Handwritten Character Recognition Using Residual Network

[1] Anju Mohandas; [2] Kavitha V K; [3] Dr.Radhakrishnan B

[1] CSE Department, BMCE
APJ Abdul Kalam Technological University, Sasthamcotta, Kerala, India

[2] CSE Department, BMCE
APJ Abdul Kalam Technological University, Sasthamcotta, Kerala, India

[3] CSE Department, BMCE
APJ Abdul Kalam Technological University, Sasthamcotta, Kerala, India

Abstract-Handwritten character recognition has been one of the active research area in deep learning. This Recognition processing includes many applications such as reading bank cheques, converting written documents to structural text form. Handwritten recognition is a challenging task for computer system. Deep learning techniques are used for understanding the handwritten data through training. Recently used network is Convolution neural network for recognition process. In this paper, we used residual network for recognition. Before applying CNN we had performed image processing operations like pre-processing, conversion to greyscale, thresholding, image segmentation etc. With the use of residual networks, we can achieve fast training process and can attain more accuracy than other networks. Residual network is differing from Convolution neural network due to which residually adding a parallel connection to the layers of convolution neural network in order to providing better performance.

Keywords - *Convolution Neural Network, Residual Network, Machine Learning, Python*.

1. Introduction

Handwriting Recognition is one of the active areas of research where deep neural networks are being utilized. Recognizing handwriting is an easy task for humans but a daunting task for computers. Handwriting recognition systems are of two types: Online and Offline. In an online handwriting recognition system, the handwriting of the user is recognized at the same time the user writes. The information like the order in which the user has made the strokes is also available. But in offline handwriting recognition system, the handwriting of user is available as an image.

Handwriting recognition is a challenging task because of many reasons. The primary reason is that different people have different styles of writing. The secondary reason is there are lot of characters like Capital letters, Small letters, Digits and Special symbols. Thus a large dataset is required to train a near-accurate neural network model. Image classification is process including image pre-processing, image segmentation, key feature extraction and matching identification. During the rise of deep learning, feature extraction and classifier has been integrated to a learning framework which overcomes the traditional method of feature selection difficulties.

The idea of deep learning is to discover multiple levels of representation, with the hope that high-level features represent more abstract semantics of the data. One key ingredient of deep learning in image classification is the use of convolutional architectures. In recent years, the optimization of convolutional neural network is mainly concentrated in the following aspects: the design of convolutional layer and pooling layer, the activation function, loss function, regularization and convolutional neural network can be applied to practical problems. In this paper, we proposed a convolutional neural network with additional residual network and cascaded part.

2. Related works

Wei Lu, Zhijian Li et al [1]. In this paper, neural network is used to extract local features from pattern. And based on the feature maps, a fuzzy logic recognizer is adopted to do the recognition. Experiments show that the system has

large ability to deal with distortion and shift variations in handwriting characters.

Marzuki Khalid, Emilie Poisson et al [2]. They proposed Support Vector Machine (SVM) is an alternative to NN. It gives a better recognition result compared to the system based on hybrid NN/HMM.

Dewi Nasien, Habibollah Haron et al [3]. They proposed a recognition model for English handwritten (lowercase, uppercase and letter) character recognition that uses Freeman chain code (FCC) as the representation technique of an image character. Support vector machine (SVM) is chosen for the classification step.

Tianmei Guo, Jiwen Donget al [4].Among different type of models, Convolutional neural networks have been demonstrated high performance on image classification. In this paper is build a simple Convolutional neural network on image classification. This simple Convolutional neural network completed the image classification.

Rohan Vaidya, Darshan Trivedi et al [5].They designed an image segmentation based Handwritten character recognition system. In their system they have made use of OpenCV for performing Image processing and have used Tensorflow for training the neural Network. They developed this system using python programming language.

3. Design and Method

In deep learning, convolutional neural network (CNN or ConvNet) is a class of deep neural networks, most commonly applied to analysing visual imagery. Here proposed system takes image as the input and given to neural network. Our system is a combination of convolution neural network and residual network with cascade become more effective. Convolution network consists of set of layers are followed.

Convolutional Layer: The convolutional layer is the core building block of a CNN. The layer's parameters consist of a set of learnable filters (or kernels), which have a small receptive field, but extend through the full depth of the input volume. During the forward pass, each filter is convolved across the width and height of the input volume, computing the dot product between the entries of the filter and the input and producing a 2-dimensional activation map of that filter. As a result, the network learns filters that activate when it detects some specific type of feature at some spatial position in the input.

