Digit Recognition System by using Back Propagation Algorithm

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ABSTRACT
An artificial neural network is configured for a specific application, such as pattern recognition or data classification, through a learning process. Just like biological systems involves adjustments to the synaptic connections that exist between the neurons, artificial neural network also works on the same principle. The work described in this research does not have the intention to compete with existing systems, but merely served to illustrate to the general public how an artificial neural network can be used to recognize handwritten digits.

General Terms
Digit Recognition, Security, Artificial Neural Network et. al.

Keywords
BPNN, Patten Recognition, Neural Network, epoch etc.

1. INTRODUCTION
Digit recognition is an art of detecting segmenting and identifying digit from image. The phenomenon of digit recognition involves detection and recognition of digits from input image and then it is converted into ASCII or other equivalent machine editable form so that it can be processed[1][2]. It helps greatly to the advancement of automation process and improving the interface between man and machine in many applications .Digit Recognition system is the combination of pattern recognition and artificial neural network[3].Digit recognition is getting more and more attention since last decade due to its wide range of application. This is because it has an importance in several fields and it may probably be used in checks in banks or for recognizing numbers in cars plates, or many other applications. Conversion of handwritten digits is important for making several important documents related to our history, such as manuscripts, into machine editable form so that it can be easily accessed and pres independent work is going on .Digit recognition system can be implied by both the techniques i.e. offline as well as online. Both the techniques has their advantages as well as constraints. Offline digit recognition system, in this document is first generated, digitized, stored in computer and then it is processed. While in case of online digit recognition system, digit is processed while it was under creation. In offline system external factors like pressure, speed of writing have little influence, but they have great impact on online system [4]. Again, offline or online system (Fig 1. (a) & (b)) or handwritten digits can be applied on optical digit (Fig 2.(a)) or handwritten digits (Fig 2.(b)).

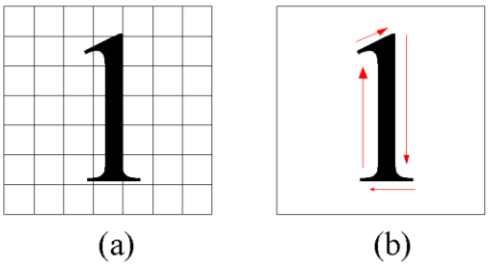

Fig 1: (a) Offline digit recognition; (b) Online digit recognition

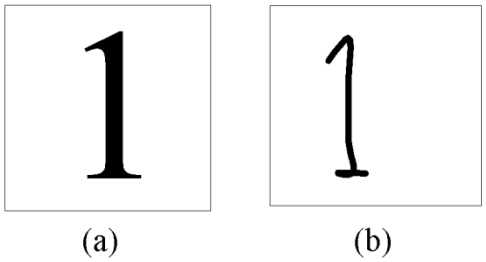

Fig 2: (a) Optical digit (b) Handwritten digit

By comparision online methods are superior over offline methods due to temporal information present in digit generation [5].There are various existing systems which involves computational intelligence techniques such as artificial neural networks or fuzzy logic, while others techniques includes large lookup tables that contain possible realizations of handwritten digits. Artificial neuron, which is a simple mathematical model of a biological neuron, is nowadays using for generating neural networks. These can be implemented in hardware and software. Previously work were performed in hardware but now a days, it is implemented by means of software which is more convenient. Neural network simulations appear to be a recent development. However, this field was established before the advent of computers, and has survived at least one major setback and several eras. They considered the case of a network made up of binary decision units and showed that such a network could perform any logical function on its inputs. This was taken to

mean that one could ‘mechanize’ thought, and it helped to support the development of the digital computer and its use as a paradigm for human thought. The result was made even more intriguing due to the fact that the binary decision units is a beautifully simple model of the sort of nerve cell used in the human brain to support thinking. This led to the suggestion that here was a good model of human thought. Before the logical paradigm won the day, another American, Frank Rosenblatt, and several of his colleagues showed how it was possible to train a network of binary decision networks, called a perceptron, so as to be able to recognize a set of patterns

