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Simplified Neural Network Design for Hand Written Digit Recognition

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Abstract:- **Neural Network is abstraction of the central nervous system and works as parallel processing system. Optimization, image processing, Diagnosis and many other applications are made very simple through neural networks, which are difficult and time consuming when conventional methods are used for their implementation. Neural Network is the simplified version of human brain. Like human brain, neural networks also exhibit efficient performance on perceptive tasks like recognition of visual images of objects and handwritten characters etc: Recognition of handwritten digits is one of the oldest applications of ANN. The recognition of digits written in different handwritings and also from scanned text has remained a trouble thus it has received much attention of researchers in the field of artificial neural networks. We can distinguish among handwriting of different persons due to the fact that human brain is capable to even slight variations of visual images. In this research work a very simple and flexible neural network scheme is proposed and implemented for handwritten digit recognition, which will assist beginners and A.I students who want to understand perceptive capability of neural network. In the proposed system, a very simple design of artificial neural networks is implemented. First of all learning mechanism of the neural network is described and then its architecture is discussed. Proposed network is trained in supervised manner using various (approx: 250) patterns /fonts of handwritten digits. Unique token is allocated to digit when it is made input to the system. Network becomes adaptive when different patterns of the same digit are taught to the network for one particular token.**

Keywords:Neural Network, Visula Images, digit recognition

I. RELATED WORK

Recognition is a Windows based Neural Network system to learn and accept mouse driven characters. It can be taught easily to recognize new characters [1].

Sajjad S. Ahranjany and Farbod Razzazi proposed a new method for handwritten Farsi/Arabic digit written. Recognition Results of different convolutional Neural Networks were fused with gradient descent training algorithm [2].

Zhang Xinbo and Wu Lili proposed an improved learning rate BP algorithm by establishing functional relationship between the error E and the learning rate η [3].

Online Urdu handwriting recognition system was designed that can recognize about 850 single character, with input of about 18000 common words from the Urdu Dictionary [4].

JORMA LAAKSONEN [5] suggested subspace classifiers for recognition of handwritten digits. The result was applicable in other identical cases of recognizing two-dimensional independent visual objects

Development of recognition and verification system for unconstrained handwritten digits is challenging task due to variety of writing styles of different writers.[6].

A back-propagation neural network was trained and evaluated to recognize printed text as well as handwritten given by both male and female candidates [7].

II. OBJECTIVE(S) AND SCOPE

The research aims at "Developing a simple neural network architecture that can recognize various patterns of handwritten digits". In this research I will analyze and answer following research question.

"How to design simplified and efficient ANN architecture for handwritten digit recognition?, how handwritten/mouse drawn digits will be digitized?, How to implement learning mechanism to train the proposed architecture by no. of already stored patterns of hand drawn digits? And finally what results are obtained by comparing and analyzing them."

Following objectives gives entire scope of my research work.

-Developing a simple neural network architecture that can recognize various patterns of handwritten digits

-Digitization of input digit.

-Designing learning mechanism of ANN for its training against already stored patterns.

-Comparing and evaluating the results of input handwritten digit with already stored patterns on which ANN is already trained.

III. METHODOLOGY

Proposed methodology for handwritten digit recognition using simplified neural network architecture is given as under.

3.1 Digitization

This process of digitization is important for the neural network used in the system. In this process, the input image is sampled into a binary window which forms the input to recognition system. In the figure 1, the digit 3 has been digitized into 14*16=224 digital cells. I assigned +1 to each black pixel and 0 to each white pixel and create the binary image matrix. So much conversion is enough for neural networking. Digitization of an image into a binary matrix of fixed predetermined dimensions. This establishes uniformity in the dimensions of the input and stored patterns as they move through the recognition system.

