Performance Analysis of Neural Network Algorithms in Character Recognition

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Abstract-**Character recognition is one of the challenging tasks in Image Processing and Artificial Neural Networks research field. It has variety of applications such as banking, robotics, security products and other research fields etc. This paper is aimed to recognize numbers using neural network technology. Character recognition process mainly consists of four stages such as image acquisition, pre processing operations, initialization, creation of neural network and recognition. Characters are recognized using a scanned document or acquisition of image directly using MATLAB. Neural network algorithm helps in character recognition based on features extracted from database. In this paper, performance of different neural network algorithms such as 'gradient descent back propagation', 'gradient descent with adaptive learning rate back propagation', 'gradient descent with momentum and adaptive learning rate back propagation' are analyzed and compared. This approach is implemented in MATLAB using image processing functions [1].**

Keywords: Character recognition, Gradient algorithms, Image processing, Neural Networks

I. INTRODUCTION

Character recognition plays a very important role in communication field. As the growth of internet increases, the whole world is going to be digitized, and also demand of online information system is increased. Character recognition system find applications in bank cheque transaction, number plate recognition, and writer identification [2]. Character recognition is mainly partitioned into two types handwritten and typewritten. In type written character recognition, system uses documents which has already typed and scanned. For example, documents in libraries, offices and companies. In handwritten character recognition, system tries to identify character which has written by human. Handwritten character recognition is mainly divided into two types ie., offline and online character recognition, where offline gives good accurate results. This paper mainly concentrates on Handwritten number recognition. It is one of the challenging tasks and it is more complex to interpret because it is different in styles, sizes and orientation also varies from one person to person [3], [4], [5].

Manuscript received Nov 22, 2016

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Here, neural network technology is used to recognize characters. A neural network is explained as a network which is created to perform desired task in away like human brain do work. Human brain as developed its own rules to identify particular pattern since birth time, it is often called as an experience. Like human brain, neural network stores knowledge regarding pattern through learning process. Algorithm is required to train system and make it to learn characters which are written in different styles. Initializing network weights and biases for network training then it can be trained for pattern association, classification and function application. Training process mainly requires network inputs and target outputs [6], [7]. Several training algorithms used for feed forward networks. This algorithm used gradient of the performance function means it determines how to adjust the weights to minimize the performances. Gradient uses the technique called back propagation. It is mainly used because to update the network weights and biases gradually performance function also decreases rapidly [8].

II. METHODOLOGY

This paper mainly uses four methods such as Image acquisition, Image pre-processing operations, Initialization and creation of neural network, handwritten number recognition. Here, we have applied four different neural network algorithms for character recognition and their performances are compared. Flow of this method is as shown below.

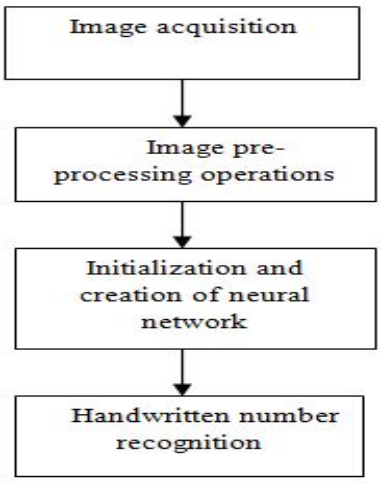

Fig.1.Flow chart for proposed methodology

A. IMAGE ACQUISITION:

In this paper, scanned answer script is given as input image which is to be tested. It contains question numbers in the margin. Our main task is to recognize question numbers which are written in different styles.

