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Handwritten Font Recognition Based on Convolutional Neural Network

Cui Dongyan[1], Hou Shen[1]
[1] School of Artificial Intelligence, North China University of Science and Technology ,Tangshan, Hebei, China
E-mail: *cdy_xxz@163.com*

Abstract

With the development of social artificial intelligence, people's demand for intelligent recognition of handwritten Chinese characters is increasing, and handwritten Chinese character recognition has a wide range of application prospects in Chinese automatic processing and intelligent input, but due to the diversity and similarity of handwritten Chinese characters, different people's writing habits and styles are very different, making handwritten Chinese character recognition a difficult and hot spot in related research fields. In order to solve the problem of cumbersome feature extraction in traditional Chinese character recognition, this paper uses the pythorch framework to recognize handwritten Chinese character images based on convolutional neural network in deep learning, and the HWDB1.1 dataset is used for simulation experiments. Through the comparison of multiple model training sets and the analysis of experimental results, it is found that deep learning can effectively extract image features, and EfficientNetV2 is a deep learning model worthy of attention and attempt, which has the advantages of being smaller, faster, more accurate, more reliable, and more convenient to customize.

Keywords: Handwritten Chinese Characters, Convolutional Neural Network, Intelligent Recognition, Deep Learning.

1. Introduction

Chinese handwriting recognition is an important research direction of optical character recognition technology, and many researchers have begun to use convolutional neural networks to study handwriting recognition. In 1989, LeCun et al. used the BP algorithm to train multi-layer convolutional neural networks and recognize handwritten numbers [1]. In 1998, LeCun et al. formally proposed LeNet5, the first formally formed convolutional neural network, LeNet-5, which is a convolutional network that recognizes handwritten digits [2]. In 2002, Gao Xue et al. established an SVM-based model based on the risk minimization criterion and analyzed the special problems encountered in recognizing handwritten Chinese characters [3]. In 2012, Pham et al. successfully applied convolutional nets to online English handwriting and digital handwriting recognition, using MNIST and UNIPEN datasets, and using the traditional Lenet-5 as the prototype structure of convolutional nets to improve [4].At the 13th International Conference of ICMLC held in Tianjin in 2013, Liu Caihua and Liu Jie et al. proposed a study on the English aspects of handwriting character recognition [5]; At the 12th International Conference on ICDAR in 2013, the task of Chinese handwriting recognition was proposed, and Wu Chunpeng of Fujitsu Beijing Research Center proposed a system for recognizing Chinese characters using a convolutional neural network based on the voting mechanism and using GPUs to improve performance [6]. In addition, Ciresan et al. from Switzerland also presented a recognition system based on deep convolutional neural networks for offline Chinese handwriting recognition at the ICDAR conference in 2013 [7]. At the same time, Graham et al. from the University of Warwick (Hong Kong) in the United Kingdom have made a breakthrough in the application of convolutional neural networks to online Chinese character recognition, and have made a major breakthrough in the online Chinese character recognition task of ICDAR for the first time [8]. The development of convolutional neural networks has brought about technological innovation, which has triggered a new wave in the field of Chinese character recognition..

In order to solve the problem of cumbersome feature extraction in traditional Chinese character recognition, this paper uses the pythorch framework to recognize handwritten Chinese character images based on convolutional neural networks in deep learning, which is of great significance for improving the accuracy of handwritten font recognition and promoting the development of artificial intelligence.

2. Theoretical Basis of Convolutional Neural Networks

Convolutional neural networks are at the forefront of many fields, especially in object detection. Convolutional neural networks convolve images through convolutional layers to fully recognize semantic information, extract features through convolution and pooling, and finally aggregate them through skeleton networks. As shown in Fig. 1.

