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Neural Network Algorithm for Radar Signal Recognition

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Abstract
Nowadays, the traditional recognition method could not match the development of radar signals. In this paper, based on fractal theory and Neural Network, a new radar signal recognition algorithm is presented. The relevant point is extracted as the input of neutral network, and then it will recognize and classify the signals. Simulation results show that, this algorithm has a distinguish effect on classification under the condition of low SNR.
Keywords: Signal Recognition; Fractal Theory; Neural Network

I. INTRODUCTION

Radar signal recognition based on traditional feature parameters would not afford the request, and a much more careful and effective feature is needed for recognition.
Fractal theory has been widely used in the fields of seismic wave detection and image processing, which can describe the complex and irregular degree of signals. Hausdorff Dimension is a basic fractal dimension in the theory, however, it brings out difficulties in the calculation. Relevant dimension can calculate the relevant of different sample points of signals' internal . It is able to extract the character of radar signals much more accurately. Therefore, in this paper, the relevant dimension feature of radar signals has been extracted and Neutral Network is used to classify the modulation type of radar signals. [2 ,3 ,4]

II. NEURAL NETWORKS

Neural networks are composed of simple elements operating in parallel. These elements are inspired by biological nervous systems. As in nature, the network function is determined largely by the connections between elements. We can train a neural network to perform a particular function by adjusting the values of the connections (weights) between elements. Commonly neural networks are adjusted, or trained, so that a particular input leads to a specific target output. The network is adjusted, based on a comparison of the output and the target, until the network output matches the target. Typically many such input/target pairs are used to train a network.. A Matlab package is used for accomplishing the neural network algorithm.
Neural networks have been trained to perform complex functions in various fields of application including pattern recognition, identification, classification, speech, vision and control systems. Today neural networks can be trained to solve problems that are difficult for conventional computers or human beings. Throughout the toolbox emphasis is placed on neural network paradigms that build up to or are themselves used in engineering, financial and other practical applications. The supervised training methods are commonly used, but other networks can be obtained from unsupervised training techniques or from direct design methods. Unsupervised networks can be used, for instance, to identify groups of data. We do not view the Neural Network Toolbox is simply a summary of established procedures that are known to work well.
The computer Matlab program gets the radar signals as input data. The data get processed in order to obtain the recognition .

III. III . METHODOLOGY

The poor self-adaption of traditional classifier could hardly satisfy the request of recognition effect even in the complex circumstance. The Neutral Network gives us a method of classifier design.
The process of Neutral Network can be summarized as below:
Suppose the input pattern vector as:

$$A_k = (a1, a2, \ldots\ldots, an) \quad , \quad k = 1, 2, \ldots\ldots m \qquad \ldots\ldots\ldots(1)$$

Where ; m = learning model component; n = input layer unit number.

The expected output in response to the input pattern is:

$$Y_k = (y1, y2, \ldots\ldots, yq) \qquad \ldots\ldots\ldots\ldots\ldots..(2)$$

q = output layer unit number.
We calculate the input of middle layer units:

$$S_j = \sum_{I=1}^{n} (\omega_{ij} a_i - \theta_j) , j = 1,2,.....p$$

……..(3)

Where ; ωij = connection weight between input layer and middle layer;

θj = threshold of middle layer unit;

p = number of middle layer units.

Taking Sj as function (Sigmoid function), we calculate the output of every unit in middle layer.

$$b_j = f(S_j) = \frac{1}{1 + e^{-S_j}}$$

…..….(4)

Where ; bj = motivate value of the unit in the middle layer.

In the same way, we could get the input and output of every unit in the output layer

$$L_t = \sum_{j=1}^{n} (v_{jt} b_i - Y_t)$$

……..…….(5)

$$C_t = f(L_t) = \frac{1}{1 + e^{-L_t}} , t , t = 1,2,.....q$$

……...(6)

Where ; vjt = connection weight between middle and output layer .

Yt = unit threshold of output layer.

Neutral Network does excellent in pattern recognition and self-adapt to the environmental change, and what is more, it can handle complex non-linear recognition problem well. It is always used in the design of signal classifier which benefit from the stability.

IV. RESULTS

The neutral net is trained for recognition. The recognition rate is as shown in figure (1). Here we take four kinds of radar signals which are FSK, PSK, LFM and CSF, extract their relevant dimension characters.

For the four kinds of radar signals, a 10 samples were extracted and 5 samples were taken as training samples and the else as testing samples. Then we got 20 training and 20 testing samples as input of neutral network. The input layer of neutral network has 4 units which are accidently to be the number of output layers, and units of hiding layer are set to be 3. The result in figure (1) suggests that we have got a better recognition rate when SNR is larger than (-5db), and even a perfect 100% recognition rate. So, it has been testified that this radar signal recognition algorithm has got a good effect on classification based on relevance curve feature and NNs.

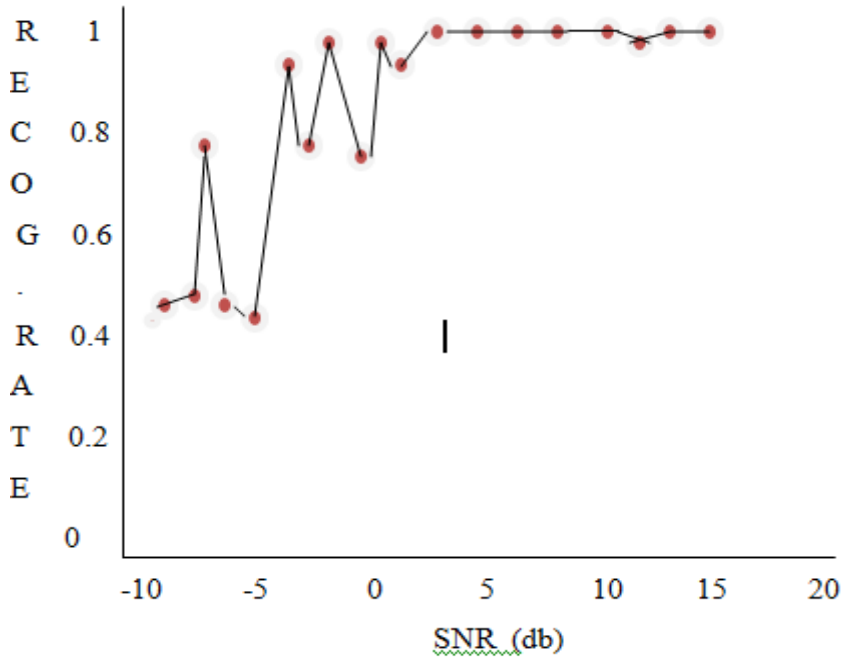

Figure (1). The recognition rate of radar signals in different SNR

The radar signals are used as an input . The output from the neural network is the radar signal recognition., Training the neural network is performed by the Matlab package.
The number of epochs assumed is equal 40 as shown in equation (7).

Net.trainParam.epochs = 40 …….(7)

Training is performed by equation (8).

[net.tr] = train [net , p , t] ……(8)

Where ; p = input , t = target

V. CONCLSION

This paper has been exhibiting a radar recognition algorithm based on relevance feature and neutral network. It adopts a concept to design a system that acts as a platform to feed radar signals to the neural network and use its output for signal recognition . Since the relevant feature extracted has a poor linear character, the paper gave out a new method to regard the points of relevance curves as feature vectors which are the input of neutral network. Simulation analysis shows that the method has got a high recognition effect, and a high recognition rate when SNR is larger than (-5db).

There are a variety of kinds of design and learning techniques that enrich the choices that a user can make.. The system design is dynamic and further development and modification can be done .

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