ANALYSIS OF THE POSSIBILITIES OF USING NEURAL NETWORKS TO CONTROL THE SYSTEM OF SOFTWARE DEFINED RADIO

Hula I. V.
Khmelnitsky National University, Instytutska St. 11, Ukraine
E-mail: holmenetwork@gmail.com

Nowadays, there are a number of approaches to solving the problem of automatic recognition of digital modulation types, among which the most universal is the approach based on artificial neural networks(ANN). Among a large number of neural network approaches, the most important is multilayer neural networks, a multilayer perceptron that is used in this article to recognize types of digital modulation [1,2,3].

To use the ANN, it must first be trained. Training of the ANN is performed by supplying its input with features that characterize a specific type of modulation, specifying the type of modulation (teacher's instructions), for example, its number in the list of recognized modulation types, and then correcting the ANN memory. For training, databases for the input of the ANN and teacher's instructions corresponding to this input are used.

The modeling of the system for recognizing types of digital modulation is performed in the Scilab environment using Scilab Application Toolboxes [4, 5].

The training process is performed offline, the maximum number of epochs is 1000. The training algorithm is TRAINSCG (scaled gradient method). The parameters of the neural network are shown in Table 1.

Table 1.

Basic parameters of a neural network

Number of layers	2
Number of inputs	17
Number of neurons in the hidden layer	500
Number of neurons in the output layer	8
Maximum number of epochs	1000
Activation function in the hidden layer	Sigmoidal
Activation function in the output layer	Sigmoidal

To test the trained neural network, 6 cumulative feature databases were created. For this purpose, similarly to the creation of the training database, 1200 transmitted information signals (on average, 150 signals for each of the 8 types of digital modulation) were generated for each database and further subjected to the appropriate types of modulation.

Table 2 shows a summary comparative analysis of the test results for the first 4 test databases. The test results are given for all types of digital modulation considered in this paper at different variants of the set of OFDM signal parameters.

Table 2.

Summary results of recognition of digital modulation types in the presence of noise in the communication channel (in percent)

The type of modulation	Test database numbers			
	№ 1	№ 2	№ 3	№ 4
2-PSK	100	100	100	100
4-PSK	100	100	100	100
8-PSK	100	100	100	100
2-FSK	100	100	100	100
8-QAM	100	100	100	100
16-QAM	98,17	99,34	100	100
64-QAM	97,81	99,35	98,10	97,65
OFDM	99,30	100	100	100

Table 2 shows that the use of cumulative features in the trained multilayer neural network made it possible to recognize all the studied types of digital modulation in noise conditions with a probability close to one.

Regardless of the probability density of the noise in the communication channel, the law of error distribution in the IQ data becomes close to normal. This fact is another important argument for the use of cumulative features in the task of automatic recognition of digital modulation types.

Further research can be aimed at expanding the set of high-order cumulative features used, which can increase the probability of correct recognition of digital modulation types, and solving the recognition problem when the frequency and initial phase of the carrier signal are unknown.

References

1. Marko, M. R. Application of artificial neural networks in classification of digital modulations for software defined radio / M.R. Marko, M.N. Aleksandar, J.N. Natasa // IEEE EUROCON 2009. - P. 1700 - 1706.

2. Taira, S. Automatic classification of QAM signals by neural networks / S. Taira // Acoustics, Speech, and Signal Processing (ICASSP '01), 2001. -Vol. 2. - P. 1309 - 1312.

3. Young, A. F. Classification of digital modulation types in multipath environшents /A.F. Young // Master's Thesis. Naval Postgraduate Schoo1, Monterey, CA 93943-5000, California. June 2008. P. 1 - 65.

4. Hula I.V. Research of neural networks for controlling the Software Defined Radio system / Hula I.V., Polikarovskikh O.I. // Herald of Khmelnytskyi national university. - 2021. - №6. - P. 150-156

5. Dassault Systemes [online] Available: https://www.scilab.org/