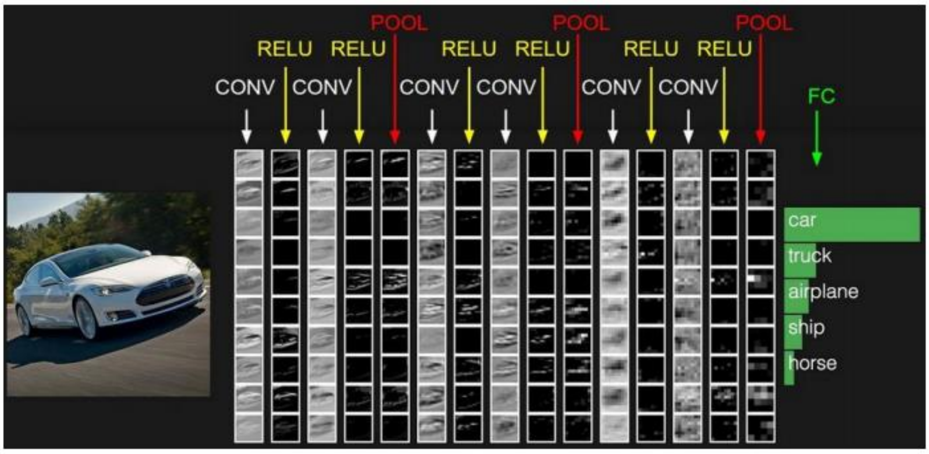

Fig.1 Example of Convolutional Neural Network

2.2. Basic Framework Structure

The received image is completed by the input layer, and convolution, pooling, and other operations are performed in the hidden layer to extract corresponding object features. Finally, the output layer completes classification and regression. The composition of the hidden layer consists of convolutional layers, pooling layers, and activation functions. In the study, a BN layer will also be added.

3. Experimental environment and data set

3.1. Experimental environment

In this experimental design, the handwriting font recognition system is built on Pycharm 2022.3.2, the development language is python 3.8.10, the deep learning framework is built by PyTorch 1.10.0, and the system is implemented based on Opencv-python library and PyQt. The experimental environment is shown in Table 1.

Table 1. Experimental environment

Experimental environment	
CPU	Intel Core i7-9750H
Memory	16GB
GPU	8GB
Memory	NVIDIA GeForce GTX1650
Development language	Python

3.2. HWDB1.1 Dataset

The HWDB1.1 dataset is a large-scale database for Chinese handwriting character recognition, hosted by the Institute of Automation, Chinese Academy of Sciences. The dataset contains 3755 basic Chinese characters with a total of 3,537,281 handwritten character images, making it one of the most widely used handwriting databases. Each image is a 32x32 grayscale image with a resolution of 300 dpi.

3.3. Evaluation Indicators

1) Accuracy: Accuracy = Number of correctly identified samples/Number of populations

2) Precision: Precision=TP/(TP+FP)

3) Recall: Recall = TP / (TP+FN)

4) F1 value: F1 = 2*Precision * Recall / (Precision ++Recall)

4. Experimental Results and Analysis

In this paper, the handwriting font recognition system is trained using six network models of ShuffleNetV2, EfficientNet-b0, ResNet18, AlexNet, EfficientNetV2-s, and VGG16, as shown in Table 2.

Table 2 Legend

color	model
orange	Train\ShuffleNetV2
Dark blue	Train\EfficientNet-b0
brown	Train\ResNet18
light blue	Train\AlexNet
pink	Train\EfficientNetV2-s
green	Train\VGG16

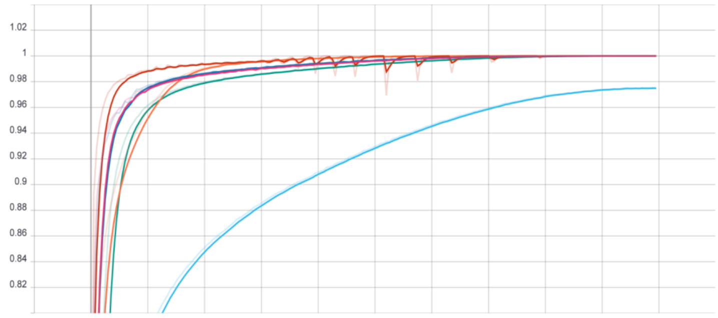

Fig.2 Training set precision

As shown in Fig. 2, the training set precision of the six models is represented.

As can be seen from Figure 2, the accuracy of the AlexNet model is low, and the accuracy of other models is high.

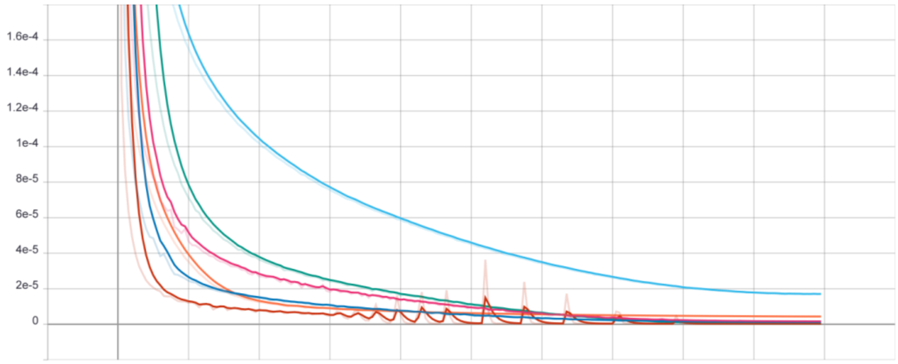

Fig.3 Training set loss rate

As shown in Fig. 3, the loss rate of the training set of six models is shown, the AlexNet model has a large loss rate, and the other models have a small loss rate.

