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# Threshold optimization of Hopfield neural network to gain higher success rate for image recognition

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***ABSTRACT*** -Hopfield Neural Network takes decision on predefined threshold value. In this paper I have shown a new threshold derivation technique which reduce false pattern and increase the success rate of image recognition .

### General Terms

Optical character recognition, Hopfield network, Image correction, Threshold value deduction .

### Keywords

Threshold optimization, Image correction, Hopfield Network, Threshold value deduction, Threshold optimization.



## 1. INTRODUCTION

Hopfield network is very much effective for image correcting purpose. . It is also used for feature extraction of patterns [1] .It has been proved that Hopfield Neural network can store 15N pattern in the network where N is the number of neuron. But if the number of train set and image size increases the performance reduced due to two reasons

1. The stored patterns become unstable;

2. Spurious stable states appear (i.e., stable states which do not correspond with stored patterns).

That is why it is not suitable for pattern recognition purpose where we store large number of patterns in the network. It best works where number of stored pattern and the number of pixel are very less.

## 2. New threshold derivation algorithm

It has observed that if the number of test pattern and size of the matrix increase then Hopfield neural network produces false pattern. Thus Hopfield neural network is not suitable for pattern recognition.

New threshold derivation technique reduces the false pattern and increase the success rate for large pattern size and large sate of training pattern

### 2.1 Concepts

The Hopfield net consist of a number of nodes , each connected to every other node

[2 3] . It is fully connected network .It is also a symmetrically weighted network,
The weights on the link from one node to another are same in both directions. This network have matrix of weight [4] a

$$W=1/n \sum_{i=1}^{D} \xi_i^T \xi_i$$

Where D is the number of class patterns { $\xi_1 , \xi_2 \ldots\ldots\ldots \xi_D$ }, vectors consisting of +/-

elements to be stored in the network, and n is the number of components, the dimension, of the class pattern vectors.

The update function for nodes in a Hopfield network, given below

$$\sum_{J \neq k} W_{ij}\, \mathbf{x}_i \begin{cases} >0 \; x_i \rightarrow +1 \\ =0 \text{ remains in previous state} \\ <0 \; x_i \rightarrow -1 \end{cases}$$

Here k is the number of test patterns and j is the row number of weight matrix and jth test pattern has chosen from the k number of patterns.

The threshold value is taken here is '0' .
. In this case, the weights of the connections between the neurons have to be thus set that the states of the system corresponding with the patterns which are to be stored in the network are stable.
I have constructed a HNN classifier according to the Hopfield theory.

I have consider the bipolar value to prevent data loss.
I have multiplied Pattern Matrix array value with 2 and then a subtraction has done by 1 to make the input data bipolar. Bipolar simply is a representation of binary string with –1's and 1's rather than 0's and 1's. This is done because binary has one minor flaw. Which is that 0 is not the inverse of 1. Rather –1 is the mathematical inverse of 1.

### 2.2 Algorithm

Step-1: $Z_i = w_{ji} * X_{ki}$ for i=0 to number neuron
K is pattern number

Step-2: Low =$|Z_{low}|$
High=$|Z_{high}|$
$X$=low+ high

Step-3: Boundary value calculation
For v= 1 to n
$P_v = X/2^v$ while $2^v < X/2$

**Threshold assignment for boundaries**

Step-4:
For all ( $-P_{2n+1}$ to $-P_{2n+2}$) values the $X_{ki}$ =1 and ( $-P_{2n}$ to $-P_{2n+1}$ ) values $X_{ki}$=0 .while n= 0 to X

