Neural Network based Handwritten Character Recognition system without feature extraction

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Abstract—**Handwriting recognition has been one of the active and challenging research areas in the field of image processing and pattern recognition. It has numerous applications which include, reading aid for blind, bank cheques and conversion of any hand written document into structural text form. In this paper an attempt is made to recognize handwritten characters for English alphabets without feature extraction using multilayer Feed Forward neural network. Each character data set contains 26 alphabets. Fifty different character data sets are used for training the neural network. The trained network is used for classification and recognition. In the proposed system, each character is resized into 30x20 pixels, which is directly subjected to training. That is, each resized character has 600 pixels and these pixels are taken as features for training the neural network. The results show that the proposed system yields good recognition rates which are comparable to that of feature extraction based schemes for handwritten character recognition.**

Keywords - *Handwritten Character Recognition, Image processing, Feature extraction, Feed forward propagation neural Network*

I. Introduction

Handwriting recognition has been one of the most fascinating and challenging research areas in field of image processing and pattern recognition in the recent years [1]. It contributes immensely to the advancement of automation process and improves the interface between man and machine in numerous applications. Several research works have been focusing on new techniques and methods that would reduce the processing time while providing higher recognition accuracy [2] [3].

In general, handwriting recognition is classified into two types as off-line and on-line handwriting recognition methods. In the off-line recognition, the writing is usually captured optically by a scanner and the completed writing is available as an image. But, in the on-line system the two dimensional coordinates of successive points are represented as a function of time and the order of strokes made by the writer are also available. The on-line methods have been shown to be superior to their off-line counter parts in recognizing handwritten characters due to the temporal information available with the former [4]. However, in the off-line systems, the neural networks have been successfully used to achieve comparably high recognition accuracy levels [5] [6]. Several applications including mail sorting, bank processing, document reading and postal address recognition require off-line handwriting recognition systems. As a result, the off-line handwriting recognition continues to be an active area for research towards exploring the newer techniques that would improve recognition accuracy [7] [8].

In this paper a neural based off-line handwritten character recognition system, without feature extraction is proposed. The pre-processed image is segmented into individual characters. Each character is resized into 30x20 pixels and these pixels are used to train a feed forward back propagation neural network employed for performing classification and recognition tasks. Extensive simulation studies show that the recognition system provides good recognition accuracy.

The rest of the paper is organized as follows. In section II, the proposed recognition system is presented. Section III presents the experimental results and comparative analysis and finally, the paper is concluded in section IV.

II. the proposed recognition system

In this section, the proposed recognition system is described. A typical handwriting recognition system consists of pre-processing, segmentation, classification and post processing stages. The general schematic diagram of the recognition system is shown in Fig.1.The proposed method which does not include feature extraction stage is shown in Fig.2.

A. Image acquisition

In Image acquisition, the recognition system acquires a scanned image as an input image. The image should have a specific format such as JPEG, BMT etc. This image is acquired through a scanner, digital camera or any other suitable digital input device.

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B. Pre-processing

The pre-processing is a series of operations performed on the scanned input image. It essentially enhances the image rendering it suitable for segmentation. The various tasks performed on the image in pre-processing stage are shown in Fig.3 Binarization process converts a gray scale image into a binary image using global thresholding technique. Dilation of edges in the binarized image is done using sobel technique, dilation the image and filling the holes present in it are the operations performed in the last two stages to produce the pre-processed image suitable for segmentation [9].

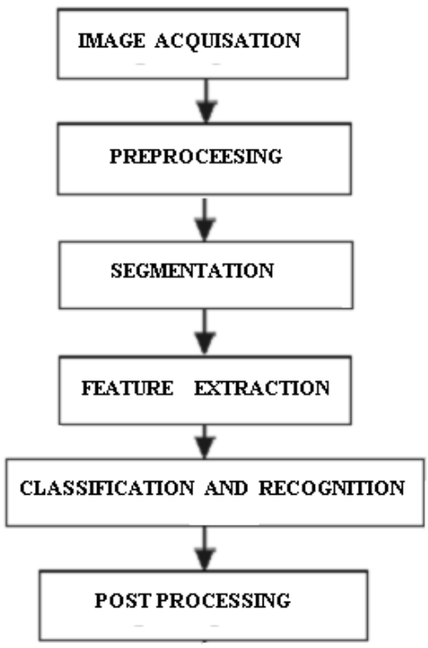


Fig.1. General -line character recognition system

C. Segmentation

In the segmentation stage, an image of sequence of characters is decomposed into sub-images of individual character [10]. In the proposed system, the pre-processed input image is segmented into isolated characters by assigning a number to each character using a labeling process. This labeling provides information about number of characters in the image. Each individual character is uniformly resized into 30X20 pixels.