Fig. 4 shows the F1 values of the six models, with the AlexNet model having the lowest F1 value, the ShuffleNet V2 model having a low F1 value, and the other models having a high F1 value.

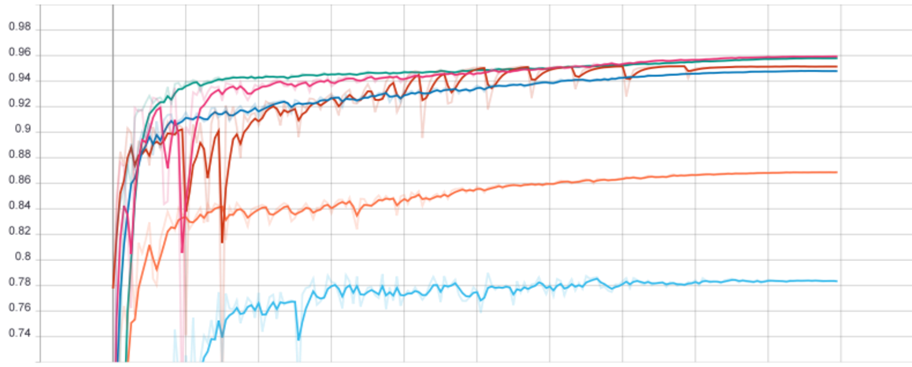

Fig.4 F1 values

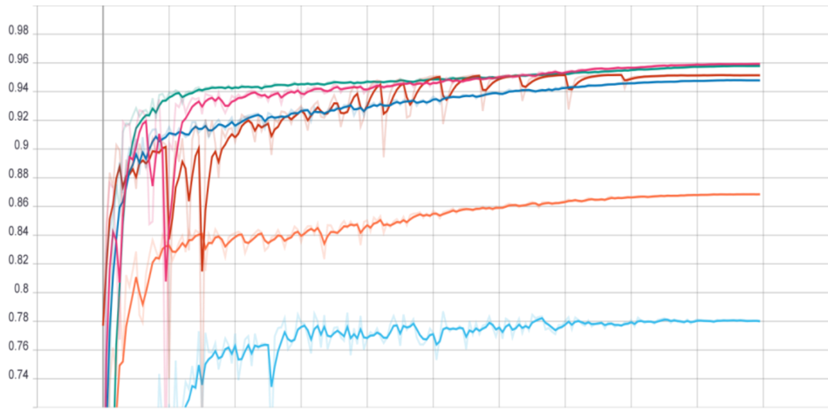

Fig.5 Accuracy of the training set

As shown in Fig. 5, the accuracy of the training set of the six models is the lowest, the accuracy of the AlexNet model is the lowest, the ShuffleNetV2 model is low, and the other models can reach more than 94%.

As shown in Fig. 6, among the six models, the AlexNet model has the lowest accuracy, the ShuffleNetV2 model is lower, and the accuracy of other models is similar, reaching over 94%.

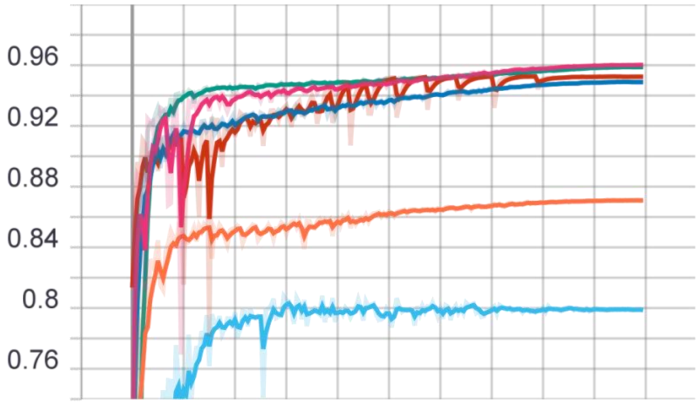

Fig.6 Accuracy

As shown in Fig. 7, the AlexNet model has a high recall, the VGG16 model has a high recall, and the other models have a low recall.

