



A Novel Approach to Recognition of English Characters Using Artificial Neural Network

Prerna Kakkar¹, Umesh Dutta²

Assistant professor, Dept. of ECE, Manav Rachna International University, Faridabad, India¹

Assistant professor, Dept. of ECE, Manav Rachna International University, Faridabad, India²

ABSTRACT: This paper presents an Artificial Neural Network (ANN) based approach for the recognition of English characters in the presence of noise. Noise has been regarded as one of the major issue that degrades the performance of character recognition system. In order to overcome this limitation, the back propagation (BP based ANN is designed for the English character recognition in presence of noise. The recognition system is designed and tested in MATLAB under different noise levels. Experimental results indicate that the proposed approach can obtain very high recognition rate for all English alphabets in the presence of noise.

KEYWORDS: OCR, MCR, ANN, Character Recognition, Back Propagation Algorithm etc

I. INTRODUCTION

Character recognition is a process which associates a symbolic meaning with objects (letter, symbols & numbers) drawn on an image. Character recognition can be on line or off line. On line character recognition has real time contextual information while off line character recognition system operates in non real time. Both of these systems face performance challenges due to many sources of variability. Noise is perhaps known to be a major source of variability and can make random changes to a pattern or character thereby making its interpretation difficult.

Optical character recognition (OCR) and magnetic character recognition (MCR) methods are most widely used for the recognition of characters or patterns. OCR uses optical means to acquire the character typically using a camera or optical scanner. Here the characters are in the form of pixel images and it could be either hand written or printed, of any size, shape or orientation. On the other hand in MCR the characters are printed with magnetic ink and the reading device recognize the character on the basis of the unique magnetic field that is created by each character. Both MCR and OCR find use in banking and various industrial applications.

ANN approach for character recognition is now gaining importance because of ANN's highly parallel architecture and fault tolerance. Zhao et.al.[1] proposed an SMT (Surface Mount Technology) product character recognition using back propagation neural network. Liu et.al. [2] proposed degraded character recognition system by using two stage process, one for character image quality evaluation and other for character recognition. This paper describes an ANN based approach for designing character recognition system in presence of noise. Images of different English alphabets are acquired and during acquisition they get distorted due to various reasons. A graphical user interface (GUI) of character recognition system is also designed in MATLAB.

The rest of the paper is organized as follows: Section II presents a brief introduction to neural networks. Back propagation neural network architecture is described in section III. Section IV presents the design steps adopted in designing noisy character recognition system. Experimental results are shown in section V and finally in section VI conclusions are drawn.

II. NEURAL NETWORKS

Neural Network is formed by interconnecting a number of elements called neurons in different layers together. These neurons work in a same manner as they do in biological terms. Consider a system in which a neural network is formed using three layers –Input, Hidden and Output as Shown in figure where Input layer is used to feed all the input data into

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 6, June 2014

the network, which is followed by a hidden layers of neurons for further processing of data and finally the output layer of neurons for calculating the desired response of the Neural network Created.

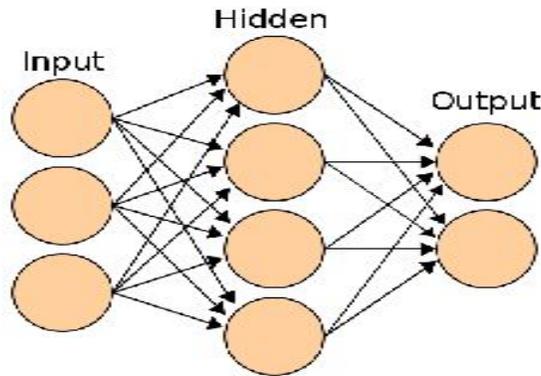


Figure-1 Diagram of a Neural Network

The above figure-1 shows the three layers of a neural network-input , hidden and output layer.The output of individual neuron can be given by:

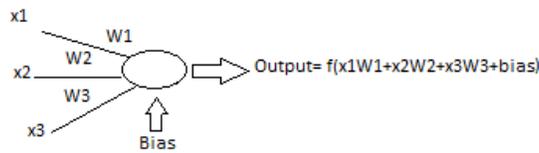


Figure- 2 Output of individual Neuron

OUTPUT= $f(X_1W_1 + X_2W_2 + X_3W_3 + BIAS)$ as shown in the above figure-2 , Where X1,X2 and X3 are the input values whereas W1 ,W2 and W3 are the weights in that layer.

Some functions used in Neural Network are as follows:-

In Multilayer neural networks , Log-sigmoid transfer function called Logsig are frequently used.[9]

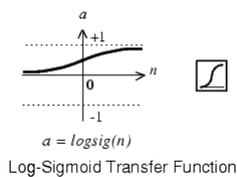


Figure-3 Log-Sigmoid Transfer Function

The figure-3 shows that the logsig function gives the outputs between 0 and 1 whenever the neuron's net input goes from negative to positive infinity as shown in the above figure.Tan –sigmoid transfer function Tansig can also be used in Multilayer networks.[9]



International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 6, June 2014

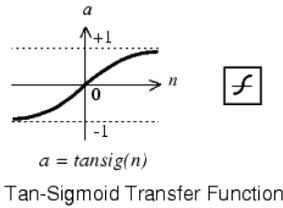


Figure-4 Tan-Sigmoid Transfer Function

The above figure-4 shows the Tan-sigmoid Transfer function .Another function called the Linear Transfer function Purelin is used in back propagation method.[9] and is shown in the figure-5.