00001111111000
00000000110000
00000001100000
00000011000000
00000011110000
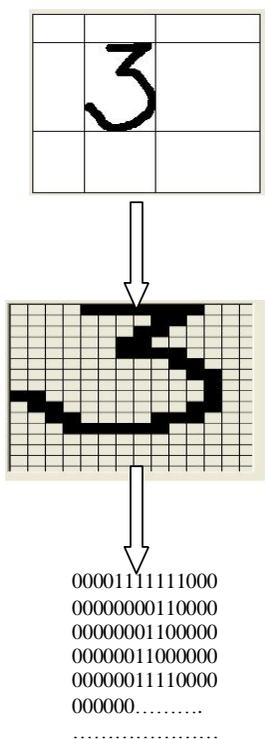000000..........
....

Figure 1. Digitization of digit 3.

3.2 Learning and Recognition Module

In proposed network, supervised learning mechanism is used to train it against input digits. As mentioned in introduction section, unique token is allocated to digit when it is made input to the system. Network becomes adaptive when different patterns of the same digit are taught to the network under one particular token, shown below in figure 1 and 2 are some sample training patterns of digit 3 and 4. Initially matrix M1 is made input to the network. Proposed architecture of the digit recognition system is shown in Fig. (1). Input pattern I is the input. The block 'M' provides the input matrix M to the weight blocks Wk for each k. There are totally n weight blocks for the totally n characters to be taught (or already taught) to the system.
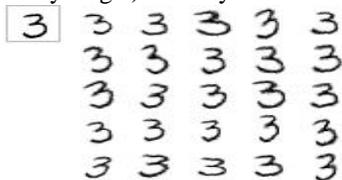

Figure 2. Different patterns of digit 3.
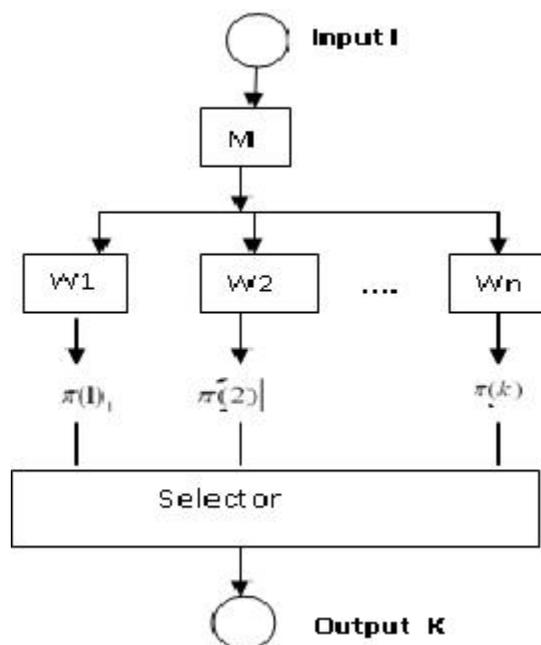

Figure 3. Different patterns of digit 4.

Figure 4. Proposed Neural Network Architecture for Hand Written Digit Recognition

Following statistics is used for the recognition of patterns.

Contestant Score (ψ):

It is product of respective elements of the weight matrix Wk of the kth taught sample and an input sample I as its contestant.

$$\psi(k) = \sum_{i=1}^{x} \sum_{j=1}^{y} W_k(i,j) * I(i,j)$$

.... (C)

3.2.2 Positive Sum Total Score (μ):

It is summation of all +ve numbers of the weight matrix of a learnt sample. It is given as under, where $\mu(k)$ is set to zero each time.

```
i=1;
j=1;
While ( i<= x)
{
        While ( j<= y)
        {
            if (Wk(i,j)>0)   then
              {
                μ(k) = μ(k) +  Wk(i, j);
              }
        }
}
```

3.2.3 Recognition Ratio (R):

It provides statistics about the recognition capability of the system i.e. finding an input sample as a matching candidate for one of its many taught samples.

If value of R is greater, then the system has more confidence on the input pattern as being analogous to a sample already recognized to it. It is given as under:

$$R(K)= \frac{\overline{\psi(k)}}{\mu(k)}$$

…………………………………… **(D)**

3.3. Proposed Algorithm

The classification of input sample now goes through the following process:

A. For every input candidate sample I, calculate the recognition Ratio (R (K)) for each learnt pattern k.

B. Find out the value of k for which R(k) has the highest value.

C. If highest value is too small (< 0.5) then it indicates poor recognition. In such situation: There are two possibilities;
   a) Assume that the candidate pattern has no existence inside knowledge base
       OR
   b) Train the network with the candidate pattern until a acceptable value of R(k) is got.