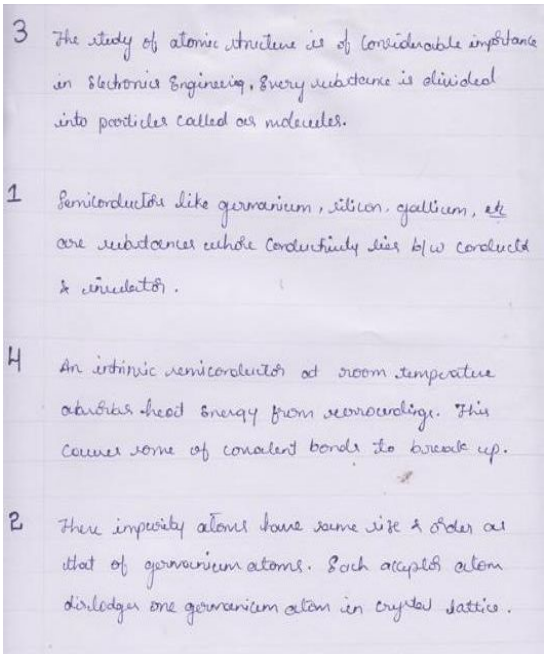

Fig.2. Input image

B. IMAGE PRE-PROCESSING OPERATIONS:

In pre-processing step, scanned answer sheet is converted into gray then to binary to obtain accurate results. Image contains some noise. To remove noise from image, morphological operations are used. Morphological operations are defined as process of defining shape and form of objects. Morphological Sstructuring element and create an output image of same size. Basic morphological operations are dilation and erosion. Here, we have used 'dilation' and 'open' operations. **Dilation** is used to make objects larger and to increase the thickness of image. 'strl' is the function used to construct structuring objects. **Open** considers only thick connections and removes noisy portions and smoothen image. Next step is number extraction. To extract each question number in scanned answer script, firstly margin is cropped, then each number is cropped to the edge. Cropping is done by using starting and ending points of rows and columns of each number. Each question number is scaled down to 10*10 single vector character representations.

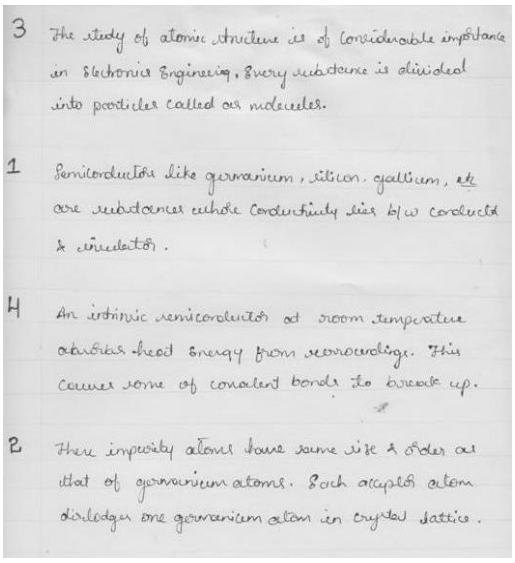

Fig.3.Gray conversion of input image

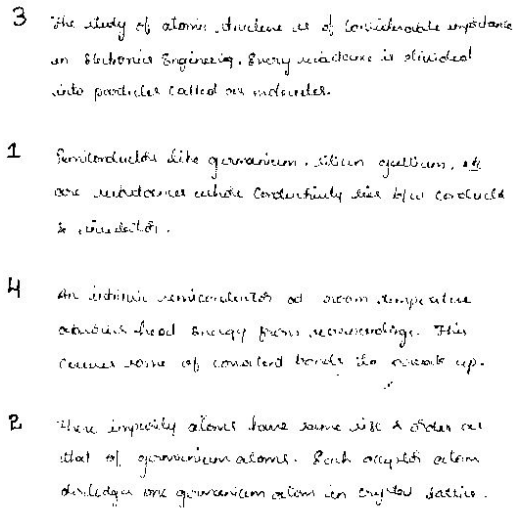

Fig.4.Binary conversion of the input image

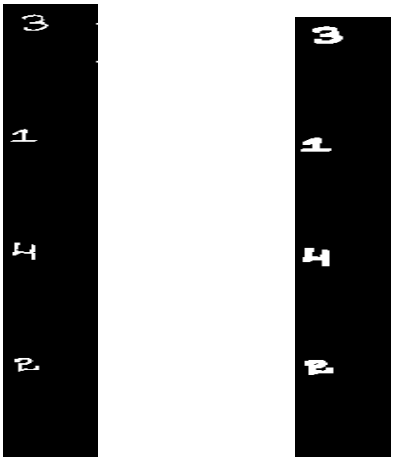

Fig.5.Noise free cropped margin in the image

C.INITIALIZATION AND CREATION OF NEURAL NETWORK:

Network is created using initial parameters such as goal, epochs, performance, learning rate, and momentum. Neural network is initialised and trained using neural network algorithms and database. Database contains numbers which are written in different styles. Features of all numbers which are present in database are extracted and used by algorithms to recognize numbers. Based on statistical, structural approaches, features of all numbers are calculated [5], [6].

D.HANDWRITTEN NUMBER RECOGNITION:

Once the feature extraction is completed, number with maximum matching is displayed.

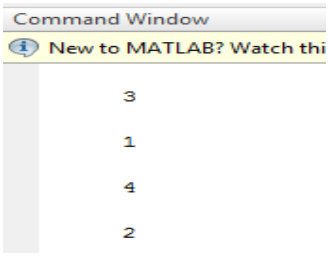

Fig.6.Recognised Numbers displayed in command window

E.NEURAL NETWORK ALGORITHMS:

Here, four neural network algorithms are analyzed, compared and explained.

1. Gradient descent back propagation (traingd):

This algorithm comes under batch mode. In this algorithm batch mode weights and biases of the network are updated after training set is applied to the network. The batch steepest descent function is traingd. Training parameters of this algorithm are epochs, goal, time, minimum gradient, maximum fail, learning rate. If the step is bigger, then learning rate is larger. If the learning rate is too large then the algorithm becomes unstable and also it takes more time to converge.

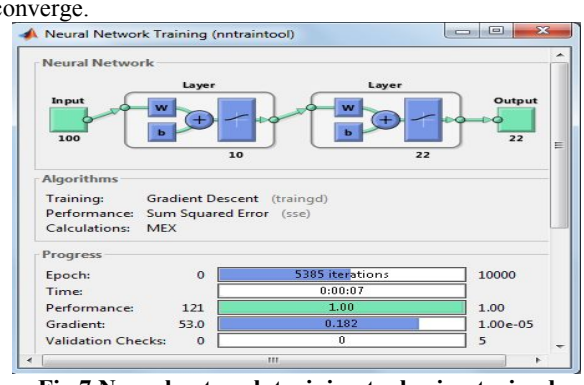

Fig.7.Neural network training tool using traingd

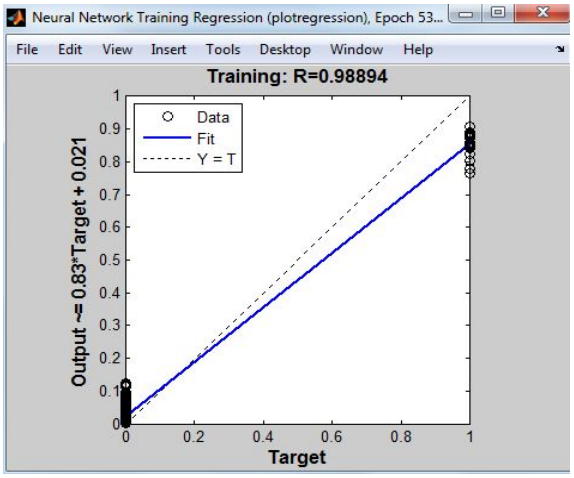

Fig.8.Regression plot shows accuracy in traingd

2. Gradient descent with momentum (traingdm):

This algorithm acts like low pass filter. This momentum allows the network to ignore small features in the error surface. Training parameters of these algorithms are epochs, goal, time, minimum gradient, maximum fail, learning rate and momentum. Here, learning rate and momentum is constant that means 0 for no momentum and 1 for insensitive to local gradient ant it does not learn properly. Both traingd and traingdm are too slow for practical problems.

