International Journal of Advanced Research in Computer and Communication Engineering
Vol. 3, Issue 6, June 2014

ISSN (Online) : 2278-1021
ISSN (Print) : 2319-5940

Adaptive Modulation of OFDM by using Radial Basis Function Neural Network

Parminder Kaur[1], Kuldeep Singh[2], Hardeep Kaur[3]

M.Tech Student, Department of Electronics Technology, Guru Nanak Dev University, Amritsar, India[1]

Assistant Professor, Department of ECE, Regional Campus Guru Nanak Dev University, Sulatnpur Lodhi, India[2]

Assistant Professor, Department of Electronics Technology, Guru Nanak Dev University, Amritsar, India[3]

Abstract: Adaptive communication is one of the methods used for high rate communication with efficient spectrum efficiency and with improved accuracy for future wireless communication systems. In this paper, we propose an adaptive modulated Orthogonal Frequency Division Multiplexing (OFDM) system based on Radial Basis Function (RBF) and then their performance (MSE) and classification accuracy is evaluated according to the number of neurons in the RBF network. Radial basis function (RBF) network which learns the features of M-QAM signal before reconstructing the correct signal under noisy conditions.

Keywords: Adaptive Modulation, Orthogonal Frequency Division Multiplexing (OFDM), Radial Basis Function Neural Network (RBFNN), Mean Square Error (MSE), Classification Accuracy.

I. INTRODUCTION

Adaptive Orthogonal frequency-division multiplexing (AOFDM) is a powerful system for high rate transmission channels.OFDM has been developed in the many fields for example the digital audio broadcasting (DAB), asynchronous digital subscriber line (ADSL), digital video broadcasting (DVB), and wireless local area network (WLAN). The main advantage of OFDM is to split the wide band signal into a large number of independent narrow-band sub channels and it allows the orthogonal overlapping between each subcarrier.

The performance of wireless communication system improves according to the SNR, BER and by adjusting transmission parameter like modulation order. Transmission parameters of each subcarrier of OFDM are changed by applying the adaptive transmission to the OFDM system. Adaptive modulation is evaluated by using adaptive quadrature amplitude modulation schemes which provides better performance than fixed modulation systems for different channels [1].

In OFDM system by using the adaptive modulation with code rate which maximizes the total capacity and provides proper service for each user according to transmit power and channel conditions by maintaining the transmission's quality of service (QoS) at the receiver side [2].

The throughput of an OFDM system is improved by adding adaptive modulation (AD) with turbo coding. Each OFDM block is independently modified according to channel state information (CSI) [3].The performance of OFDM system under different environment such as Ricean fading & Rayleigh fading with AWGN by using neural network which is better than the conventional channel equalizer structures [4].The radial basis function network is one of the most used neural network models and is useful for approximating continuous functions. They have been used for channel equalization .RBF equalizers with MMSE have shown better performance than the ones with LS. RBF networks can also be used for channel estimation, considering the anti-noise property of the RBF networks [5].Neural network helps to improve the performance of

OFDM system [10].MSE can be reduced by using BPNN algorithm for OFDM systems [11].

The paper is organized as follows: Section II describe OFDM system model, Section III describe radial basis function networks (RBFN), the implementation and results are given in Section IV. Section V presents the conclusion.

II. OFDM SYSTEM MODEL

Orthogonal Frequency Division Modulation (OFDM) is one of the current modulation techniques used to conflict the frequency-selectivity of the transmission channels, by achieving high data rate without inter–symbol interference (ISI) [6]. OFDM is an advance technique that removes the necessity of very difficult equalization.

In a conservative serial data system, the codes are transmitted sequentially with the frequency spectrum of each data allowed to take up the entire available bandwidth. There are more chances that the frequency selective channel response disturbs in a very distinguishing manner the different spectral constituents of the data symbol, hence presenting the inter symbol interference (ISI) [7].

The performance of Bit error rate and spectral efficiency of various modulations like QPSK, MQAM is analyzed and then compared with the fixed modulation technique, result shows adaptive modulation is better than the fixed modulation [8].

A neural network is a mathematical tool that can simplify a relationship between input and output data of a system. In this paper we propose that the performance of adaptive modulation of OFDM system can be improved with the help of RBF neural network (RBFNN).

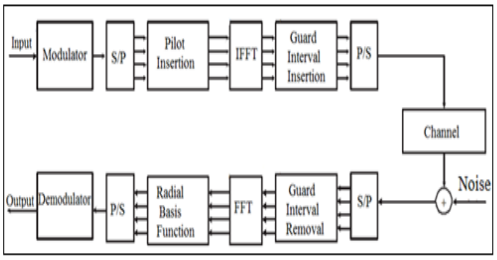

Figure 1: Block diagram of OFDM by using RBFNN

III. RADIAL BASIS FUNCTION NEURAL NETWORKS (RBFNN)

Radial Basis Function Neural Network is a Multilayer Feed Forward neural network which contains three layers: input layer, hidden layer and output layer. Radial Basis Function Neural Network uses radial basis functions as activation functions for each hidden layer of the network [9]. The output of RBFNN is weighted linear superposition of this radial basis functions. The main features of RBF are:

- They are two-layer feed-forward networks.
- The hidden nodes employ a set of radial basis functions (e.g. Gaussian functions).
- The output nodes employ linear summation functions as in a multi layer perceptron (MLP).
- The training of the network is divided into two parts: first the weights from the input layer to hidden layer are calculated, and then the weights from the hidden layer to output layer are calculated.
- The training of weights is very fast process.
- So, due to the better approximation abilities, simple network structures and faster learning algorithms, RBF neural networks have been broadly used in many science and engineering applications.

