SELF ORGANIZING FUZZY NEURAL NETWORK
AN APPLICATION TO CHARACTER RECOGNITION

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ABSTRACT

Character recognition is a very important field in DSP. Many different methods are used for this purpose. The ANN technique based on back propagation algorithm is very slow as its computational complexity is very high. On the other hand the Self-orthogonal ANN offers less computational complexity but it is not able to deal with the uncertainty associated with the input data sequence. Hence, fuzzy logic is applied in this case. The fuzzy logic based self-orthogonal neural network has been applied to the scale changed and distorted characters only. The problem of invariance to rotation has been discussed using the four layered feed forward fuzzy neural network.

1. INTRODUCTION

Artificial Neural Network (ANN) is a massively parallel structure consists of several computing elements which are connected to each other through the weights. A Neural Network (NN) is a trainable non-linear system which stores patterns with distributed coding. ANN finds extensive application in the field of hand written character recognition problems [3, 6, 7]. Recently NN has been used to the pattern recognition problem where the input patterns are shifted in position and scale changed. Many researchers have developed the neural pattern recognition systems which are trained by the back propagation algorithm which can also be applied to recognize the rotated patterns. In this case the algorithm has two phases, the first phase is the training phase where all the weights of the network are free parameters and they are adaptively adjusted according to the given input pattern during training. In the testing phase, if the testing pattern has any similarity with any of the trained pattern then the network can recognize that pattern else for any pattern other than the trained patterns is fed to the network as testing pattern then the network has to be relearned. Hence the computational complexity associated with this type of network is very high.

Carpenter and Grossberg [1] developed the self-organizing system which does not perform satisfactorily due to the formation of many noisy exemplars. In recent years fuzzy logic has been reported a very effective tool for pattern recognition. Some work has been carried out on fuzzy neural system for pattern recognition[4, 5]. Kwan et. al. [3] have developed a four layered fuzzy neural network and applied this to the pattern recognition problem where the input pattern is shifted, distorted and scale changed form of the original pattern.

In this paper the self organizing fuzzy neural network has been applied to the problem of invariance to rotation using the four layered feed forward fuzzy neural network proposed in [3]. Unlike the existing BP based technique the fuzzy neural network does not require iterative learning procedure. In this technique the network first of all fuzzyfies the given input pattern. The network can directly code the fuzzy input pattern to a neuron. After coding all the desired patterns the, in the testing phase if the given test pattern has any similarity with any one of the coded patterns then the network can easily identify the pattern and if it has no similarity with any one of the coded pattern then the network treats it as a new pattern and code it to another neuron which is provided in the structure. Hence in this case no relearning of the network is required. In this paper we have also compared the no. of operations with that of the existing back propagation (BP) neural network. It is observed that the proposed technique offers significantly less no. of computations compared to the BP based algorithm. Thus the proposed technique will be preferable for on-line implementation. The organization of the paper is as follows. In Section II the algorithm pertaining to self organizing fuzzy neurons is outlined. In Section III the special features of the proposed network has been depicted. The details of the simulation study is given in Section IV. The concluding part of the simulation is presented in Section V.

2. ALGORITHM FOR SELF ORGANIZING FUZZY NEURONS

Non-negative signals often describe the competitive status of the neurons “competing” in a lateral inhibitory neuronal field. Here each neuron excites itself and the near neighbors and inhibits distant neighbors. The neurons
neuron represents the pattern rotated by 60° and the third one represents the 210° rotated pattern. But when \( T_f = 0.1 \) for all the twelve testing patterns the network needs twelve neurons in the third and fourth layer, since the system doesn't find any similarity between the trained patterns and the testing patterns. As \( T_f \) increases the no. of neurons in the third and fourth layer decreases. For \( T_f = 0.7 \) the network requires only two neurons in the output layer and also in the previous layer, one for the erect T pattern and the other one for the pattern rotated by 210°. But if we change the value of \( T_f = 0.75 \) then only one neuron is required in the last two layers. This proves that the network is invariant to rotation.

Table 1. shows that as the value of \( \alpha \) changes for different values of \( T_f \) then the no. of neurons required in the third and fourth layer changes. The system is invariant to rotation when \( \alpha = 1.5, \beta = 0.02, T_f = 0.75 \), and \( \alpha = 2.0, \beta = 0.02, T_f = 0.95 \). \( \alpha = 2.0, \beta = 0.02, T_f = 0.65 \) i.e. one neuron is required in the last two layers. Similarly in Table 6.6. when \( \alpha = 2.0, \beta = 0.01, T_f = 0.35 \) and \( \alpha = 2.0, \beta = 0.02, T_f = 0.65 \) the network is invariant to rotation. But for \( \alpha = 2.0, \beta = 0.03 \) the network is not invariant to rotation for all values of \( T_f \) lying between 0 and 1.

### Table 6

<table>
<thead>
<tr>
<th>( \beta )</th>
<th>( T_f )</th>
<th>Total No. of Training Pattern</th>
<th>No. of FN in 3rd &amp; 4th Layer</th>
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<tbody>
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<td>5</td>
</tr>
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<td>3</td>
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<td>0.3</td>
<td>12</td>
<td>1</td>
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<td>0.02</td>
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<td>12</td>
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<td>12</td>
<td>4</td>
</tr>
</tbody>
</table>

### 5. CONCLUSION

In this paper we have shown that the four layered feed forward fuzzy neural network provides invariant to rotation. The special feature of this network is that it can learn new additional patterns at any time without relearning the previously learned patterns and also it can predict the angle of rotation of a rotating object. This type of NN involves very less no. of computations as compared to the supervised learning algorithms. Hence it provides rapid learning and this may be applied to real time environment. The invariance to rotation property finds extensive applications in recognizing rotating objects, in case of pattern recognition problems, space craft orientation problems and in many other fields.

### 6. REFERENCES:


