International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2017): 7.296

Deep Learning based English Handwritten Character Recognition

Somil Gupta[1], Tanvi Bansal[2], Manish Kumar Sharma[3]

[1, 2]Final Year Student, Department of CSE, Galgotia College of Engineering and Technology, Greater Noida, India
[3]Assistant Professor, Department of CSE, Galgotias College of Engineering and Technology, Greater Noida, India

Abstract: ***In this paper we propose a convolutional neural network based handwritten character recognitionusing SVM as an end classifier. The learning model is based on CNN (Convolutional Neural Network) which is used as a feature extraction tool. The proposed method is more efficient than other existing methods and will be more efficient than modifying the CNN with complex architecture. The recognition rate achieved by the proposed method is 93.3% which is greater than other existing methods. The computation time of training phase is 13.14sec and that of testing phase is 13.27 sec. The proposed system was validated by 6 validation points. The overall accuracy of system is 93%***

Keywords: Deep Learning, Convolutional Neural Network, Handwriting recognition, SVM

1. Introduction

Handwriting recognition is a very important field of research. Both the Machine leraning and computer vision fields have research areas regarding handwriting recognition. [1] A number of different algorithms and techniques have been provided, but still it is an unresolved area. With various different writing styles handwriting recognition is still very complex to implement.

Some problems in handwriting recognition are due to uncertainty of inut data, as characters of different persons are different, some [2] are disconnected and distorted, gthe thickness of characters varies.

Handwritten character recognition is an area of pattern recognition which defines an ability of a machine to analyze patterns and identify the character.

Pattern recognition is the science of making inferences from perceptual data based on either a priori knowledge or on statistical information [1] [2]. The subject of pattern recognition spans a number of scientific disciplines uniting them in the search for the solution to the common problem of recognizing the members of a class in a set containing elements from many patterns in classes. A pattern class is a category determined by some given common attributes.

We have used Covolutional Neural Network algorithms for feature extraction. For the classifier we have used the SVM.

2. Related Work

Some researches have been conducted to develop a variety of methods and algorithms that can be used to recognize a handwritten character

Azmi [7] have used Freeman Chain Code with the division of the region into nine regions and normalization of chain code as feature extractor. He also explains four features consisting of top, right, wide, and high-ratio of characters.Artificial Neural Network (ANN) is used as a classifier.

In paper [8] the author uses Zernike Moments to extract the features of characetrs and uses SVM for classification.

In [9] Nasienproposes Freeman Chain Code to remove a feature of uppercase characters. Hallale [10] proposed a 12-directional method for feature extraction ofEnglish characters. The data are classified based on the similarity between the feature of data training and the feature of data testing.

3. Proposed Method

A. CNN (Convolutional Neural Network)

The learning model is based on Convolutional Neural Network (CNN) as a powerful feature extraction. The learning model was used to construct a handwriting recognition system to recognize a more challenging data on form document automatically [3]. The pre-processing, segmentation and character recognition are integrated into one system. The output of the system is converted into an editable text. [4]

Convolutional Neural Network (CNN) is one of the deep learning architecture. [4] It can extract multiple features from low-features to high-features automatically. Currently, CNN is a state of the art of handwriting characters recognition Convolutional Neural Networks are very similar to ordinary Neural Networks, they are made up of neurons that have learnable weights and biases. Each neuron receives some inputs a dot product and optionally follows it with a non-linearity.

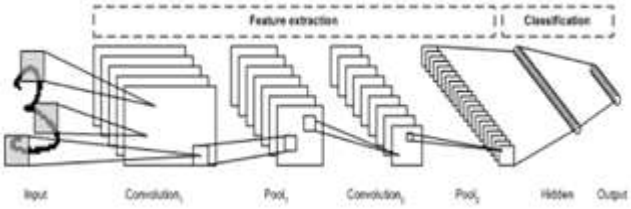

Figure 1: Architecture of CNN for feature extraction

B. SVM (Support Vector Machine)

SVM first introduced by Vapnik. It widely used for classification and regression. The basic idea of SVM is finding the

best hyperplane which maximizing the margin of the hyper-plane [5]. The hyperplane with maximum margin performs a good generalization. It can be formulated into quadratic programming problem which defined as:

$\min 1/2 \|W\|^2$

$$s.t yi(x_i.w+b) -1>=0 \quad (1)$$

SVM is a quadratic programming where the class of a new input data can be predicted using

$$f(x_d) = \sum i=1^{Ns} \alpha_i y_i x_i x_d + b \quad (2)$$

Where xi is a support vector, Ns is some support vector and xd is the input data which will be predicted. [6] In the real world, some data are nonlinearly separable. Therefore, the (2) cannot be used to predict the input data.Thereare number of kernels that can be used in Support Vector Machines models. [5]These include linear, polynomial, radial basis function (RBF) and sigmoid:

1) Linear

$K(x_i, x_j) = x_i^T x_j$

2) Polynomial

$K(x_i, x_j) = (\gamma x_i^T x_j + r)d, \gamma>0$

3) RBF

$K(x_i, x_i) = \exp(-\gamma \| x_i - x_i \|^2), \gamma>0$

4) Sigmoid

$K(x_i, x_j) = \tanh(\gamma x_i^T x_j + r)$

where $K(x_i, x_j) = \varphi(x_i)\, \varphi(x_j)$

that is, the kernel function, represents a dot product of input data points mapped into the higher dimensional feature space by transformation φ.The algorithm requires that each data instance is represented as a vector of real numbers. Hence, if there are categorical attributes, it has to be first converted into numeric data.

C. Dataset

In this system, we used our own dataset. We gathered handwritten character samples from 50-60 people and used it for training. For the testing we used downloaded different image from different sources.

Figure 2: Example of dataset

The original size of the images in dataset is of 128x128 pixel. Preprocessingtechniques like cropping and resizing conducted onthe dataset. We cropped the character to remove the unnecessary noise from the background and resize the image into size of 28x28 pixel.

C. Handwriting Recognition System

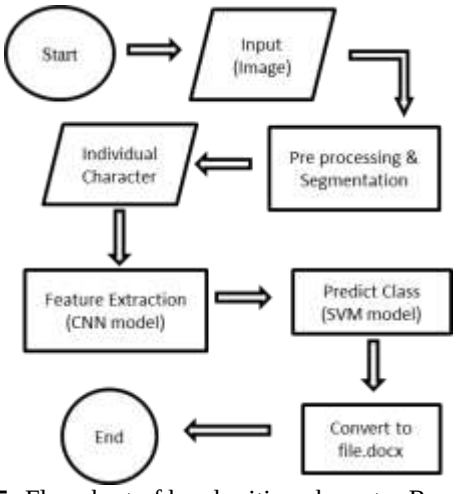

Figure 5: Flowchart of handwriting character Recognition

4. Result and Discussion

In this system, we evaluate the proposed method using NIST dataset both for training and testing.

We evaluate the proposed method using Intel(R) Core(Tm) i-5 3230M CPU @2.60 GHz, Memory 8.00 GB RAM, Harddisk 1TB , AMD Radeon HD 7600M Series, Matlab 2015b 64 bit.

The following Table 1 depicts average accuracy achieved in recognition of the uppercase characters and the computation time for training and testing.

Table 1: Accuracry and Computation Time

Method	Accuracy	Computation Time	
		Training	Testing
CNN + SVM	93.3 %	13.14 sec	13.27 sec

The average accuracy rate of the system is 93.3% and the average computation time is 12.3 sec for training and 13.74 sec for testing.

The result of this system is compared to the results of the previous studies related to handwritten character recognition are given in Table 2 below

Table 7.2: Comparative Results of All Methods

Author	Method	Data-Set	Number of Class	Accuracy (%)
A. N. Azmi [7]	Freeman Chain Code + ANN	Owner (Uppercase)	26	87.3
D. Nasien [9]	Freeman Chain Code + SVM	NIST (Upper)	26	88.46
S. B. Hallale [10]	12 directional feature + similarity	Owner (Upper)	26	88.29
Proposed System	CNN + SVM	Owner (Upper)	26	93.3

As seen in the Table 2 above the proposed system gives the best accuracy for uppercase English handwritten characters

than the previous methods.

5. Conclusion and Future Work

In this system CNN is used as a feature extraction algorithm and SVM is used as an end classifier. Based on the experimental results using the own test images we have achieved an accuracy rate of 93.3% that is greater than any other preivous method.

A system is created based on the research and results of the proposed method.

In the future the system will be expanded to recognize lower case characters, digits, a combination of characters and digits and even cursive characters.

In the next research, some other segmentation method will be used to achieve even greater accuracy and even changing the architecture of CNN to achieve even better results. Also, some techniques of postprocessingcan also be used to even improve the accuracy of the end text.

References

[1] R. K. Thampi (1994), "Classification of handwritten characters: definition, identification and utilization", International Conference on Pattern Recognition
[2] Vijay LaxmiSahu , BabitaKubde (2013), "Offline Handwritten Character Recognition Techniques using Neural Network: A Review", International Journal of Science and Research (IJSR) Volume 2
[3] L.Chen, S.Wong, W.Fan, (2015) "Reconstruction Combined Training for Convolutional Neural Networks on Character Recognition" , 13th International Conference on Document Analysis and Recognition (ICDAR), 2015
[4] R. R. Nair, B. U. Kota, I. Nwogu, V. Govindaraju (2016) "Segmentation of Highly Unstructured Handwritten Documents using a Neural Network technique" 23rd International Conference on Pattern Recognition (ICPR), 2016
[5] Shruthi A. , M. S. Patel (2015), "Offline Handwritten Word Recognition using Multiple Features with SVM Classifier for Holistic Approach", International Journal of Innovative Research in Computer and Communication Engineering, 2015
[6] Anne-Laure Bianne-Bernard (2011), "Dynamic and Contextual Information in HMM Modeling for Handwritten Word Recognition, " IEEE Transaction on Pattern Analysis and Machine Intelligence VOL. 33, NO. 10, Oct 2011.
[7] Aini Najwa Azmi, Dewi Nasien (2014), "Feature Vector of Binary Image using Freeman Chain Code (FCC) Representation based on Structural Classifier", 2014.
[8] E. Juharwidyningsih, C. Fatichah, and N. Khotimah (2013), "English handwritten Character Recognition using Zernike Moments and Support Vector Machine, " vol. 2, no. 1, pp. 1–5, 2013.
[9] D. Nasien, H. Haron, and S. S. Yuhaniz (2010), "Support Vector Machine (SVM) for English handwritten character recognition, " 2010 2nd Int. Conf. Comput. Eng. Appl. ICCEA 2010, vol. 1, pp. 249–252, 2010.
[10] S. B. Hallale and G. D. Salunke (2013), "Twelve Directional Feature Extraction for Handwritten English Character Recognition, " no. 2, pp. 39–42, 2013.
[11] Abdalla Mohamed Hambal, Dr. Zhijun Pei (2015), "Image Noise Reduction and Filtering Techniques", International Journal of Science and Research (IJSR)