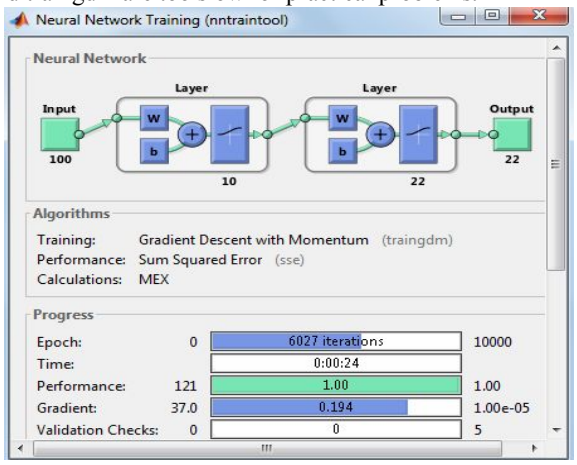

Fig.9.Neural network training tool using traingdm

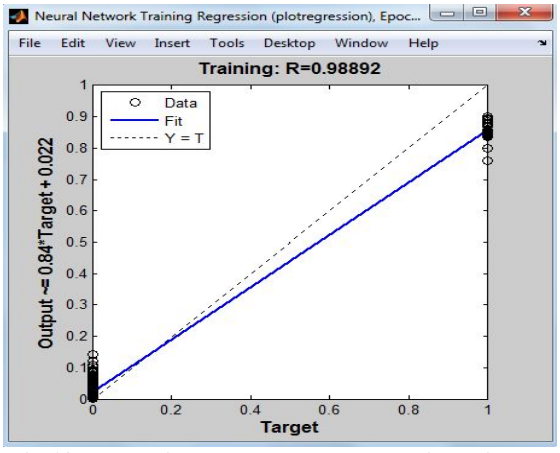

Fig.10.Regression plot shows accuracy in traingdm

3. gradient descent with adaptive learning rate back propagation (traingda) and gradient descent with momentum and adaptive learning rate back propagation(traingdx)

In these algorithms learning rate is constant throughout training. The performance of algorithms is very sensitive to the proper setting of the learning rate. If the learning is set too high, the algorithm can oscillate and become unstable. If learning rate is set too small then it takes long time to converge. Adaptive learning rate keep the learning step size as large as possible while keeping learning stable. Here new error is less than the previous error as learning rate is increased. This procedure increases the learning rate but only to the extent that the network can learn without large error increases. Larger the learning rate results in stable learning. Learning is high it guarantees to decreases in error. It decreases until stable learning resumes. The function traingdx combines adaptive learning rate with momentum.

