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CHANNEL ESTIMATION OF OFDM BASED SYSTEM USING PILOT ASSISTED NEURAL NETWORKS

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Abstract

This paper uses Artificial Neural Network (ANN) for channel estimation in OFDM systems over AWGN fading channels. This technique utilizes the learning property of neural network. By using this feature, there is no need of any matrix computation and proposed technique is less complex. This technique is useful to achieving the high data rate, transmission capability with high bandwidth, efficiency and its robustness to noise. In OFDM system, the Channel estimation is an essential problem so the Pilot-aided channel estimation has been used; a good choice of the pilot pattern should match the channel behavior both in time and frequency domains. In this arrangement, the performance of the channel estimation is analyzed with estimators based on finding weights and biases of ANN are carried out through MATLAB Simulation and coding. The performance of OFDM is evaluated on the basis of Bit Error Rate (BER). The OFDM with ANN has been shown to perform much better than other channel estimators.

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Signal to noise ratio

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I. INTRODUCTION

OFDM is becoming a very popular multi-carrier modulation technique for transmission of signals over wireless channels. Now OFDM is widely used for high-speed communications over frequency selective channels. OFDM divides the high data rate stream into parallel lower data rate and hence prolongs the symbol duration, thus helping to eliminate Inter Symbol Interference (ISI). It also allows the bandwidth of subcarriers to overlap without Inter Carrier Interference (ICI) as long as the modulated carriers are orthogonal. Therefore OFDM is considered as an efficient modulation technique for broadband access in a very dispersive environment.

The frequency selective fading, is caused by multipath could lead to carriers used, being heavily attenuated due to destructive interference at the receiver. The result of this is the carriers being lost in the noise [1].To increase performance of OFDM system under frequency selective channels; the channel estimation is required before demodulation of OFDM signals [2]. The channel estimation is a process of characterizing the effect of the transmission medium on the input signal.

In OFDM system there are several techniques for channel estimation [2-14].Among these techniques; Block type Pilot based channel estimation technique is more popular. The Block type Pilot based estimation techniques can be based on Least-Square (LS). The LS estimators have low complexity.

In this paper, we propose an artificial neural network (ANN) based on channel estimation technique as an alternative to Block type pilot based channel estimation technique for OFDM systems over AWGN fading channels. The Simulation results show that ANN based on channel estimator gives better results as compared to Block type pilot based channel estimator and without ANN for OFDM systems over the AWGN fading channel.

II. FEED FORWARD ANN

Artificial Neural Network (ANN) is an interconnected group of artificial neurons. They uses a mathematical or computational model for information processing. In Feed Forward ANN a multilayer perceptron is used. For feed forward as the structure is parallel, the input/output relationship is given by the equation as:

$$Y = \Phi(W*X+b)$$

where X is a N by 1 vector of inputs, W is an M by N vector of weights, b is an M by 1 vector of biases, and Y is the M by 1 vector of outputs. The operator Φ(o) is the element-by-element activation function for each neuron. The architecture for Feed Forward ANN is as given bellow:

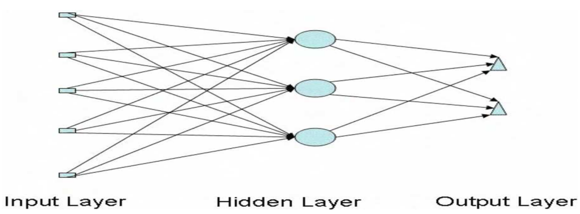

Fig 1 – Architecture of Feed Forward ANN

In fig, neural network with 5 inputs and 3 neurons in hidden layer and 2 outputs.

The Normal ANN used usually uses Back propagation algorithm in feed forward networks as learning algorithm to update weights and biases of the network when inputs are applied to the network. The Back propagation has a tendency to stick at local minima or maxima. Also the performance evaluated for the system under consideration show delayed convergence.

III. SYSTEM DIAGRAM

A. System with Channel Estimation using ANN

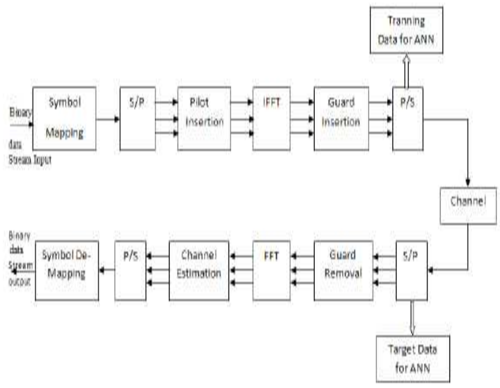

Figure 2 – Channel Estimation using ANN

The proposed system uses ANN with 4 pilots and 48 data symbols. The pilots were separated into real and imaginary part and then given as input to ANN. The total inputs to ANN were 8 (4 real and 4 imaginary). The outputs of the ANN were again 8 (4 real and 4 imaginary). Single hidden layer was used with 12 Neurons. The transfer functions used were log sigmoid to first 2 layers and linear to the output layer. The number of maximum iterations was 2000. The pilots were taken in the range [0 1] with offset of 0.125.

For training the ANN these pilots with 1e-06 imaginary part were simulated for signal to ratio from o dB to 10 dB. The received pilots were then stored and given as input to ANN separated into real and imaginary part.