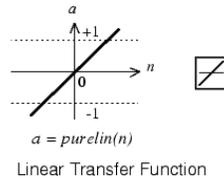


Figure-5 Linear Transfer Function

III .BACK PROPAGATION NEURAL NETWORK

There are two major basis on which types of networks can be differentiated i.e. a network with feedback and a network without feedback. In the prior one, the output values are fed back to the input values. There are some networks in which ,output can be predicted by the output values calculated by the input values fed in the network without applying the feedback, so there is only forward flow of information through the network. Such a network structure is called as feed forward networks. There are many such networks but the most important type of feed forward networks is the Back Propagation Network[14].

Back propagation method is used for training a multi-layer artificial neural networks with mathematical foundation. The method is used in multi-layer forward network with gradient –descent based on delta –learning rule along with a supervised training learning method. The main objective of this network is to train the network to balance between the input patterns that are used in training and their responses to the input patterns.[14]

In back propagation Method , the measure of error function is given by Mean square error ‘E’

$$E = (Target - Output)^2 \dots\dots\dots \text{equation-1}$$

Partial derivatives of the error function w.r.t the weights [13]

For Output Layer Neurons:

$$\delta_{y=f'(\text{net})(\text{target } y-\text{output } y)} \dots\dots\dots \text{equation-2}$$

$$\frac{\partial E}{\partial w_{yx}} = -\text{output}_x \delta_y \dots\dots\dots \text{equation-3}$$

Where y =output neuron
 X =neuron in last hidden layer

For hidden Layer Neurons:



International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 6, June 2014

$$\delta y = f'(net_y) \cdot \sum (\delta_k \cdot W_{ky}) \dots \dots \dots \text{equation-4}$$

$$\frac{\partial E}{\partial w_{yx}} = -output_x \delta_y \dots \dots \dots \text{equation-5}$$

Where y=hidden neuron
x=neuron in previous layer
k=neuron in next layer

IV. PROPOSED MODEL

The Proposed Model design steps involved in designing ANN based noisy character recognition system are summarized in the form of a flow chart as shown in fig.-6

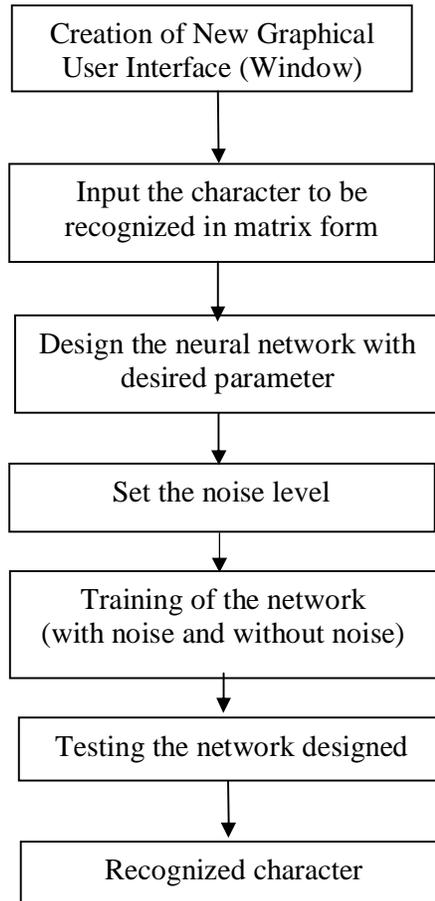


Figure-6 Proposed Model

A GUI is created in MATLAB and English character in the form of 5X 7 matrix are treated as input to the network. For example---

Letter A = [0 0 1 0 0 ...



International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 6, June 2014

0 1 0 1 0 ...
1 0 0 0 1 ...
1 1 1 1 1 ...
1 0 0 0 1 ...
1 0 0 0 1]';

A neural n/w is designed with 3 layers (input, hidden, output layer). In this work 2 hidden layers are used and number of neurons in each hidden layer is 8. Noise level is set to a particular value and then the n/w is trained. Training is done both in the presence of noise and without noise. Here supervised type of learning is used and finally the trained n/w is tested to see whether it has created a good balance b/w memorization (accuracy) and generalization.

V. EXPERIMENTAL RESULTS

In this work, a system has been designed using Neural Network in MATLAB to recognize the noisy character. The network created is being trained and tested. For each character, features were computed and stored for training the network. Here are some tables displaying the results obtained from the program.

