# Handwritten Digit Recognition using various Neural Network Approaches

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### ABSTRACT

**Handwritten digit recognition is one of the important problems in computer vision these days. There is a great interest in this field because of many potential applications, most importantly where large number of documents must be dealt such as post mail sorting, bank cheque analysis, handwritten form processing etc. So a system should be designed in such a way that it is capable of reading handwritten digits and provide appropriate results. This paper presents a survey on various neural network approaches to recognize handwritten digits.**

**Keywords: Image Acquisition, Image Rendering, Character Extraction, Image Processing, Edge Detection, Neural Network, Back Propagation Network, Multi Layer Perceptron Network**

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## 1. INTRODUCTION

With the advancement of technology, the interfacing between man and machine has increased the scope of research in various domains, thereby making majority of tasks automated and easier to perform. MATLAB is one such powerful machine tool where in the availability of Image Acquisition Toolbox, Image Processing Toolbox and Neural Network Toolbox simplifies the task of obtaining and understanding handwritten text.

[2] The two commonly used methods of handwritten character recognition, On-line and Off-line methods, have their own advantages and disadvantages. Where the off-line method provides more accuracy, the on-line method is superior in recognizing characters due to temporal information available to it.

**TRAINING AND TESTING A NETWORK**

Next, we create a training vector for the neural network in order to match the input accepted by the neural network function. The steps performed in creating and training the neural network has been illustrated below:

Type nntool in Matlab. A dialog box appears where in we are required to Import the Inputs and Targets from the MATLAB workspace. After importing, the created network appears in the network list. Open the network and select training tab. Here, we can choose the training parameters and data (inputs and targets) and finally click on Train option to train the network. I used feed forward back propagation neural network. In other words, [4] implementation based on Multi- Layer Perceptron Network (MLPN) trained with back propagation was done. [6] Other complex training methods employing Error Back Propagation Algorithm have been used earlier. There were two hidden layers used with TANSIG (tan-sigmoid) function.
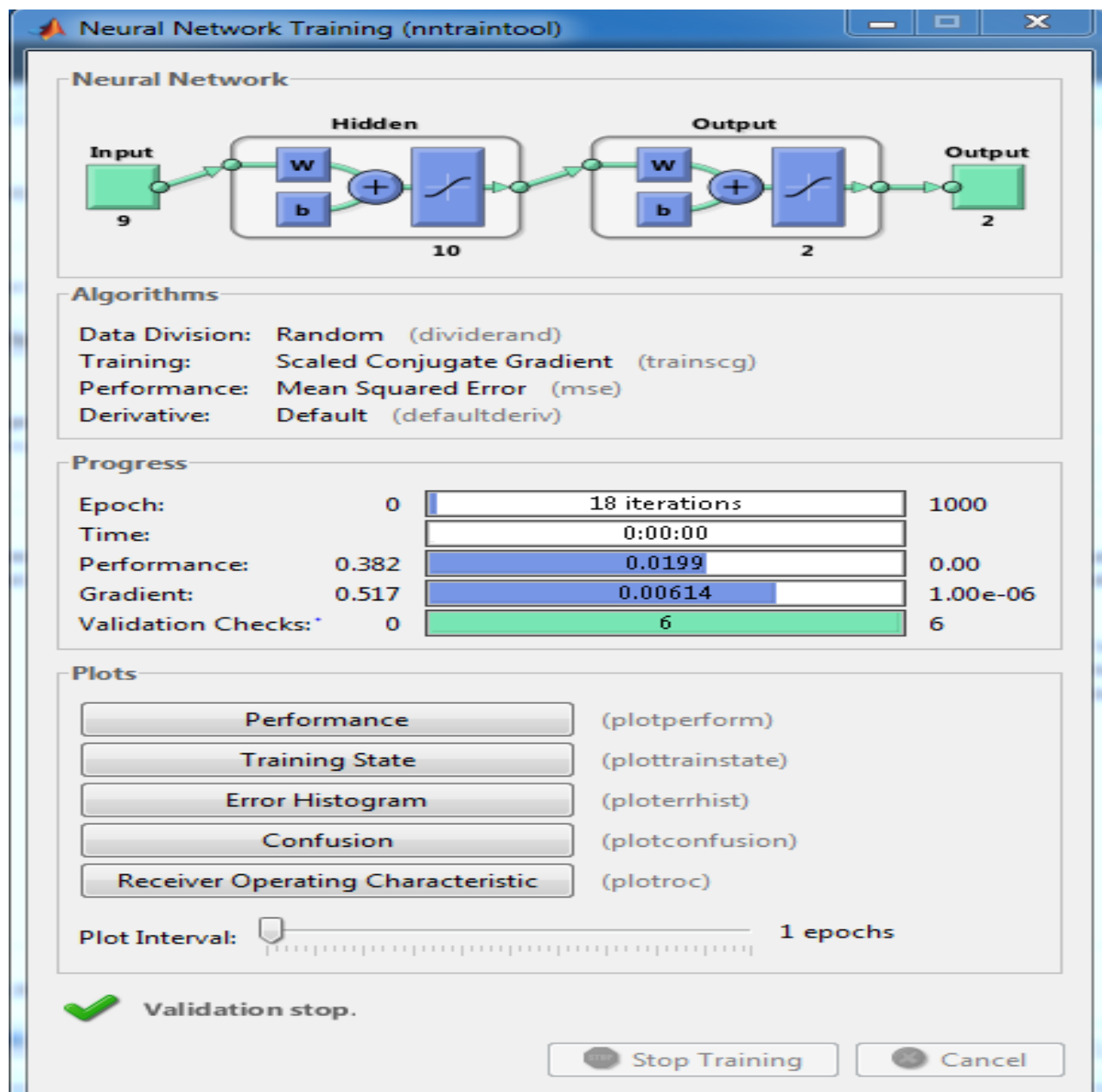
## ABOUT NEURAL NETWORK

