th) and the real value, the loss function is obtained:

$$Loss = \sum_i^N (t_*^i - \hat{w}_*^T \Phi(A^i))^2 \tag{2}$$

The objective of function optimization is:

$$w_* = \arg\min_{\hat{w}_*} \sum_i^N (t_*^i - \hat{w}_*^T \Phi(A^i))^2 + \lambda \left\| \hat{w}_* \right\|^2 \tag{3}$$

The loss used by the whole network is as follows:

$$L(\{p_i\},\{t_i\}) = \frac{1}{N_{cls}} \sum_i L_{cls}(p_i, p_i^*) + \lambda \frac{1}{N_{reg}} \sum_i p_i^* L_{reg}(t_i, t_i^*) \tag{4}$$

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
May-June 2022 Page No. 2177-2184
Article History: Received: 24 February 2022, Revised: 05 April 2022, Accepted: 08 May 2022, Publication: 30 June 2022

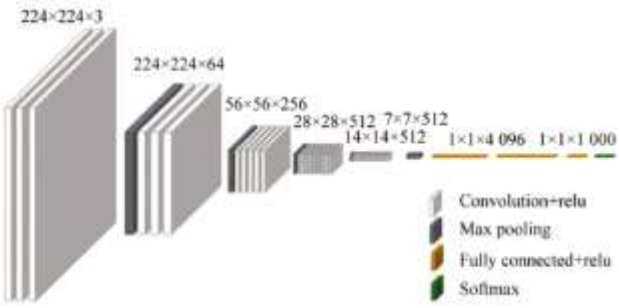

Figure 7 VGGnet structure

VI. CONCLUSION

This paper uses fast RCNN and VGGnet model to locate and recognize the license plate. The license plate is located by fast RCNN, recognized by VGGnet model, trained and tested in the license plate data set. The experimental results show that the method used in this paper can effectively extract the license plate image and recognize the license plate number, and the detection accuracy is as high as 99.2%. Compared with the traditional license plate recognition algorithm, although the model training time is longer, it can get higher accuracy and higher recognition efficiency. Due to the limited number of sample pictures and many factors affecting the quality of license plate pictures, if more samples are added to enrich the data, the recognition accuracy of the model will be improved accordingly.

REFERENCES

[1] Luoshan License plate location based on mathematical morphology and projection method. Journal of Panzhihua University, 2019, 36 (2): 78-81
[2] Luoshan A license plate location method based on morphology and region analysis. Shanxi electronic technology, 2018 (6): 13-16
[3] Li Wenju, Liang Dequn, Zhang Qi, et al. A new method of license plate location based on edge color pair. Journal of computer science, 2004, 27 (2): 204-208
[4] Weiming Research on license plate detection based on fasterr CNN. Automotive industry research, 2019 (1): 59-62
[5] Li Wenpeng Research and application of deep learning in license plate recognition. Xi'an: Xi'an University of engineering, 2018
[6] Xue Qian License plate location algorithm based on image preprocessing and texture features. Electronic design engineering, 2014 22(16):159-162.
[7] Cui Wenwen, Cui Yichuan, Wang Zhaohui, et al License plate character segmentation algorithm based on template matching and vertical projection. Journal of Qiqihar University (NATURAL SCIENCE EDITION), 2015, 31 (6): 12-16
[8] Wang Minghua A license plate image segmentation method based on fuzzy clustering. Journal of Heilongjiang Institute of Engineering (NATURAL SCIENCE EDITION), 2013, 27 (1): Central - supply
[9] Xu Bin, Wang Yuandi Mathematical modeling and implementation of machine learning method for license plate recognition. Journal of Applied Mathematics and computational mathematics, 2011, 25 (1): 53-64,
[10]Ren Shaoqing, He Kai mi ng, Girshick Ross. Faster R-CNN: To wards Real-Time Object Detection with Region Pioposal Net works. IEEE transactions on pattern analysis and machine in- telligence, 2017, 39(6).

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
May-June 2022 Page No. 2177-2184
Article History: Received: 24 February 2022, Revised: 05 April 2022, Accepted: 08 May 2022, Publication: 30 June 2022

[11] Wang W, J Tu. Research on License Plate Recognition Algorithms Based on Deep Learning in Complex Environment. IEEE Access, 2020, 8(5):91661 - 91675.
[12] Khazaee S, Tourani A, Soroori S, et al. An Accurate Real-Time License Plate Detection Method Based On Deep Learning Approaches. International Journal of Pattern Recognition and Artificial Intelligence, 2021, 35(12):216-224.
[13] Li Q, He C. A new algorithm of vehicle license plate location based on convolutional neural network. Journal of Computational Methods in Sciences and Engineering, 2018, 18(8):1-13.
[14] Ma C, Sun X, Yao C, et al. Research on Sheep Recognition Algorithm Based on Deep Learning in Animal Husbandry. Journal of Physics Conference Series, 2020, 1651:012129.
[15] Ma L, Zhang Y. Research on Vehicle License Plate Recognition Technology Based on Deep Convolutional Neural Networks. Microprocessors and Microsystems, 2021, 82(8):103932.
[16] Hab ee bDhuha, NomanFuad, Ahmed A A, et al. Deep-Learning-Based Approach for Iraqi and Malaysian Vehicle License Plate Recognition. Computational intelligence and neuroscience, 2021, 2021:3971834.
[17] Adedayo K D, Agunloye A O. Real-time Automated Detection and Recognition of Nigerian License Plates via Deep Learning Single Shot Detection and Optical Character Recognition. Computer and Information Science, 2021, 14.
[18] Pustokhina I V, Pustokhin D A, Rodrigues J, et al. Automatic Vehicle License Plate Recognition Using Optimal K-Means With Convolutional Neural Network for Intelligent Transportation Systems. IEEE Access, 2020, 8:92907-92917.
[19] Kim S G, Jeon H G, Koo H I. Deep-learning based License Plate Detection Method using Vehicle Region Extraction. Electronics Letters, 2017, 53(15):1034-1036.