The model used for training data is shown below,

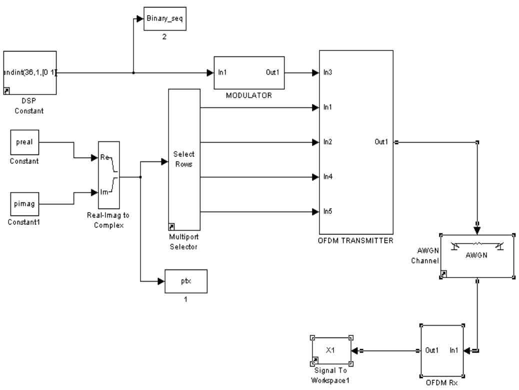

Figure 3 – Simulink model for data pilots for training ANN

The system parameters used were,

Table 1 – System parameters

Modulation	**BPSK**
OFDM	64
Pilots	4
Data Symbols	48
Code rate	¾
Frame Period	4e-04
Channel	AWGN

The total pilots transmitted were – 09.

[0 0.125 0.250 0.375 0.50 0.625 0.750 0.875 1].

Each pilot was simulated over SNR = 0 to 10 that is 11 times and the total period over which the system was simulated was 4e-04 that is for every pilot number of target pilots received was 5. The total combination for pilots used in 4 places was 24.

Therefore total input to ANN training was 9*24*11=2376.

B. The System for channel Estimation using ANN

The figure 3 shows the actual model for 802.11a WLAN system using the ANN block to channel estimation. The ANN used in the system was trained offline using MATLAB coding. The pilots transmitted were used as

Targets and the received pilots were used as the inputs to the ANN. The ANN used has 3 layers excluding inputs and outputs [8 12 8].

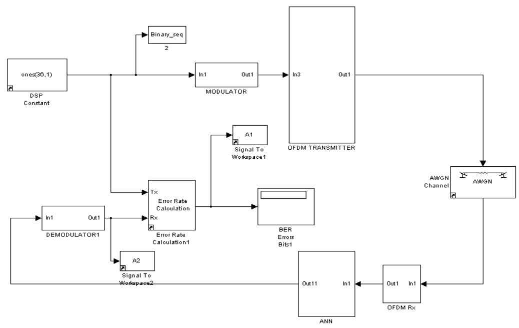

Figure 4 - System showing ANN block for Channel Estimate

The main problem was to estimate the data symbols. After OFDM demodulation the pilots were grounded. The ANN was trained for 4+4=8 inputs (4 real and 4 imaginary). The training was done in such a manner that all 24 combinations for 4 pilots were considered and the system was simulated.

The 48 data symbols were broken into group of four and 12 such block of ANN were utilized for estimating the data symbols. After estimation all the real and imaginary part was again combined and vertically concatenated to form 48 symbols and then fed to the receiver part of the system.

Transfer functions – [logsig logsig purelin]

IV. RESULTS

The graph shows the performance of the system without estimating the channel parameters.

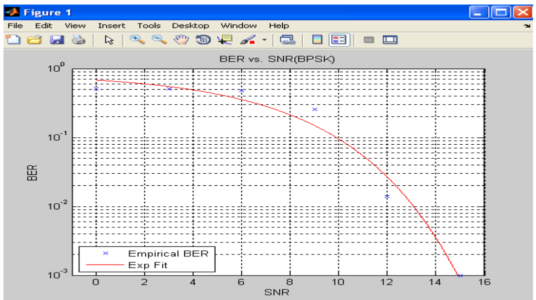

Figure 5 – Performance of BPSK-OFDM without channel estimation.

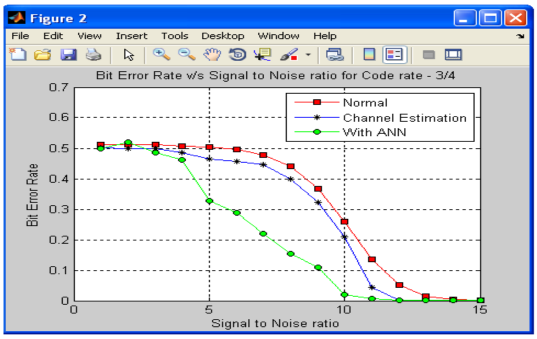

Figure 6 – Performances of BPSK-OFDM with and without channel estimation using ANN (Normal plot).

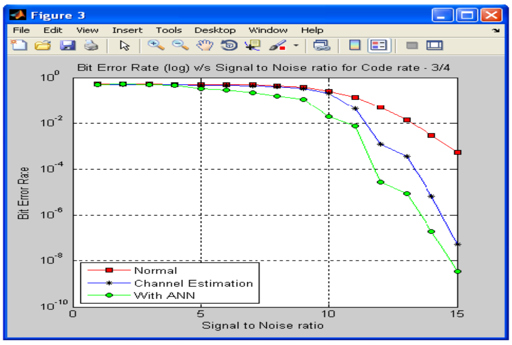

Figure 7 - Performances of BPSK-OFDM with channel estimation using ANN

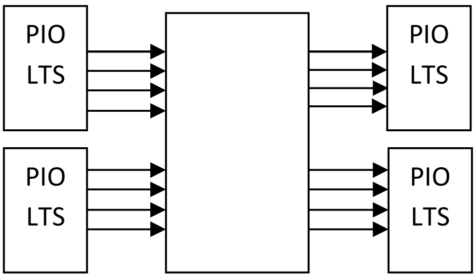

Figure 8 - Training for Neural Network

V. CONCLUSION

The performance of ANN for channel estimation for the OFDM based 802.11a WLAN using BPSK modulation with a code rate of ¾ was superior as compared to estimation by channel impulse response. Also the ANN showed early convergence and low BER for high noise.

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