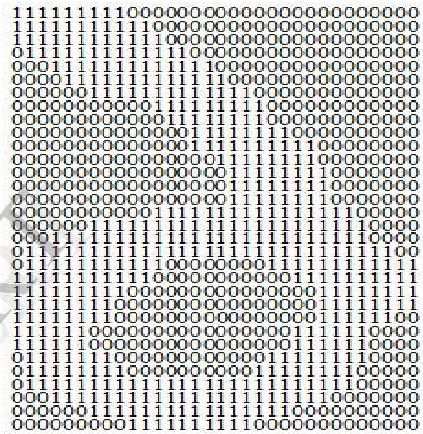
Step-5:
For all ( $P_{2n+1}$ to $P_{2n+2}$ ) values the $X_{ki}$ =0 and ( $P_{2n}$ to $P_{2n+1}$) values $X_{ki}$=1 .while n= 0 to X

Step-6:
And the value of $X_{ki}$ remain unchanged if the value of $X_{ki}$ matches with the randomly chosen ¼ th numbers of $Z$ value ..

### 2.2.1 Train phase

I have used binarized Bangla numerals in a minimum bounding box and normalized into 32 × 32 pixels .

Then I have trained both network with the Bengali digit 1,2 and 3



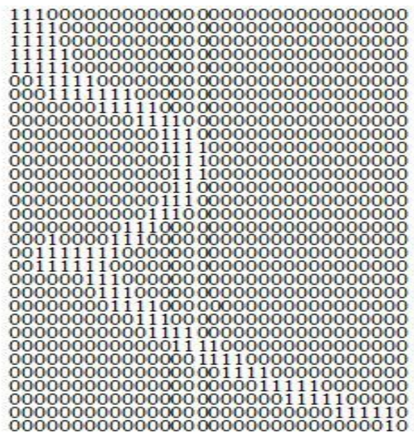


**Fig 2.Binary representation of the Numeric image 1and 2**

### 2.2.2 Test phase

I have tested both type network with a corrupted image of digit 1 and 2

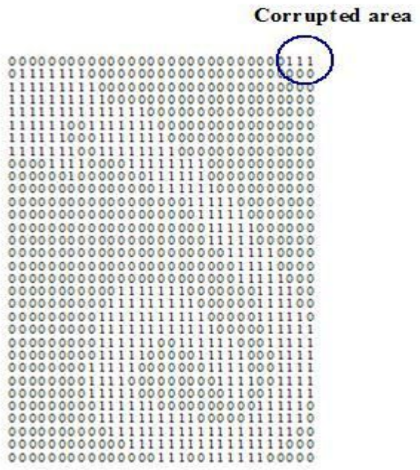



**Fig 3. Binary representation of the Test image**

## 3. TEST RESULT

**Case 1**

When I am taking threshold 0 for 8*8 pixel Image With number of different 10 patterns and number of train set 10 Hopfield neural network success fully recognize the test image with no false state . New Threshold optimization algorithm also recognize test image success fully with no false state.

**Case 2**

When I am taking threshold 0 then for the 32 * 32 Image with number of different 1 pattern and number of train set 5 then Hopfield neural net field to recognize test image with false state. But with new threshold values the network successfully recognize the test image .

**Case 3**

when I am taking threshold 0 then for the 32 * 32 image with number of different pattern 2 and number of train set 5 then Hopfield neural net failed to recognize the test image with false sate. but with new threshold values it success full to recognize.



## 3. CONCLUSION

**Image size – 8*8 Pixel**

| Threshold Value | Number of different pattern | Number of train set | Recognition result |
|---|---|---|---|
| **0** | **10** | **10** | **Successful** |
| **New value** | **10** | **10** | **Successful** |

**Image size – 32*32 Pixel**

| Threshold Value | Number of different pattern | Number of train set | Recognition result |
|---|---|---|---|
| **0** | **1** | **1** | **Failed with false pattern** |
| **New value** | **1** | **1** | **Successful** |

**Image size – 32*32 Pixel**

| Threshold Values | Number of different pattern | Number of train set | Recognition result |
|---|---|---|---|
| **0** | **2** | **5** | **Failed with false pattern** |
| **New value** | **2** | **5** | **Successful** |

New threshold optimization technique reduces false pattern and increase the success rate for large image size and training set.

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## 8. REFERENCE

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