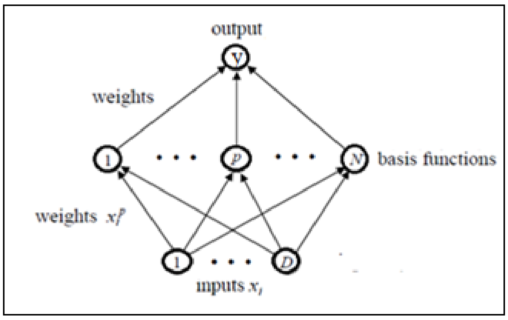

Figure 2: Radial Basis Function Neural Network

The *N* training patterns {xi *p, tp}* determine the weights directly. The hidden layer to output weights multiply the hidden unit activations in the conventional manner, but the inputs to hidden layer weights are used in a very different fashion.

IV. IMPLEMENTATION AND RESULTS

In this research work ,we have analyzed performance of adaptive modulation of orthogonal frequency division multiplexing (OFDM) by using Radial Basis Function Neural Network (RBFNN) ,in this RBF is trained by using manual data, which includes signal to noise ratio (SNR),Bit Error Rate (BER), Present Modulation (PM), Code Rate (CR) as inputs and Adaptive Modulation (AM) as output. This manual data is created by using FIS tool of MATLAB R2009b.In this manual data rules are edit which contains different values of SNR,BER,PM,CR and AM parameters.

That manual data contains total 2100 samples out of which 2000 samples are used for training for the RBF and remaining 100 are used for testing of the RBF . MATLAB R2009b is used to develop RBFNN program. Below the table shows the values of the Training Time, Mean Square Error (MSE) and Classification Accuracy according to the variation of the no. of neurons in the RBF program. So, this table shows the performance of the manual data of the adaptive orthogonal frequency modulation (AOFDM) system which is created and then used to train and test the RBF network.

Table 1: Values of the Training Time, MSE, and Accuracy with the variation of Neurons

Sr.No.	No. of Neurons	Training Time (Minutes)	MSE	Accuracy %
1	50	0.18	0.06827	30
2	100	0.36	0.05587	37
3	150	0.55	0.03966	58
4	200	1.30	0.02874	75
5	250	2.31	0.02278	79
6	300	4.50	0.01976	86
7	350	5.40	0.01877	87
8	400	7.27	0.01705	88
9	450	10.28	0.01660	88
10	500	11.15	0.01649	89

From the above experimental implementation during the training and testing of RBF, we can analyze:

- As the number of neurons in the RBF network increases, the MSE decreases, thus it improves the performance of the overall system.
- As the no. of neurons increases, the time taken to train and test the RBF is also increases.
- As the no. of neurons increases the overall accuracy of the system is also increases.
- As the number of training epochs increases, the error is minimum.

Training and testing determine the most suitable variables for this network, working on this particular dataset. The performance of the RBF is analyzed in terms of its mean-squared error (MSE).

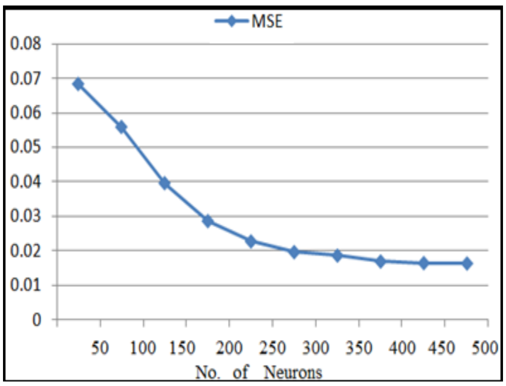

Figure 3: MSE vs No. of Neurons

ISSN (Online) : 2278-1021
ISSN (Print) : 2319-5940
International Journal of Advanced Research in Computer and Communication Engineering
Vol. 3, Issue 6, June 2014

Figure 3: This graph shows by increasing the no. of neurons, the MSE of the system decreases which further improves the performance of the system. So, for the no. of neurons of 500, it provides minimum MSE of 0.01649.

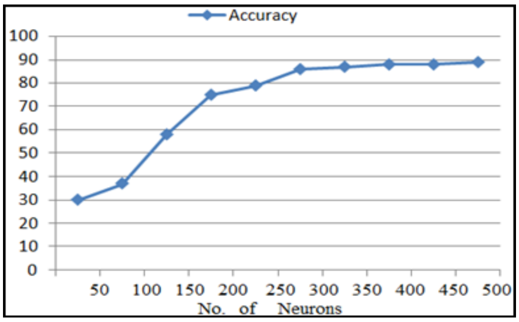

Figure 4: Accuracy vs No. of Neurons

Figure 4: This graph shows that as by increasing the no. of neurons, accuracy of the system increases. So, for no. of neurons of 500, it provides maximum accuracy of 89%.