D. Classification and Recognition

The classification stage is the decision making part of the recognition system [11]. A feed forward back propagation neural network is used in this work for classifying and recognizing the handwritten characters. The 600 pixels derived from the resized character in the segmentation stage form the input to the classifier.

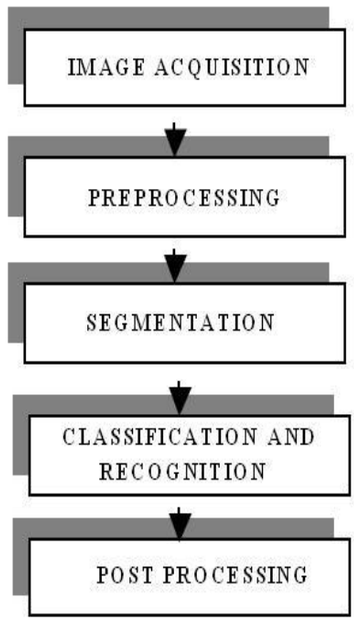


Fig.2. Schematic diagram of the proposed off-line recognition system

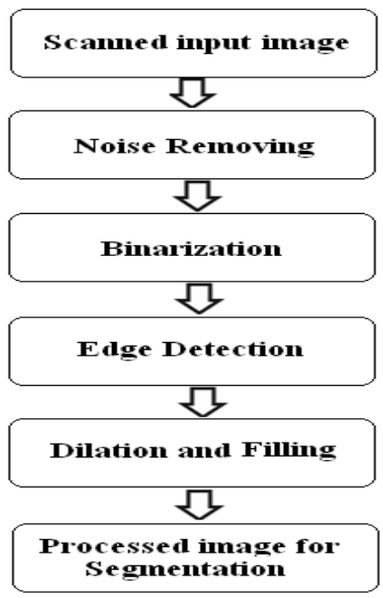


Fig.3. Pre-processing of handwritten character of image

The neural classifier consists of two hidden layers besides an input layer and an output layer as shown in Fig.4.The

hidden layers use log sigmoid activation function and the output layer is a competitive layer as one of the characters is required to be identified at any point in time. The total number of neurons in the output layer is 26 as the proposed system is designed to recognize English alphabets [12].

D. Post- processing

Post-processing stage is the final stage of the proposed recognition system. It prints the corresponding recognized characters in the structured text form by calculating equivalent ASCII value using recognition index of the test samples.

TABLE I
DETAILS OF THE SEVEN NEURAL BASED CHARACTER RECOGNITION SYSTEMS

Networks	1	2	3	4	5	6	7
No of layers	2	2	2	3	3	3	3
No of neuron in input layer	600	600	600	600	600	600	600
No of neurons in 1st hidden layer	50	100	200	50	100	200	300
No of neurons in 2nd hidden layer	0	0	0	50	100	200	300
No of neuron in output layer	26	26	26	26	26	26	26
Learning rate	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Error rate	10e-8						

III. RESULTS AND DISCUSSION

The proposed recognition system has been implemented using Matlab7.1. Seven different neural networks architectures were chosen and each was trained with 50 data sets for a target MSE of 10e-8 as shown in Table. I.

All these seven networks were tested using 10 different handwritten data sets and the results obtained are summarized in the Table.II and depicted in Fig.5. The neural network having two hidden layers each with 100 neurons is found to yield the highest recognition accuracy of 90.19% as can be seen from Table.II. and Fig.5. The convergence profile of this network obtained during the training phase is shown in Fig.6.

The architecture of the network with two layers is illustrated in Fig.4. The output of i^{th} layer is given by