chosen beforehand. This training process uses the connection weights between different neurons. Each of these weights is a number by which one must multiply the activity on a particular input in order to obtain the effect of that input on the binary decision units. The total activity on the BDN is the sum of such terms over all the inputs [6]. The connection weights are the most important objects in a neural network, and their modification (so-called training) is presently under close study. The essence of the training rules was very simple: one would present the network with examples and change those connection weights, which led to an improvement of the results, so as to be closer to the desired values. Artificial neural nets have successfully been applied to handwritten digit recognition many times, with very few error margins. Image processing and pattern recognition plays significant role in handwritten digit recognition. Basically the process of image processing involves feature extraction and transformation. Various types of classification of feature extraction methods like statistical feature based methods, structural feature based methods and global transformation techniques exists[7]. Feature extraction involves simplifying the amount of resources required to describe a large set of data accurately. When performing analysis of complex data one of the major problems stems from the number of variables involved. Analysis with a large number of variables generally requires a large amount of memory and computation power or a classification algorithm which overfits the training sample and generalizes poorly to new .Image transform is basically a representation of an image. There are two reasons for transforming an image from one representation to another. First the transformation may isolate critical components of an image pattern so that they are directly accessible for analysis. Second,the transformation may place the image data in a more compact form so that they can be stored and transmitted efficiently. There are different types of image transform such as fourier transform, walsh transform, hadamard transform, slant transform, discrete cosine transform, KL transform, radon transform etc. Feature extraction process includes various low level and high level features such as width, height, curliness, aspect ratio etc of the digit . These alone cannot be used to distinguish one digit from another digit set[8].

2. ARTIFICIAL NEURAL NETWORK

Artificial neural networks are computational models which are inspired by human nervous systems that are capable of machine learning and pattern recognition. It can also be defined as the interconnected group of artificial neurons that uses a mathematical model or computational model for information processing based on a connectionist approach to computation. A neural network is a powerful data modeling tool that is able to capture and represent complex input/output relationships. The traditional Back-propagation Neural Network (BPNN) Algorithm is widely used in solving many practical problems. The BPNN learns by calculating the errors of the output layer to find the errors in the hidden layers [9].

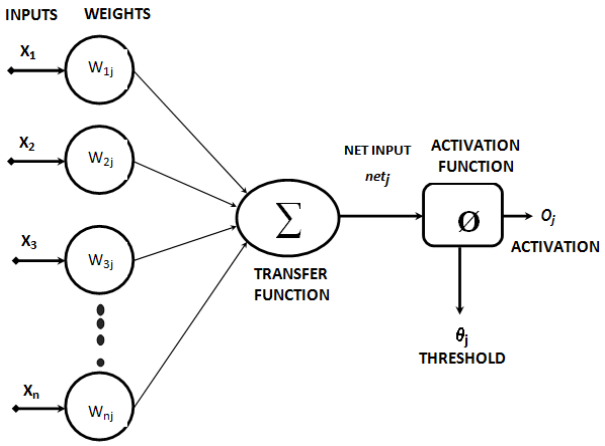

Fig 3: Structure of ANN

3. PROPOSED SYSTEM

One algorithm, which has hugely contributed to neural network fame, is the back-propagation algorithm. The principal advantages of back-propagation are simplicity and reasonable speed (though there are several modifications which can make it work faster). Back-propagation is well suited to pattern recognition problems shown in fig 4.

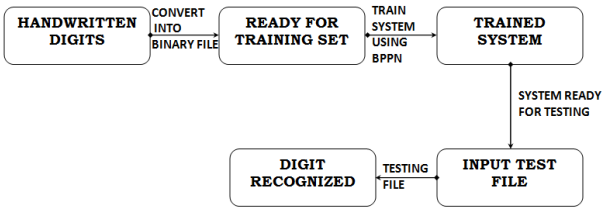

Fig 4: Structure of the proposed system

The training algorithm for a BPN consists of the following steps:

i. Selection and Preparation of Training Data

ii. Modification of the neuron connection weights

iii. Repetition

iv. Testing

Block diagram of the typical digit system. Each stage has its own problems and effects on the overall system's efficiency, either by solving each particular problem. This recognizer is designed by following steps. The algorithm is designed and tested in the related sections.

3.1 Detailed Training Procedure

1. Split the data set into a training set and a test set. Normally the training set is larger than the test set. Often the desired outputs have to be normalized to the range [0: 1] since the sigmoid function only returns values in this range. The input patterns do not have to be normalized.
2. Initialize all weights, including all biases if any, to small random values (normally in the range of -1 to +1).
3. Forward propagation of the first input pattern of the training set from the input layer over the hidden layer(s) to the output layer, where each neuron sums the weighted inputs, passes them through the non linearity and passes this weighted sum to the neurons in the next layer.

4. Calculation of the difference between the actual output of each output neuron and its corresponding desired output. This is the error associated with each output neuron.

5. Back propagating this error through each connection by using the Back propagation learning rule and thus determining the amount each weight has to be changed in order to decrease the error at the output layer.
6. Correcting each weight by its individual weight update.

