International Journal of Research in Engineering, Science and Management
Volume-1, Issue-10, October-2018
www.ijresm.com | ISSN (Online): 2581-5792

Handwriting Character Recognition

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***Abstract*—Handwriting recognition is an approach of a computer to construe handwritten input from sources such as documents, printed notes, handwritten notes and other electronic devices. There are "Off-line" and "On-line" methods which makes it easier for the classifier to interpret the result. The proposed method is based on Convolution Neural Network (CNN) and Support Vector Machines (SVM).These help us to determine the handwriting character recognition and the recognition rate achieved are greater for the numerical characters. A SVM is a classifier defined by a hyperplane. It's a plane that divides into two parts, wherein each class lay on either side. In Neural network, if we increase the training examples, we can increase the accuracy of the network .The following process includes pre-processing, segmentation and character recognition. This paper will be helpful for developing a software which will interpret the characters .This can further be implemented to develop a software which can recognize the characters of different languages.**

***Index Terms*—hyperplane, off-line approach, on-line approach, neural network**

I. Introduction

Handwriting is one of the most crucial steps in our day to day life for communication. Neural networks are used to solve problems that cannot be expressed as a series of steps and classifying them into groups, series prediction. Pattern recognition is another common topic of neural network. This network is trained to classify the input samples and simplify them into groups. This paper concerns the recognition of the handwritten characters. The process flow in the following system is shown in fig.1.This paper describes the behavior of neural network and Support vector machines. Some problems in handwriting recognition is due to uncertainty of input because each person has different style of writing.

In Machine learning, a deep convoluted class with feed forward artificial networks are most commonly applied to analyze visual imagery. They have applications in image and video recognition, recommender systems and in language processing techniques.

Convolutional Neural Network (CNN) is one of the deep learning architecture. It has multiple features. The accuracy rate of CNN is commendable. Another deep learning techniques is the pattern or object recognition. This uses variety of method to represent a data and then use a classifier to segregate it.

For the handwritten recognition system, two phase processes are involved in the overall processing of our proposed scheme: the Pre-processing and Neural network based Recognizing tasks. First, the required character or part of characters needs to be extracted from the pictorial representation.

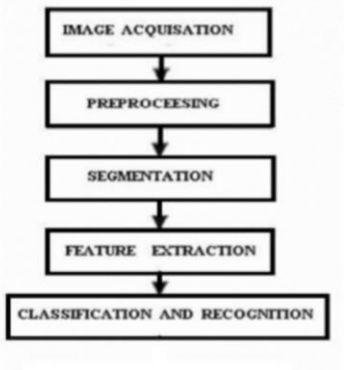

Fig. 1. Block diagram of the process

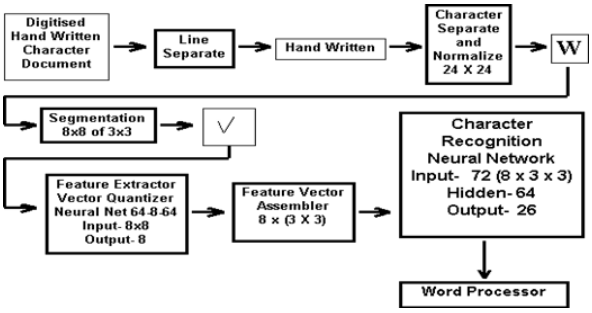

Fig. 2. Character recognizer

The CNN uses approaches to increase the accuracy and abate the processing time. Many authors have modified it to improve the rate of CNN method. Some of them have combined CNN and GLCM method for homogeneity .Some of them have modified CNN with Gabor filter. These proposed methods give better performance than CNN.

Whenever we want to modify CNN related to handwriting recognition, we have to modify the architecture of CNN. Some of the studies, help us to construe a more complex structure to improve the accuracy rate.

DeepCNet is another proposed way to do. Yang also proposed a method of Deep Convolutional Neural Network (DCNN), but it is a very time consuming process. Around recent years, dropout strategies seem to be a popular technique.

Elleuch, conducted research in which he used a Kernel Support vector machine classifier. We use SVM as an end classifier.

We have seen that the process basically has four steps for the recognition:

- Pre-processing.
- Segmentation.
- Feature Extraction.
- Classification and recognition.

Pre-processing is a series of operations performed on scanned input. This process essentially enhances and makes it suitable for segmentation purposes. The main purpose of this step is to segment the interesting pattern and noise filtering and smoothing is done in this step only.

The next step is to segment a particular character. The pre-processed input is segmented and they are assigned a character. This step allows us to resize a character.

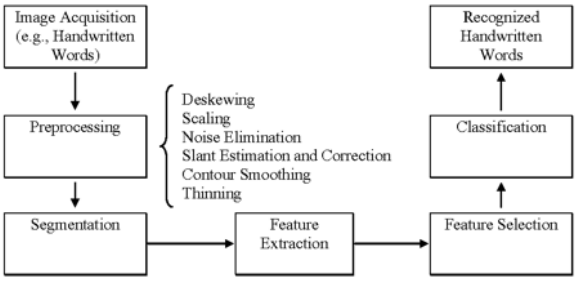

Fig. 3. Segmentation

After this has been done, normalization of the character takes place. There are some variations that are needed to normalize the size.

Further, feature extraction is a process where it extracts different line types that form a particular character. This was explained with the help of Neural Network. The universe of discourse is the shortest matrix that fits entire character. After this has been done, the image is divided into equal sizes and feature is done on individual sizes. Basically, two types of zoning are used.

This is the reason why certain pixels in the character were defined as starters, intersections, minor starters.