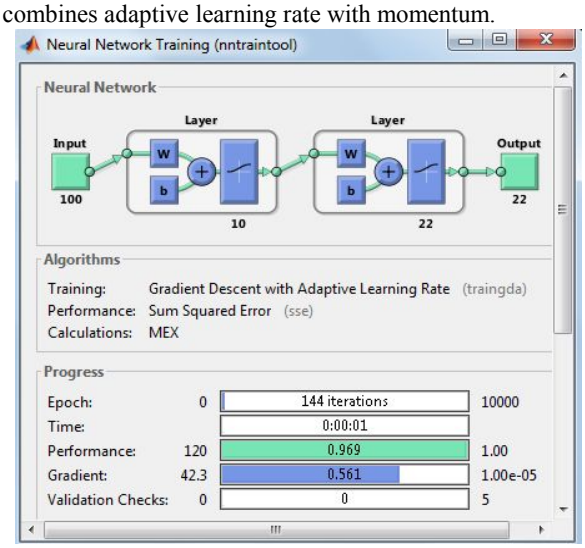

Fig.11.Neural network training tool using traingdx

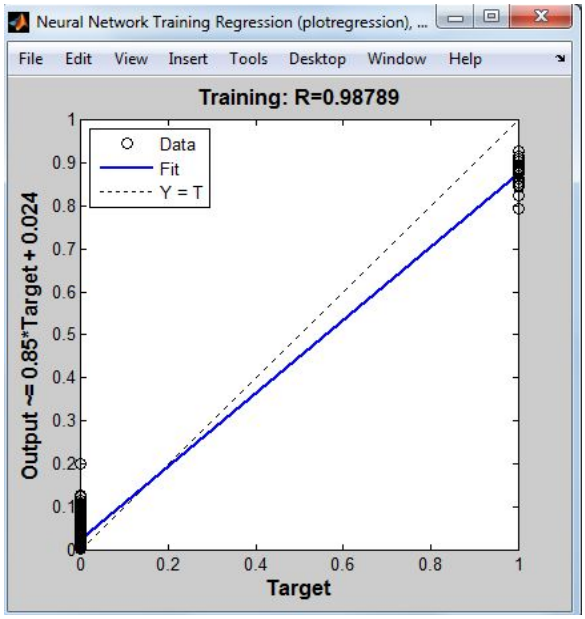

Fig.12.Regression plot shows accuracy in traingdx

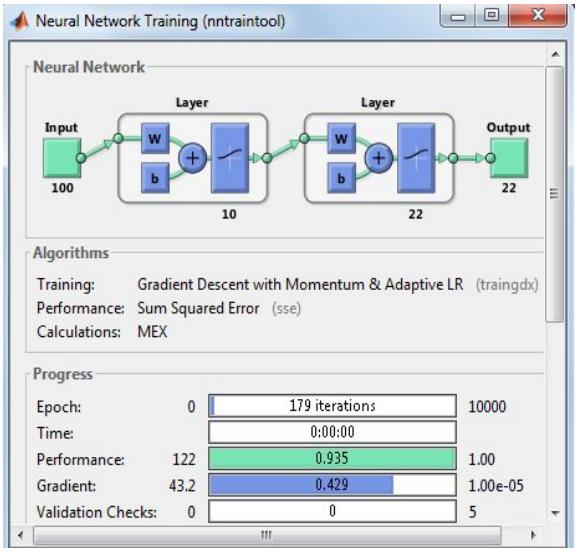

Fig.13.Neural network training tool using traingda

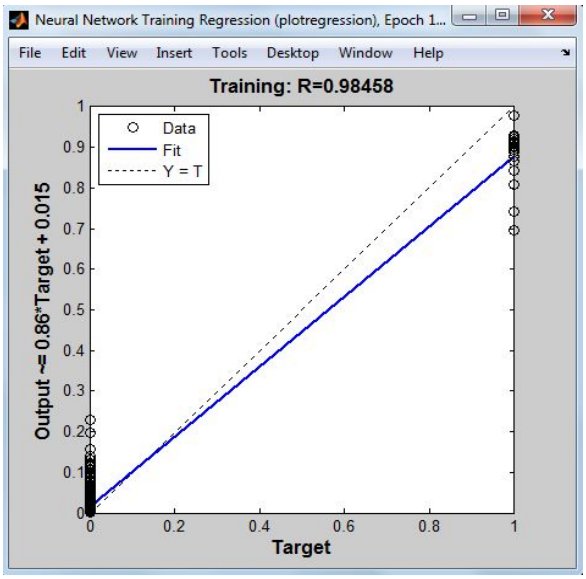

Fig.14.Regression plot shows accuracy in traingda

Slno	Parameters	Algorithms			
		traingd	traingdm	Traingda	traingdx
1.	Accuracy (%)	98.894	98.892	98.789	98.458
2.	Time require(s)	7	24	1	0
3.	Number of iterations will be taken to get SSE=0	5385	6027	144	179

Table 1: Performance analysis of neural n/w algorithms

CONCLUSION

In this paper, we have discussed and analyzed different neural network algorithms for handwritten character recognition. Here, four neural network algorithms are analyzed and compared. All algorithms give accuracy of 98% but traingd and traingdm are too slow to get solution for real time applications because it takes more iterations. So traingda and traingdx give better performance compare to previous algorithms.

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