7. Presenting and forward propagating the next input pattern. Repeat steps 3-7 until a certain stopping criterion is reached, for example that the error falls below a predefined value.

The one-time presentation of the entire set of training patterns to the net constitutes a training epoch.

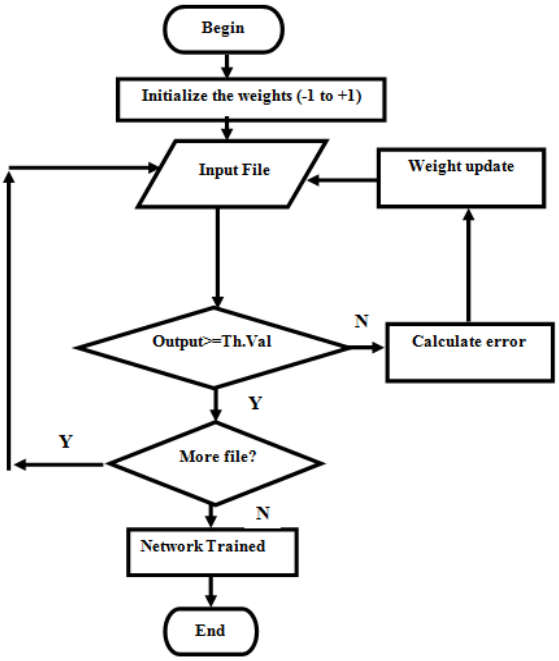

Fig 5: Flow Chart for Training Algorithm

After terminating the training phase the trained net is tested with new, unseen patterns from the test data set. The patterns are forward propagated, using the weights now available from training, and the error at the output layer is determined (no weight-update is performed!). If performance is sufficiently good, the net is ready-for- use. If not, it has to be retrained with the same patterns and parameters or something has to be changed (e.g. number of hidden neurons, additional input patterns, different kinds of information contained in the input patterns). It is also important that the net not be "over trained": if it is trained for too many epochs it starts "memorizing" the training patterns and can no longer recognize patterns other than those it was explicitly trained for. This effect can be compared to the over fitting of a discretely sampled function. In summary the goal of training a neural network is that it become able to generalize. This means that it only extracts some important features of the data and thus also classifies slightly differing patterns to belong to the same class. This also provides robustness in the presence of noise.

4. RESULT

GUI is prepared by using JAVA Coding for Digit Recognition System.

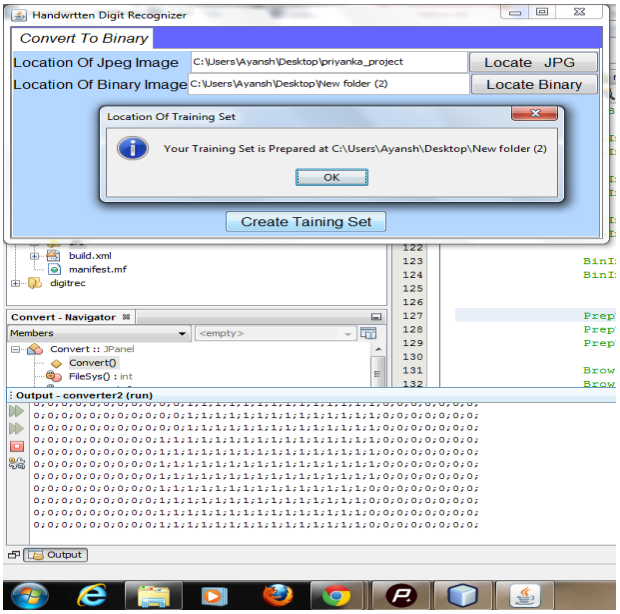

Fig 6: GUI Used for Digit Recognition System

This coding has been done on java plate form and it displays the binary form of digit "1" which is further used for comparison.

Fig 7: Result obtained after Binary Conversion

This result shows the method to convert hand written digit into binary conversion.

5. CONCLUSION

Different types of neural network was deeply analyzed and studied for developing digit recognizer. Finally, the concept of

back propagation was chosen to develop a simulation model which can recognize handwritten digits. This back propagation based simulation model provides high accuracy as compare to other approaches. In this model, the user inputs the handwritten digits using an image editor such as paintbrush which is then tested against the training set prepared. This simulation model can be used for other applications also where visual classification of entities is possible with some variations for example Handwritten Alphabet Recognition, Signature Pattern matching etc. This simulation model can also be further extended to understand characters of other languages like urdu, malyalam characters.

6. ACKNOWLEDGMENT

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