Handwritten English Character Recognition using Multilayer Perceptron Neural Network

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ABSTRACT

Character recognition is one of the most attention holding and extremely interesting areas of pattern recognition and artificial intelligence. Offline handwritten English character recognition is difficult due to variation in shape, slope and size of individual characters. Such variations in handwriting can be handled by better pre-processing and feature extraction techniques. Handwritten character recognition is more difficult process as compared to typed or printed characters. Neural networks are used in character recognition from last many years. The proposed system has been implemented using MATLAB successfully. In this paper, we present a handwritten character recognition system in which first of all original image is converted into greyscale image. After that pre-processing steps are applied on that greyscale image. Then individual characters split from word using segmentation. Features are extracted for those characters and multilayer perceptron classifier is used for classification. At last handwritten character is recognized and converted into machine printable form, which will be easier to store and use in future. The result shows that the back propagation network provides good recognition accuracy of more than 70% of handwritten English characters.

Keywords – character recognition, pre-processing, feature extraction, neural network, multilayer perceptron.

I. INTRODUCTION

Our life is under the impact of human computer interface. World around us pay more attention on Character Recognition. Every person's handwriting is different. So, recognizing handwritten characters is very complicated task. To preserve manuscripts and the historical documents it is necessary to convert them into machine editable form. The character recognition is process consists of identifying, detecting and recognizing characters from input image and converting them into equivalent machine editable form. In Today's world trend to digitize handwritten document has emerged to save the same and apply modification in future. Character recognition is getting more attention and popularity due to its wide range of applications. For character recognition system one can use neural network, principal component analysis, support vector machine, hidden markov model [12]. The numbers of applications are License Plate Recognition System which can be used in parking areas and for highly security premises, Handwriting Recognition System, Identifying Engine Number and Chassis Number, Text Recognition, Form Processing, Bank Check Processing. Every language has different shape and curve of different characters and digits [13].

Character Recognition can be classified according to two important aspects. One is based on type of text has been used: Machine printed and Handwritten. Another is based on manner in which the data has been acquired: Online and Offline [2]. In Handwritten Character Recognition the input is taken as handwritten character. Applications of HCR is processing handwritten application forms, digitizing ancient articles, postal address processing, bank checks processing, signature verification, automatic pin code reading. In Optical Character Recognition the printed or typed character is taken as input. The OCR is a technique used to translate printable characters to ASCII characters so that computer can recognize it. [11]. OCR applications are form data entry, automatic text entry, machine reading, automatic form processing, automatic bank

check clearance, postal mail sorting, automatic plate number recognition. As handwriting varies from person to person normal OCR which recognize printed text is fail to identify handwritten texts. Hence the necessity of developing HCR arises. HCR is advanced OCR program especially designed for handwriting recognizing.

II. LITERATURE SURVEY

Various approaches have been applied in order to accomplish character recognition. In literature [1], S. A. Yadav et al proposed offline English character recognition model based on artificial neural network, database of 2600 samples are collected from 100 writers for each character, flowchart of system is explained and training is performed using Feed Forward Neural Network Algorithm. In literature [2], G. Katiyar et al presented Offline handwritten character recognition of English alphabets using a three layered feed forward neural network, CEDAR CDROM-1 database is used and evaluation of feed forward neural network is described by combining four different feature extraction approaches (box approach, diagonal distance approach, mean and gradient operations). In [3], M. S. Ali et al used Back Propagation Learning Neural Network Algorithm (BPN) as the ANN and GA, accuracy of BPN is more compared to GA because BPN works with same size of images and for faster learning. In literature [4], R. S. Hussien et al proposed approach to recognize Arabic handwritten characters using off-line OCR system, Hopfield neural network is also proposed for same. In [5], V. J. Dongre et al presents approach for Devanagari numeral and character recognition, it uses structural and geometric features for feature extraction, diagram of recognition process is given in detail, 5137 numeral images and 20305 character images are taken.

In literature [6], U. R. Babu et al paper presents off-line handwritten digit recognition based on structural features, KNN as classified used for classification, it also uses four different types of structural features namely, number of holes, water reservoirs in four directions, maximum profile distances in four directions and fill-hole density for the recognition of digits. In literature [7], D. Khanduja et al proposes a hybrid approach combining the structural features of the character and a mathematical model of curve fitting to simulate the best features of a character, Neural Network classifier is used for classification. In [8], M. K. Mahto et al collected a Gurmukhi character dataset of 3500 images from 10 writers, proposed a combined horizontal and vertical projection feature extraction scheme for recognition of Gurmukhi characters. In literature [9], S. R. Patel et al proposed survey paper which gives deep classification of different types of character recognition systems and it also shows the framework of handwritten character recognition system. In literature [10], S. B. Maind et al proposed research paper on basic of Artificial Neural Network which briefly explains neural network.

III. PROPOSED WORK

In this paper we have proposed an offline handwritten English character recognition to improve accuracy by applying Multilayer Perceptron Neural Network. The steps which are followed in sequence are given below.

A. Dataset

MNIST Database (Modified NIST) is a large database of handwritten letters which contains 60,000 training images and 10,000 testing images. Database named Letter Recognition Data Set is available on UCI Machine Learning Repository.