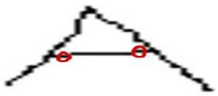

Fig. 4. Intersection

The linear SVM is more efficient than kernel SVM. The linear SVM works in the original dimensions of space while on the other hand kernel SVM works on mapping the original input to a higher class input. Another important part is the loss function.

Various researchers have contributes their work to conduct a variety of methods that can be used to recognize a handwritten character. Hadi conducted an experiment where he used freeman chain code. Jindal also conducted a research to classify printed and handwritten characters. This uses ICG technique.

Here, the word and the character recognition are the main ways of generation. While grouping ways of G1, G2 and G3, it might so happen that one character maybe recognized as two. The word recognition is a method where the recognition-with-segmentation is respectfully, feasibly convinced.

Thus, the proposed method will have a scheme for recognizing handwritten characters.

Here, the goal of a character recognition system is to transform a hand written character on paper into a digital format that can be processed by a software. Also, the optimal selection of the parameter depends upon the complexity of the character.

II. Methodology

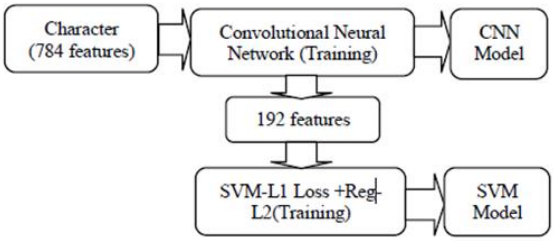

Fig. 5. Block diagram of the process

The diagram above gives an overview of the process involved in handwriting recognition.

The dataset which is used is the NIST SD 19 2nd edition. This dataset consists of a series of numeral, uppercase, lowercase and a combination of uppercase and lowercase characters.

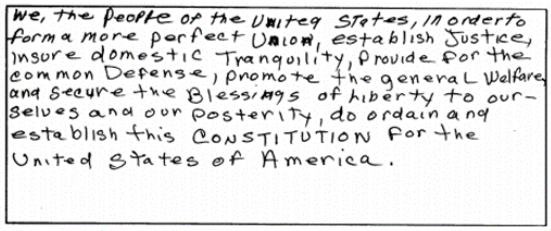

Fig. 6. Representation of the data set

The figure above is a demonstration of the NIST dataset.

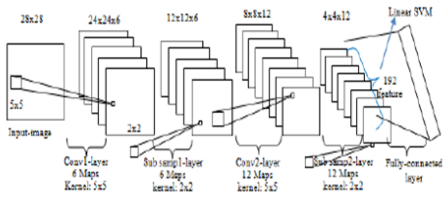

Fig. 7. Architecture of CNN

The images in the dataset are pre-processed to ensure that the input to the Convolutional Neural Network (CNN) is in the desired format.

The images of the dataset are fed to the Convolutional Neural Network. The CNN is used for the purpose of feature

extraction. The primary function of CNN is to extract the features of the input images.

The CNN works on three ideas:

- Local Receptive Fields
- Shared Weight
- Pooling

The architecture of CNN to extract features is shown in Fig. 7.

The feature extraction process works in the following manner:

The architecture consists of a total of five layers.

The first four layers include two pairs of convolutional and sub-sampling layers. The final layer is the output layer which is fully connected.

The outputs of each layer are given below:

- First Convolutional Layer: 6 Feature Maps with 24 * 24 pixels.
- Second Convolutional Layer: 12 feature maps with 8 * 8 pixels.
- First Sub-Sampling Layer: 6 feature maps with 12 * 12 pixels.

Second Sub-Sampling Layer: Transported into Vector Feature. Act as input for training the SVM classifier.

An SVM is a classifier which returns the maximum margin hyperplane. This is determined by constructing support vectors and then determining the distances from them to the required hyperplane. The vectors which yield the maximum margin to the hyperplane are chosen as the support vectors and the corresponding hyperplane is chosen as the maximum margin hyperplane.

There exists two types of SVM classifiers. One is the linear SVM which can be used for the following case:

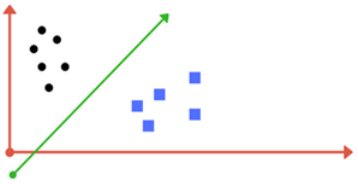

Fig. 8. Linearly separable data

Here the classification boundary can be easily constructed. However, consider the following case:

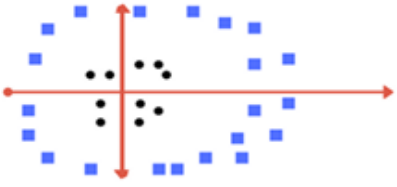

Fig. 9. Nonlinearly separable data

In this case, a straight line cannot be used to construct an appropriate classification boundary. In this case, mapping to a higher dimension is done and then a separator is devised. After this, the model is scaled back to the original dimensions.

This can be demonstrated as follows:

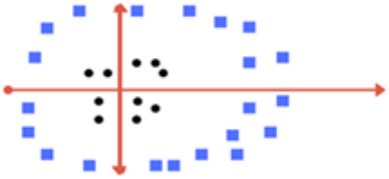

Fig. 10. The model is mapped to a higher dimension

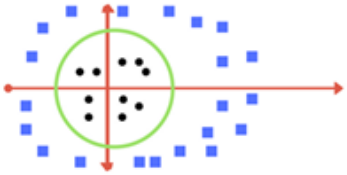

Fig. 11. The model is scaled down to lower dimension

III. Conclusion

Based on the information given above, it can be concluded that a system for the recognition of characters can be developed. Such a system can be efficiently developed by using CNN for feature extraction and SVM for classification.

The performance can be further improved by using parameter tuning.

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