As the name suggests, Neural is related to neurons, which are an important part of biological nervous system. Like [5] human nervous system processes the information it receives from nerves, in a similar way, this Artificial Network processes information to solve specific problems. Every neural network comprises of interconnected neurons which is trained or configured for a specific application. This is used in various field of study like pattern recognition, data classification and so forth to analysis a problem and adjust its parameters accordingly. The need of neural network can be realized by comparing it with the use of conventional computers which requires an algorithm to solve a specific problem. Unlike computers, neural networks follow parallel processing architecture thereby resulting in maximum efficiency. Moreover, there are multiple network types like Perceptron, feed forward, feedback networks which present a variable ways to associate input with the output.

Neural network is not just confined to MATLAB but also suitable for real time systems. It also contributes to research in medicine such as neurology to study brain mechanism in detail. The scope of neural network is not just limited to be used alone. [8] It can be used in solving Zip Code Recognition problem. It can be integrated with other important related subjects like Fuzzy logic and Artificial Intelligence for faster response and computations.
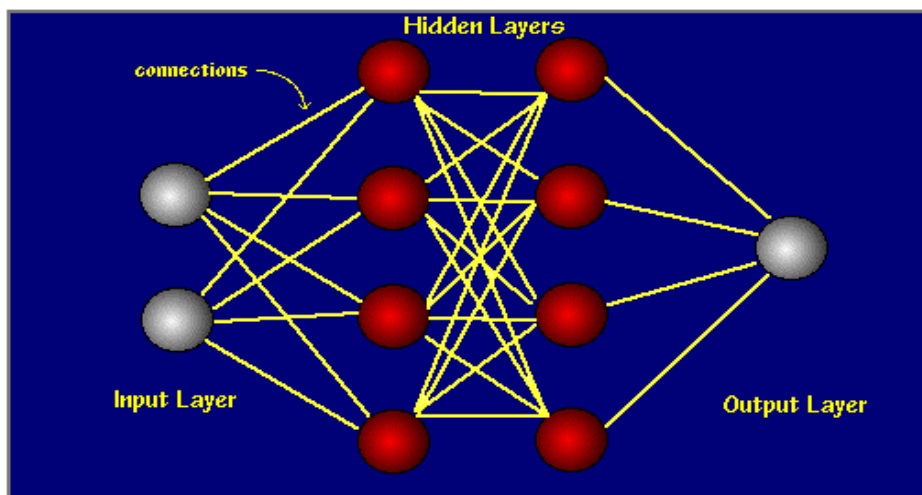
**Fig1: Handwritten Recognition system**

In this section, the proposed recognition system is described. Our approach to solve this problem of handwritten digit recognition can be broadly divided into following blocks:

- » Image acquisition,
- » Pre-processing,
- » Segmentation,
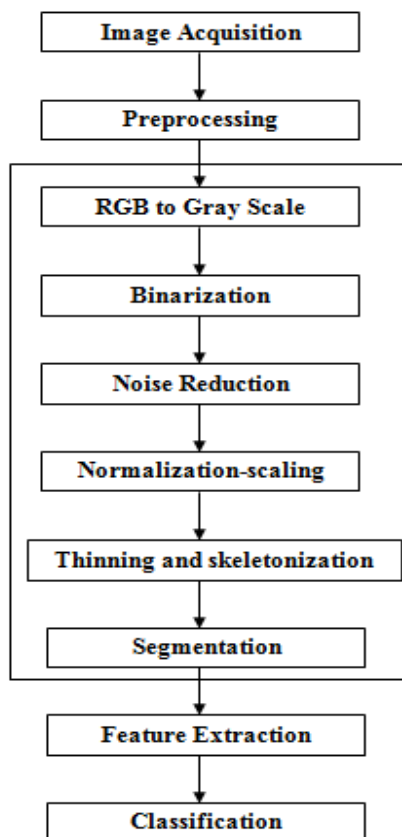- » Feature extraction,
- » Classification



**Figure: 2 System Overview**

**Image Acquisition**

In Image acquisition, the recognition system acquires that scanned image is taken as an input image. A particular format is taken for an image such as JPEG, BMP etc. In this thesis, we have collected 784 samples of MNIST dataset which have CSV file so we obtain image from CSV file, Acquired image is 28* 28 pixels of handwritten digits.