$$a^i = \log sig(w^i a^{i-1} + b^i) \quad (1)$$

Where,

$i = [1,2,3]$ and $a^0 = \mathrm{P}$

w^i = Weight vector of i^{th} layer

a^i = Output of i^{th} layer

b^i = Bias vector for i^{th} layer

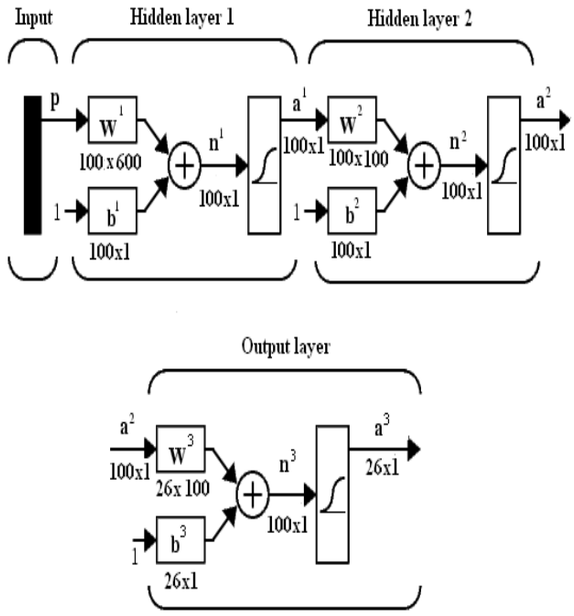
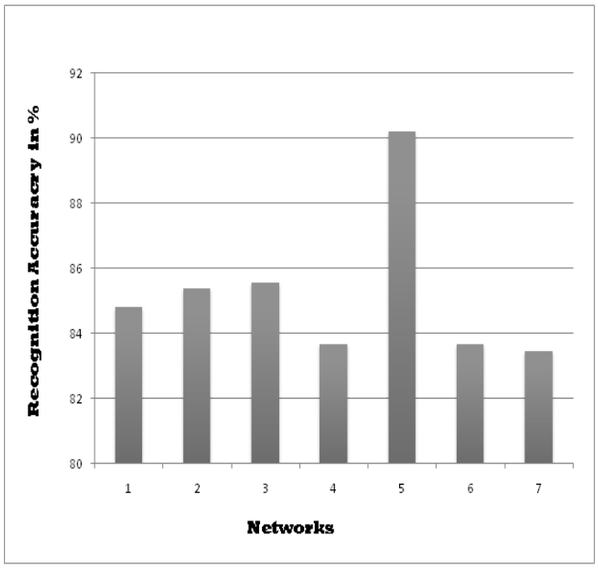


Fig. 4 Three layer neural network for character recognition

Fig.5 Comparison of the recognition accuracy for individual networks

Net	Accuracy rate in %						
	1	2	3	4	5	6	7
A	100	95	95	95	95	95	95
B	65	65	75	70	95	60	70
C	100	100	100	100	100	100	100
D	100	95	95	100	95	100	95
E	85	85	80	80	85	80	80
F	95	95	95	90	100	95	95
G	90	85	85	75	90	85	75
H	70	80	70	70	85	75	80
I	60	70	60	75	85	65	75
J	90	90	90	85	90	85	85
k	75	70	80	65	85	85	80
L	90	100	95	90	95	95	95
M	85	70	75	75	85	80	75
N	85	85	90	80	85	75	85
O	80	90	90	90	85	90	80
P	90	95	90	90	95	100	85
Q	65	55	60	60	70	40	55
R	65	65	70	55	75	55	60
S	95	95	90	95	95	90	90
T	95	100	100	95	100	90	100
U	90	85	95	90	95	90	85
V	95	95	95	85	95	90	90
W	90	95	94	75	100	95	80
X	75	75	80	75	85	80	80
Y	85	90	90	90	90	90	85
Z	90	95	90	90	90	90	95
Over all %	**84.8**	**85.4**	**85.57**	**83.65**	**90.19**	**83.6**	**83.5**

TABLE.II
THE PERFORMANCE COMPARISON OF THE SEVEN NEURAL BASED CHARACTER RECOGNITION SYSTEMS



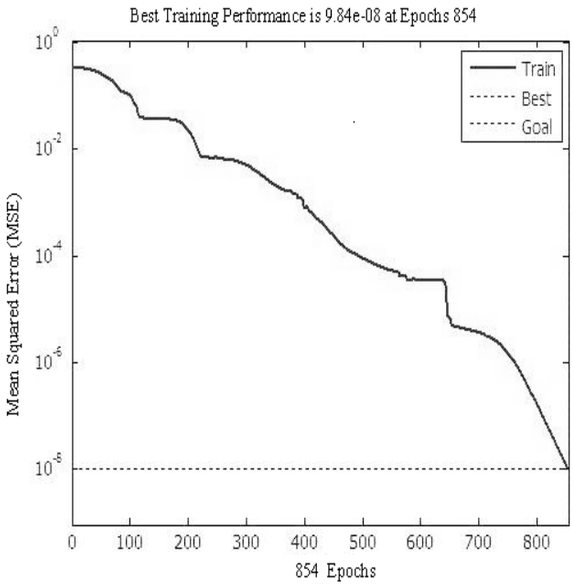


Fig.6 The variation of MSE with training Epochs

IV. CONCLUSIONS

A neural network based off line handwritten character recognition system without feature extraction has been introduced in this paper for classifying and recognizing the 26 English alphabets. The pixel values derived from the resized characters of the segmentation stage have been directly used for training the neural network. As a result, the proposed system will be less complex compared to the offline methods using feature extraction techniques. Of the several neural networks architectures used for classifying

the characters, the one with two hidden layers each having 100 neurons has been found to yield the highest recognition accuracy of 90.19%. The handwritten recognition system described in this paper will find potential applications in handwritten name recognition, document reading, conversion of any handwritten document into structural text form and postal address recognition.

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