Pooling Layer: Convolutional networks may include local or global pooling layers. Pooling layers reduce the dimensions of the data by combining the outputs of neuron clusters at one layer into a single neuron in the next layer. Local pooling combines small clusters, typically 2 x 2. Global pooling acts on all the neurons of the convolutional layer. In addition, pooling may compute a max or an average. Max pooling uses the maximum value from each of a cluster of neurons at the prior layer. Average pooling uses the average value from each of a cluster of neurons at the prior layer. We used the NIST database which contains thousands of images of handwritten characters.
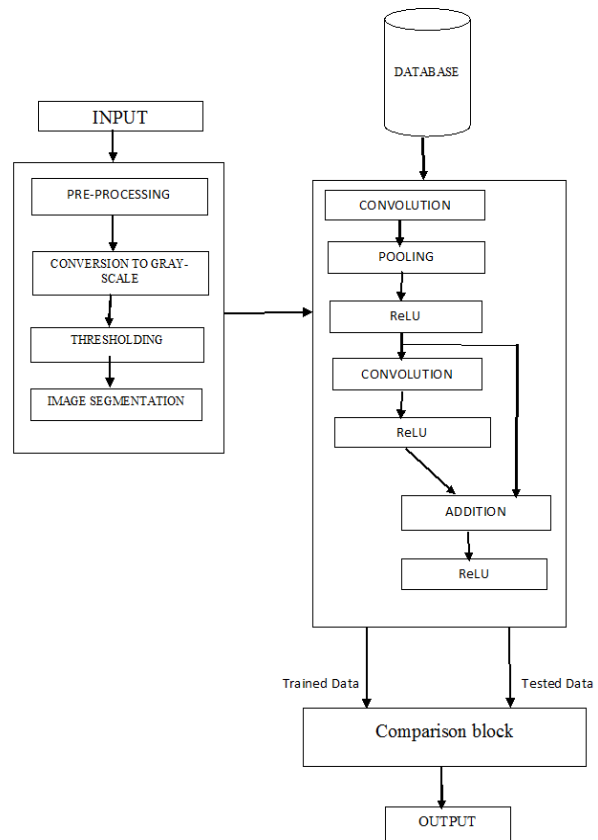

Fig 1. Convolution neural network with residual network.

ReLU Layer: ReLU is the abbreviation of rectified linear unit, which applies the non-saturating activation function f(x)=max (0, x). It effectively removes negative values from an activation map by setting them to zero. It increases the nonlinear properties of the decision function and of the overall network without affecting the receptive fields of the convolution layer. Other functions are also used to increase nonlinearity $\sigma(x) = (1 + e^{-x})r$ ReLU is often preferred to other functions because it trains

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the neural network several times faster without a significant penalty to generalization accuracy.

Output data from ReLU layer is passed through fully connected layer to form single vector. Finally comparing tested vectors with trained vectors by calculating the difference of both vectors and less difference between vector is obtained. Corresponding character to lowest difference is taken as output.

4. Experimental Result

For the experiment, a large set of handwritten character images for training and the trained results are used for testing purpose. When comparing this system with other previous model, it provides good performance and better accuracy. Comparison of model in terms of accuracy measure is follows.

Table 1: Comparison of methods

Methods	Accuracy
Combination of Neural network and fuzzy logic.	87.6%
SVM	94.05%
CNN	96%
Residual network	97.89%

5. Conclusion

There are many developments possible in this system in the future. Currently this system can only recognize text in English languages. Furthermore, languages can be recognized in future. Presently this system supports letter, digits and some special symbols. There are many applications of this system. Some of the applications are Processing of cheques in Banks, helping hand in Desktop publishing, recognition of text from business cards, helping the blind in recognizing handwritten text on letters.

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Author Profile

Anju Mohandas received her B Tech (CSE) degree from University of Kerala in 2017. She is currently pursuing her Masters in Computer Science & Engineering from KTU. She has published one paper on data mining.

Kavitha V K is working as Assistant Professor in Computer Science and Engineering Department. She has more than 10 years' experience in teaching. Her research interests focus data mining and machine learning. She has published several papers on data mining.

Radhakrishnan B is working as the Head of CSE department. He has more than 14 years' experience in teaching and has published papers on data mining and image processing. His research interests include image processing, data mining, image mining.

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