International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 04 | Apr 2021 www.irjet.net p-ISSN: 2395-0072

MIMO-OFDM System's BER Performance Using NLMS Adaptive Channel Estimation Technique

Bishwrup Kumar Mandal[1], Prof. Gurpreet Singh[2]

[1]*Research scholar, Electronics & Communication Department, Trinity Institute of Technology & Research, Bhopal*
[2]*Professor, Electronics & Communication Department, Trinity Institute of Technology & Research, Bhopal*

---***---

Abstract - *An adaptive, blind multiuser detector with integrated channel estimation for digital wireless networks in binary phase shift key (BPSK) is developed and analyzed with normalized least squares (NLMS). The detector is iteratively formed from the received signals using the minimum output energy criterion. The greater the accuracy of the technique, the more accurate the system will perform. On this paper a robust adaptive channel approximation using the normalized least mean square (NLMS) method is proposed. This approach provides higher overall performance that can be judged from the performance of BER as compared to existing algorithms namely least squares (LMS) and recursive least squares (RLS).*

Key Words: *Least Mean Square (LMS), Adaptive Channel Estimation, Convergence Speed*

1. INTRODUCTION

Wireless devices such as smart phones, laptops, and tablets have become commonplace in today's communication systems. These devices are used for applications that need a lot of bandwidth, such as streaming HD video. Reducing the symbol rate is an obvious way to maximize bandwidth. This, however, causes Inter-symbol Interference (ISI) [1]. To address ISI, multichannel modulation techniques such as Orthogonal Frequency Division Multiplexing (OFDM) [1] may be used. Appendix-A provides an overview of OFDM. The benefit of OFDM is that it can be implemented quickly using the Fast Fourier Transform (FFT) algorithm. For the downlink of a Long Term Evolution (LTE) scheme, OFDM is the chosen modulation technique [2]. Relay-based systems are the subject of some of the most recent wireless communication studies. In LTE systems, relay-based communication is widely used [3]. Cooperative communication is another name for relay-based communication [4]. In wireless communication, direct communication between source and destination is not feasible, and there is a lot of shadowing and a wall effect on the destination time. If there is a third-party device or a dedicated relay between the source and the destination that has a low shadowing effect, this device may assist in data forwarding to the destination [5]. Multiple antennas are not possible in a wireless system such as a cell phone due to space constraints. To create diversity between interacting nodes, cooperative communication can be used. This is referred to as virtual MIMO. Another valuable benefit of relaying is that it helps to save power in communicating devices by assisting in data forwarding to the destination.

Due to its ability to provide high records charge, robustness to Inter Symbol Interference (ISI), and ease of implementation, OFDM is a notable modulation method in the current situation of wireless communication [6]. For coherent record detection, the channel facts are required at the receiver [1]. Consumer demands for high data rates in a noisy and congested environment have prompted researchers to investigate new strategies that could help meet those demands. Using multiple antennas at the transmitter and receiver ends is a viable choice for obtaining higher data rates in a fading environment. Multiple input multiple output (MIMO) combined with OFDM allows for higher data rates without requiring additional power or expanding bandwidth. The difficulty of encoders, high peak-to-average power ratio (PAPR), antenna design, equalization, channel estimation, and other issues plague MIMO-OFDM systems. To avoid excessive inter-modulation distortion, MIMO-OFDM signals with a high envelope fluctuation need highly linear power amplifiers. Equalization of the MIMO-OFDM signal is also essential to reduce the effect of ISI caused by channel delay spread.