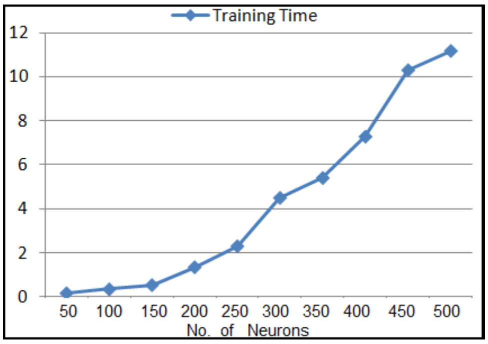

Figure 5: Training Time vs No. of Neurons

Figure 5: This graph shows the variation of time with no. of neurons, as by increasing the no. of neurons training time is also increases. So, for the no. of neurons of 500 it takes maximum time of 11.15 minutes.

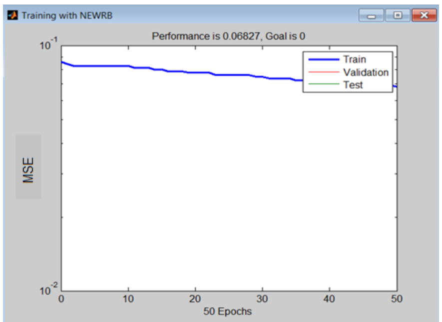

Figure 6: Performance for 50 Neurons

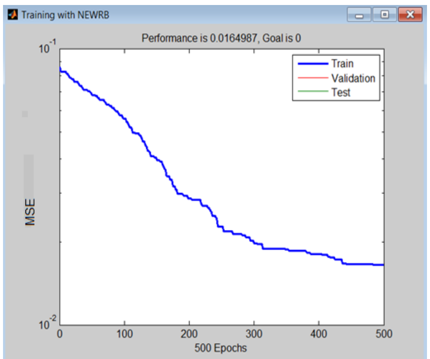

Figure 7: Performance for 500 Neurons

The Figures 6 and 7 shows that Mean Square Error (MSE) of the RBF neural network for 50 and 500 neurons, MSE for 50 neurons is 0.06827 and it becomes decreases to 0.0164987 for 500 neurons. It results by increasing the no. of neurons, MSE is decreases.

V. CONCLUSION

This paper proposed the performance analysis of Adaptive Modulation of OFDM based on RBF neural network .From all the above result,we can analyzed that by increasing the no. of neurons,MSE decreases and classification accuracy increases which improves the overall performance of the OFDM system. So, we can see for 500 neurons it provides 89% accuracy with minimum MSE of 0.01649 at the training time of 11.15 minutes.RBF provides more classification accuracy as compare to the BPNN for OFDM system. So, it helps to choose the best modulation according to the different channel variations. RBF neural network helps to enhance the performance of the OFDM system.

REFERENCES

[1] Arne Svensson"An Introduction to Adaptive QAM Modulation Schemes for Known and Predicted Channels" - Proceedings of the IEEE on Adaptive modulation and transmission in wireless system Vol. 95, No. 12, December 2007
[2] Jaek young Moon and Sangjin Hong "Adaptive Code-Rate and Modulation for Multi-User OFDM System in Wireless Communications" - IEEE transaction on Vehicular Technologyvol.4, pp-1943-1947, 2002
[3] Sami Ahmed Haider and Khalida Noori-"Adaptive Turbo Coded OFDM" -Journal of Digital Information Management Volume 5, Number 6 December 2007
[4] Aldar, Dilip S., and B. B. Godbole. "Performance analysis of neural network based time domain adaptive equalization for OFDM." International Journal of Recent Trends in Engineering 2.4 (2009): 143-147.
[5] Cha and S. Kassam, "Channel equalization using adaptive complex radial basis function networks," IEEE Journal on Selected Areas in Communications, vol. 13, no. 1, p. Jan., Jan. 1995.
[6] B. Sklar, Rayleigh Fading Channels in Mobile Digital Communication Systems- Part I: Characterization, IEEE Commun. Mag., July 1997
[7] J.G. Proakis, Digital Communications, McGraw-Hill, 1987
[8] Harivikram, T. S., et al. "Adaptive Modulation and Coding Rate for OFDM Systems."
[9] Satish Kumar, Neural Networks: A Classroom Approach, 6th edition, Tata McGraw – Hill Publishing Company Limited, New Delhi, 2008.
[10] Parminder Kaur,Kuldeep singh,Hardeep kaur, "Performance analysis of MIMO-OFDM system in 4G Technologies: A Review"-Journal of IMRF of engineering science Vol. 2,Issue 1,ISSN 2320-4338,March 2014.
[11] Parminder Kaur, Kuldeep singh, Hardeep kaur, "Adaptive Modulation of OFDM by using Back Propagation Neural Network (BPNN)"-International Multi Track Conference on Science, Engineering & Technical innovations, Vol. 1, June, 2014