**Pre-processing**

Pre-processing is the preliminary stage of handwritten digit recognition. A range of tasks are performed on the image in the pre-processing stage. On the scanned input image series, operations must be applied. It covers skew detection and correction, skeletonization, and noise reduction/removal. After pre-processing, we have enhances the image, that is inputted to the segmentation phase and making it right for segmentation. Pre-processing essentially enhances the image, exposes it to suitable segmentation. Such processing includes the following:

**RGB to Gray Scale Converter:**

The scanned image is stored as a JPEG, BMP, and TIFF image. All these images are in RGB format. In order to start operation with an image it must be converted into a gray scale image. A gray scale image represents an image as a matrix where every element has a value equivalent to how bright or dark color should the pixel have at the corresponding location. The value of a pixel lies between (0, 1).

**Binarization:** Binarization process converts a gray scale image into a binary image with thresholding technique. This image format also stores an image as a matrix but can only color a pixel either black or white. It assigns a 0 for black and a 1 for white. The image is then reversed to obtain image such that 1 represents object pixels and 0 represents background pixels because it is easy to work with 1s and leave the 0 aside. Also, smaller number of 1s will mean lesser calculations.

**Noise Reduction:** The noise introduced by the visual scanning device or the writing instrument, causes disconnected line segments, bumps and gaps in lines, filled loops etc. The alteration including local variations, rounding of corners, dilation and erosion, is also a crisis.

**Median filter:** Median filter is a low pass filter. It replaces the pixel at the center of the filter with the median value of the pixels falling under the mask. The median filter is take a pixel and then select an arbitrary size of matrix around that given by m*n and the take average value of all the pixel value and the arbitrary matrices and the assign to the pixel that chosen.

**Deblurring:** This technique is used when image is blurred. Generally image blur due to when image is captured during motion so this affect on image and image is get to blur. Deblurring is remove using weiner filter.

**Normalization-scaling:** Standard font size must be applicable within the image. This problem appears clearly in handwritten text, because the font size is not limited when using handwriting.

**Thinning and skeletonization:** Represent the form of the object in a relatively smaller number of pixels. Thinning algorithms can be parallel or sequential. Parallel algorithm is useful on all pixels simultaneously. Sequential algorithms observe pixels and transform them depending on the preceding processed outcome.

**Segmentation:** Image segmentation have two different aspects first is based on image discontinuity detection or pixel discontinuity detection whereby we had the obtain the boundary pixels from the edge pixels connected to the binary pixels using the standard pixels chaining technique and second is similarity based region segmentation which is also approach based on thresholding and threshold is choose by some optimality criteria and based on the histogram of the boundary pixel. Image segmentation process is generally refers to making parts of the image rather braking image into a constituent parts or objects. It is a subdivision or partitioning which we do based on some properties of the objects. Segmentation of a handwritten digit is a challenging task due to a variety of writing styles.

**Features Extraction**

The main goal of feature extraction is to extract a set of features, which maximizes the recognition rate with the smallest amount of elements and to generate related feature set for diversity of instances of the same symbol. Due to the nature of handwriting with its high degree of changeability and ambiguity obtaining these features, is a complicated task. Feature extraction methods evaluate the input document image and choose a set of features that individually identifies.

**Classification**

Classification methods based on learning from examples have been widely applied to digit recognition and have brought forth significant improvements of recognition accuracies. This class of method includes artificial neural networks.

## CONCLUSION

The goal of the proposed work is to make the system which recognizes the digit in an accurate and faster way. The image must process through the number of steps.   Segmentation-based methods reach better accuracy, however they are usually time consuming. This survey paper represents different feature extraction method along with different classifier in recent year. The results of our experiments show that feature selection procedure reduces the dimensionality which not affecting the performance of the classifier where the system can maintain high performance with less computational complexity comparing to the systems in the literature. To achieve high recognition of numeral text, this can be done in Classification and recognition process. So here we will use different learning methods with gradient descent back propagation algorithm in neural network classifier and solved the particular problem of handwritten digit to evaluate their performance. The outcome of this proposed work, neural network is to seem best option to recognize handwritten digits from other technique.

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