2. SYSTEM MODEL

System model of the MIMO-OFDM system are shows in figure 1. In this figure, the transmit antenna are denoted by N_{Tx} and the receiver antenna are denoted by N_{Rx} of the MIMO-OFDM system model. The modulation block applies the input random binary sequence; this block converts the input sequence to binary. After that, the modulation's output is added to the encoder block, which divides all binary data into blocks and adds a parity check bit to each block. So, with the aid of a serial to parallel converter, eight by eight blocks are created and converted to an 8-point inverse Fast Fourier Transform (FFT). A scientific block diagram of ($N_{Tx} \times N_{Rx}$) MIMO-OFDM device is proven in discern 1, in which N_{Tx} and N_{Rx} are range of transmit and get hold of antennas, respectively. Using the quadrature segment shift keying (QPSK) modulation technique, the enter bit stream Nc sub-vendors is modulated into facts symbols. Figure 2 shows the transmitted QPSK file. Via an Alamouti's encoder, the modulated QPSK symbols are encoded and fed into an OFDM modulator. The output of the encoder is a code phrase matrix M with measurement of $N_{Tx} \times T$, where T is the quantity of symbols for each OFDM blocks such as Nc sub-channels.

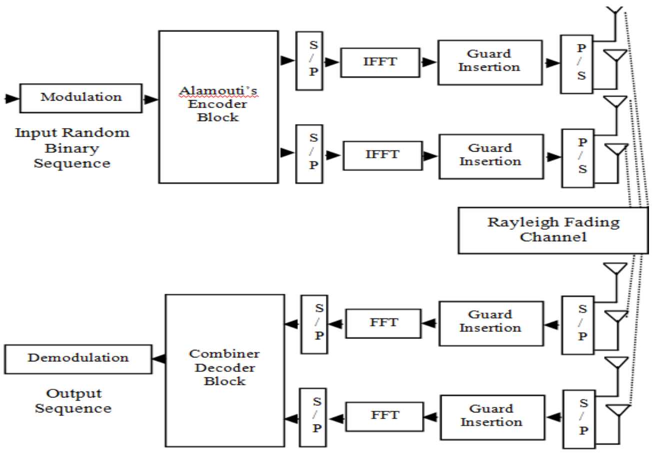

Fig -1: System Model of MIMO-OFDM system

The received signal at j^{th} antenna can be expressed as

$$R_j[n.k] = \sum H_{ij}[n,k]\, X_i\,[n,k] + W[n,k] \qquad (1)$$

In which H is the channel matrix, X is the input signal and W is noise with 0 suggest and variance. Also bi[n,k] represents the facts block i^{th} transmit antenna, n^{th} time slot and k^{th} sub channel index of OFDM. Here i and j denoted the transmitting antennas index and receiving antenna index respectively.

The equation of the MIMO-OFDM system model with number of transmit antenna N_{Tx} and number of receiver antenna can be given by as:

$$\begin{bmatrix} Z_1 \\ Z_2 \\ \vdots \\ Z_N \end{bmatrix} = \begin{bmatrix} H_{1,1} & H_{1,2} & \cdots & H_{1,NT} \\ H_{2,1} & H_{2,2} & \cdots & H_{2,,NT} \\ \vdots & \vdots & \ddots & \vdots \\ H_{NR,1} & H_{NR,2} & \cdots & H_{NR,NT} \end{bmatrix} \begin{bmatrix} A_1 \\ A_2 \\ \vdots \\ A_{NT} \end{bmatrix} + \begin{bmatrix} M_1 \\ M_2 \\ \vdots \\ M_{NT} \end{bmatrix} \qquad (2)$$

In Equation (2), the output data vector is defined by Z, the channel matrix is represented by H, and the input data vector and noise vector are represented by A, B, and M, respectively. The wireless channel used is AWGN channel. The OFDM transmitter perform N_c-points Inverse Fast Fourier Transform (IFFT) to every column of matrix M. Interference between the OFDM symbols are removed by cyclic prefix (CP) addition to each OFDM symbol, but it causes distortion in spectral efficiency.