A. NETWORK PARAMETERS

Table-1 Specifying the Network parameters

Input Layer	1
Hidden Layer	2
Output Layer	1
Number of neurons in each hidden layer	8
Noise Level	0.1

Here the input data given is the character “A” in the matrix with binary values as shown

Letter A = [0 0 1 0 0 ...
0 1 0 1 0 ...
1 0 0 0 1 ...
1 1 1 1 1 ...
1 0 0 0 1 ...
1 0 0 0 1]

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 6, June 2014

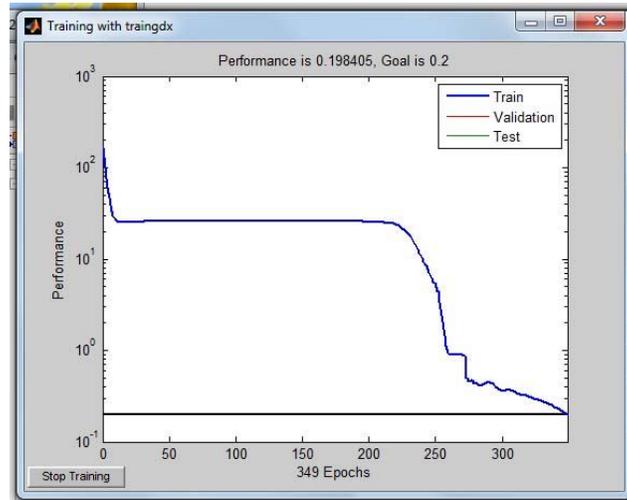


Figure-7 Performance Analysis at Goal =0.2

Network designed is first trained at a particular value of noise level to achieve desired performance goal. Figure-7 shows the performance plot during training phase to achieve goal of 0.2.

Here the goal is set up to which level the network has to be trained and provides the performance information in the form of graphs

Table -2 Performance Parameters(0.2)

Number of Epochs	373
Goal	0.2
Sum- squared error(sse)	0.196614

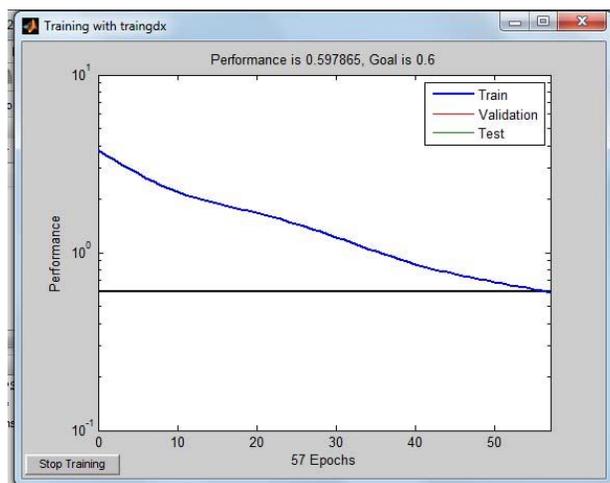


Figure-8 Performance Analysis at Goal =0.6

Figure-8 shows the performance graph during training phase for goal of 0.6



International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

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Vol. 3, Issue 6, June 2014

Table-3 Performance Parameters(0.6)

Number of Epochs	68
Goal	0.6
Sum- squared error(sse)	0.599731

Finally after designing , training & testing of the network is done .

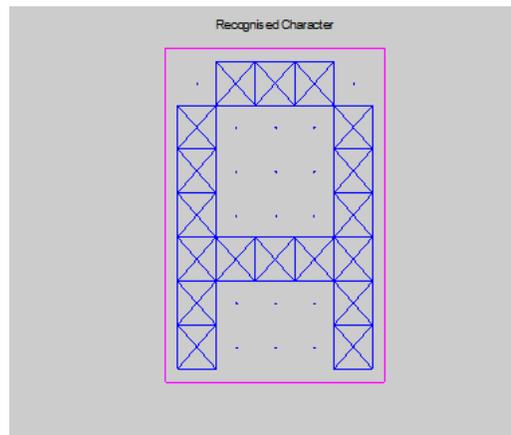


Figure-9 Recognized character

For testing letter “A” the recognized character is shown in figure-9

B. PERCENTAGE ERRORS

It has been found that the performance of network that is trained with goal 0.6 is better than the network which was trained with goal of 0.2. The results shows that the network1 (0.2) is less efficient than network 2 (0.6)

VI. CONCLUSION

Neural Network provides an efficient way for character recognition in the presence of noise .In this work, Neural Network is designed & tested for the recognition of English Alphabets under noisy environmental conditions. The results of MATLAB Simulation are presented for recognition of English alphabet “A”. Simulation results are presented for different performance goals of 0.2 & 0.6. Network is designed & trained at noise level of 0.1

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ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

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Vol. 3, Issue 6, June 2014

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BIOGRAPHY



Prerna kakkar is an Assistant Professor in Manav Rachna International University where she has brought many charms to the institute by her perseverance and intellectual. Her area of interest is Wireless& Mobile Communication and Neural Networks.



Umesh Dutta is an Assistant Professor in Manav Rachna International University where he received many awards for teaching excellence and Researches done in various areas. He has published over 6 papers in various international journals and conferences in the last one year. His area of interest is in VLSI and Embedded Systems