B. Image Acquisition

Image acquisition is the preliminary stage of any character recognition system. Recognition system is considered off-line if it is used to recognize a previously written text or on-line if it is used to recognize live text.
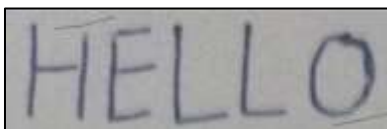
Fig. 1 Original Image

C. Image Pre-processing

Pre-processing is performed to increase quality of handwritten/printed data and applied before the feature extraction. Pre-processing is sequence of operations performed on acquired image so, that subsequent tasks become easier.

a. Grey-scaling: Any color image/ original image to be converted into binary must be converted first into grey scale.
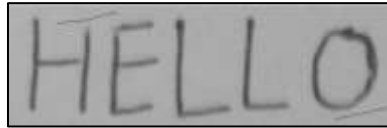
Fig. 2 Greyscale Image

b. Noise Removal: Removes any object containing less than 30 pixels which is considered as noise in the image as any unwanted dot or line.
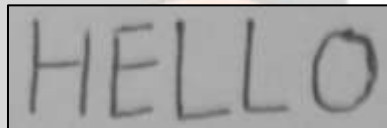
Fig. 3 Noise Removed from an Image

c. Binarization: Converts grey level image into a two-tone image/ black and white image where black represented by 0 and white represented by 1 pixel.

Fig. 4 Binarized Image

d. Invert Image: Invert the binarized image where black represented by 1 and white represented by 0 pixel.

Fig. 5 Inverted Image

e. Skeletonization: It represents structural shape of the character. It is process of reducing all lines into one single pixel thickness. It results in reduced memory space required for storing information of input character.

Fig. 6 Skeletonized Image

f. Normalization: Normalization is process to equate size of all character bitmap into standard size. To standardize character, extra rows and columns containing 0 are removed from all sides of character.

Fig. 7 Normalized Image

D. Segmentation

The goal of segmentation is to simplify and change the image representation so that it can be meaningful and easier to analyse further. Segmentation involves line, word and character segmentation.

a. Edge Detection: Identify object boundaries within image. Methods for this are Sobel, Canny, Prewitt and Roberts.

Fig. 8 Prewitt Edge Detection

b. Fill Holes: Fill the holes in character according to connected components in an image. So, that holes in image can be filled.

Fig. 9 Fill Holes

c. Dilate Image: Morphological dilation thickens foreground objects in an image. It dilates image using structuring elements.

Fig. 10 Dilate Image

d. Apply Bounding Box: To get separate sub image of character from whole word image we can apply bounding box on an image.

Fig. 11 Apply Bounding Box

e. Separate Each Individual Character: Split image document into classifiable module objects generally isolated character or modifier.

Fig. 12 Separate Each Individual Character

E. Feature Extraction

For achieving a good performance of handwritten character recognition system one of the essential steps is feature extraction. Feature Extraction is the process of extraction of certain types of information from the given character image. The features which are important for classification are extracted at this stage. It is the strongest part of any character recognition system to get high performance. The character is represented by a features vector, which becomes its identity.

F. Classification

Classification is the decision making phase of Character Recognition system. This phase uses the features extracted in the previous stage for deciding the class membership and to recognize the input characters. The performance of the classifier relies on the quality of the features to be extracted. Multilayer Perceptron Neural Network as classifies is used for classification.

G. Recognition

Efficient recognition system helps in accuracy. So, after the training set is ready and network is trained the next step is to use learning set to recognize particular character given as input. Here the character is recognized if it resides in dataset otherwise character cannot be recognized.

IV. MULTILAYER PERCEPTRON NEURAL NETWORK

The architecture that is used for neural network is arranged in layers is termed as multilayer perceptron. A multilayer perceptron maps the sets of input data onto a set of appropriate outputs. An MLP consists of the multiple layers of nodes in a directed graph, with each of the layer fully connected to the next one. Except for the input nodes, each of the nodes is a neuron with a nonlinear activation function.
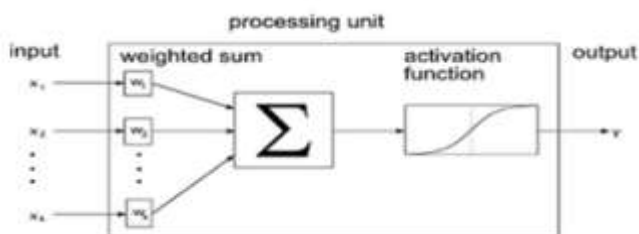

Fig. 13 Multilayer Perceptron

MLP utilizes a supervised learning technique called backpropagation for training of the network. MLP is a modification of standard linear perceptron and distinguish the data that are not linearly separable. There can be one input layer, one output layer and more than one hidden layers. Each node in one layer connects with certain weight to every node in other layer.

V. RESEARCH RESULT

A Multilayer Perceptron Neural Network based method is presented here for increasing accuracy of offline handwritten character recognition.
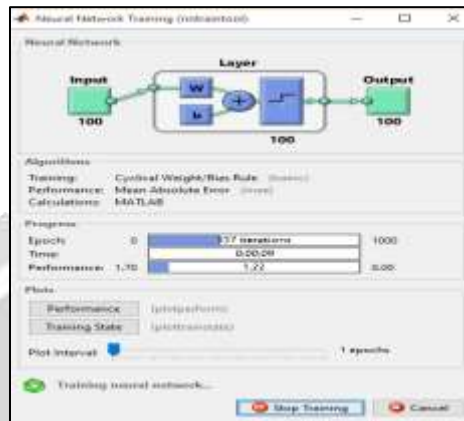

Fig. 14 Performance of Neural Network Training

VI. CONCLUSION

In this paper, we have proposed multilayer perceptron neural network based offline handwritten English character recognition system to recognize English characters. Proposed system reduced training time and cost to identify handwritten characters. Neural Networks are commonly used for character recognition due to high noise tolerance. Feature extraction is one of the most essential steps in character recognition. Strongly chosen feature set provide good recognition rate. Without effective pre-processing the extracted features of images are of low quality. Noise removal and smoothing is applied through pre-processing stage of character recognition. Handwritten character recognition is more complicated as compare to optical character recognition.

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