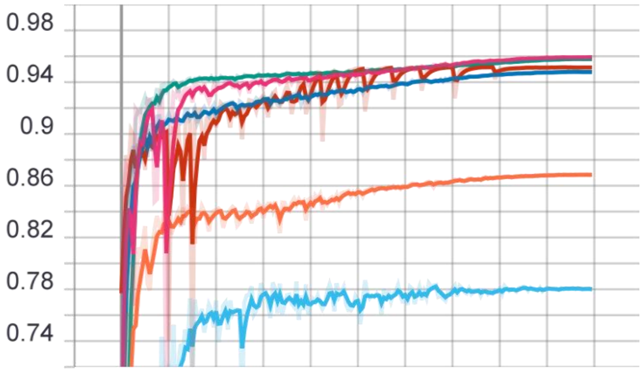

Fig.7 Recall

As shown in Fig. 8, the accuracy of the validation set of the AlexNet and ShuffleNetV2 models is low, and the other models can reach 94%.

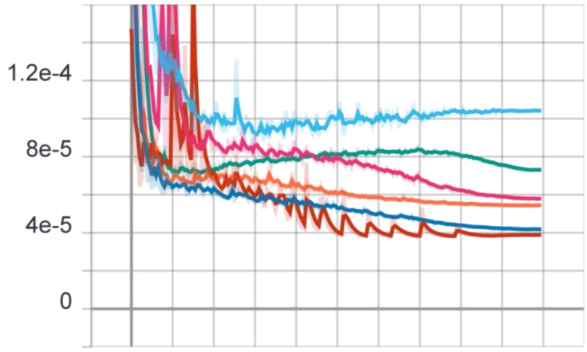

Fig.8 Validation set accuracy

As can be seen from Table 3, the EfficientNet V2 model and the VGG16 model have higher accuracy, which can reach more than 95.8%, and the EfficientNet model is better than the VGG16 model considering the number of parameters, computation and training time. Therefore, it is known that EfficientNetV2 has the advantages of being smaller, faster, more accurate, more reliable, and more convenient to customize, and is a deep learning model worth paying attention to and trying.

Table 3 Experimental results

AlexNet	13.090	28.034	1.114	200	2.45	0.787
VGG16	55.280	1293.038	4.551	200	21.08	0.958
ResNet18	13.097	144.359	3.071	200	4.42	0.952
ShuffleNetV2	4.089	5.770	2.688	200	2.48	0.869
EfficientNet-b0	8.817	38.390	11.750	200	8.34	0.948
EfficientNetV2-s	24.987	244.246	24.944	200	17.14	0.959

The EfficientNetV2 model is used to recognize handwritten fonts, and the results are shown in Fig. 9.

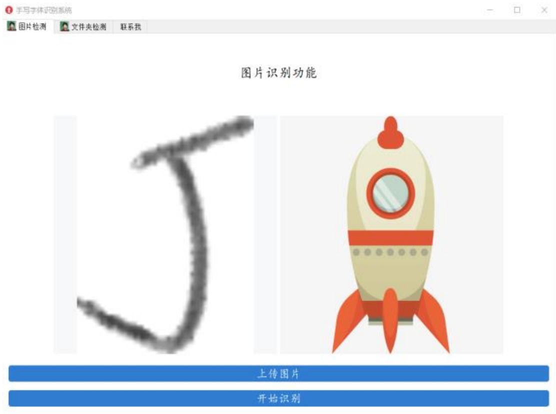

Fig.9 Putting on the recognition image

Fig.10 Identification result

As can be seen from Fig. 10, the EfficientNetV2 model based on convolutional neural network can achieve good recognition effect for handwriting font recognition.

5. Conclusion

The use of convolutional neural network for Chinese character recognition is the mainstream method in the field of Chinese character recognition research today, the convolutional neural network has strong ability to process image data, Chinese characters as the most commonly used morpheme words, a wide variety, similar glyphs, complex structure, the use of convolutional neural network for Chinese character recognition can avoid the error caused by manual processing, and at the same time ensure the recognition accuracy and accuracy. In addition, the use of convolutional neural networks for Chinese character recognition can overcome the limitations of traditional handwritten Chinese character recognition methods, and does not require professional domain knowledge, making Chinese character recognition more convenient and efficient. In this paper, we study the handwritten Chinese character recognition technology based on convolutional neural network, and use the pytorch framework to compare the training sets of various models, and it is known that EfficientNetV2 has the advantages of being smaller, faster, more accurate, more reliable, and more convenient to customize, and is a deep learning model worthy of attention and attempt. This is of great significance for the research of related technologies to improve the accuracy of Chinese character recognition and promote the ability of Chinese character recognition.

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