D. Classify the input candidate pattern as being analogous to the Kth learnt pattern OR carry on the training for getting improved performance.

In Fig.(3.3), output k given by selector is obtained by building the optimal selection (mentioned in step D)

Example:

Recognition capability of the system can be tested, result shown in figure 5 and 6 below. Here, 5 and 7 are input to the system, while the system is already trained on different patterns of 5. Recognition quotient for input 5 is Q=0.68, which is above satisfactory performance of the system. For input pattern 7, Q= 0.19, which is very poor performance, as system was not trained on 7.
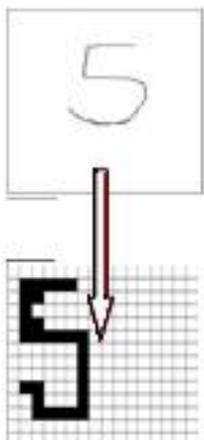
Q=0.68

Figure 5. Recognition digit 5
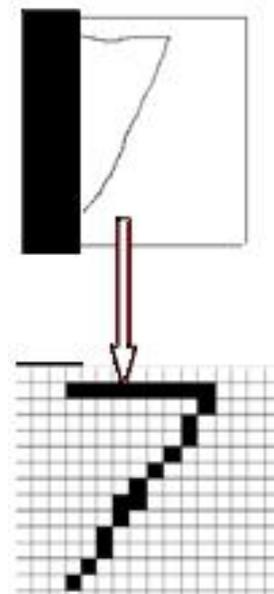
Q=0.19

Figure 6. Recognition of digit 7.

IV. CONCLUSION

A simplistic approach for recognition of handwritten digits using artificial neural networks has been described.

System is highly adaptive; minor errors and variations in patterns don't affect recognition efficiency of the system. Network is trained on 250 different handwritten fonts of digits. The knowledge base of the proposed system can be updated by feeding it new fonts of digits or feeding different patterns of earlier digits. Despite the computational complexity involved, proposed artificial neural networks offered satisfactory recognition results, which will be discussed in detail in my thesis.

REFERENCES

[1]. Neil Fraser. Software Recog, open source VB-based software, available at http://neil.fraser.name/software/recog.

[2] Sajjad S. Ahranjany, Farbod Razzazi , "A Very High Accuracy Handwritten Character Recognition System for Farsi/Arabic Digits Using Convolutional Neural Networks"

Bio-Inspired Computing: Theories and Applications (BIC-TA), 2010 IEEE Fifth International Conference.

[3] Zhang Xinbo; Wu Lili; "Hand Written Digit Recognition Based on Improved Rate BP Algorithn", Information Engineering and Computer Science (ICIECS), 2010 2nd International Conference on Digital Object Identifier: 10.1109/ICIECS.2010.5678315 Publication Year: 2010 , Page(s): 1 - 4

[4] S. A. Husain, Asma Sajjad, Fareeha Anwar, "Online Urdu Character Recognition System", MVA2007 IAPR Conference on Machine Vision Applications, May 16-18, 2007, Tokyo, JAPAN

[5] JORMA LAAKSONEN , "Subspace Classifiers in Recognition of Handwritten Digits", Doctoral Thesis, Helsinki University of Technology Department of Computer Science and Engineering Laboratory of Computer and Information Science P.O. Box 2200

[6] Ping Zhang, "Reliable Recognition of Handwritten Digits Using A Cascade Ensemble Classifier System and Hybrid Features", Doctoral Thesis, Concordia University Montreal, Quebec, Canada April 2006 ©Ping Zhang, 2006.

[7]. Alexander J. Faaborg, Using Neural Networks to Create an Adaptive Character Recognition System,

March 2002, available at:

http://web.media.mit.edu/~faaborg/research/cornell/hci_neuralnetwork_finalPaper.pdf

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