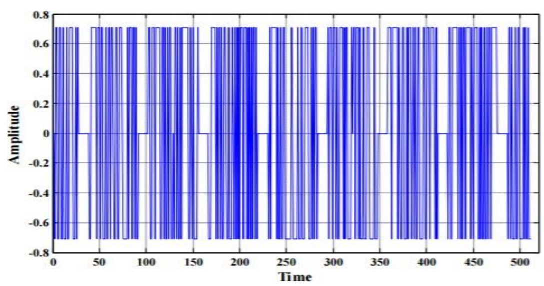

Fig -2: Transmitted QPSK symbol of MIMO-OFDM (N_{Tx} × N_{Rx}) system.

3. ADAPTIVE CHANNEL ESTIMATION

The aim of an adaptive clear out is to iteratively solve the imply rectangular optimization problem. Adaptive filtering keeps track of the device's statistical changes as well. The same old literature considers the various adaptive filtering algorithms to be unrelated. However, [9] demonstrates that this is not the case. It has already been established that any adaptive filter out can be considered an iterative Wiener-Hopf equation solver. The advantage of approaching adaptive filter out from this angle is that all of the unique adaptive filter out algorithms can be constructed and evaluated using a single framework. This theory is used to perform the consistent state analysis of the RLS filter constructed in this bankruptcy. Following that, our method can be applied to a variety of other popular adaptive filters, such as affine projection and LMS. The strength conservation approach [10] is the name given to this unified system for evaluation.

The extra the step length the more may be the convergence velocity. The time required by manner of way of the set of regulations to obtain the top-fantastic solution decreases therefore the regular country mistakes is reached. Even as if it'll growth an excessive amount of then there may be a threat that device can also turn out to be risky. If the case of recursive algorithms is visible we see that they will be now not depending at the step duration parameter, as a cease end result making them specific and fast estimators. However there can be a con in them i.e. they'll be very complex. Their complicated shape calls for extra hardware charge also. Even though they may be quicker than stochastic gradient set of hints however complexity marks them as unusable but now the situation is converting with the improved hardware structures in use.

Least Mean Squares (LMS) algorithms are a form of adaptive clean out that is used to imitate a chosen filter out by finding the clear out coefficients that are related to generating the error sign's least suggest squares (distinction among the favoured and the real sign). It's a stochastic gradient descent strategy in which the clean out is easiest adapted based on the error at the present time. The basic idea behind LMS clean out is to calculate the most accurate clean out weights (R-1 P), by updating the clean out weights in such a way that they converge to the top of the line filter weight [12]. The set of rules starts off evolved off evolved through assuming a small weights (zero in most instances), and at each step, via locating the gradient of the proposed rectangular errors, the weights are updated. That is, if the MSE-gradient is wonderful, it implies, the mistake would possibly keep developing certainly, if the identical weight is used for further iterations, because of this we want to lessen the weights.

Structure and Operation of NLMS:-

The normalized LMS filter is identical to the regular LMS filter in terms of constructional view, as shown in Figure 3. The transversal filter is the foundation of both filters.

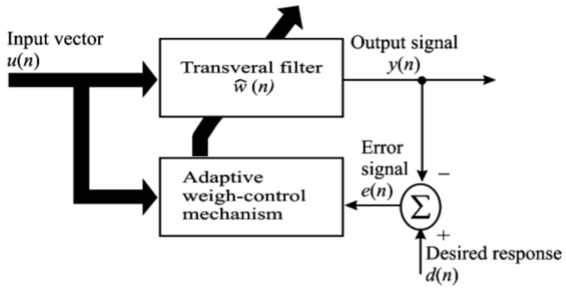

Fig -3: Block diagram of adaptive transversal filter

The normalized LMS filter produces minimal noise and can be described as follows: weight vector changes in straight weight changes step by step as iterations progress, and it is regulated by modified filter output and proposed values.

4. FLOW OF ALGORITHM

The MIMO-OFDM device was modified and applied using the MATLAB/SIMULINK software. Binary facts are used as the execution system, which are modulated using BPSK and mapped into the constellation components. The virtual modulation schema will transmit the records in parallel by assigning symbols to each sub channel, and the modulation schema will specify the phase mapping of sub-channels by using a complex I-Q mapping vector, as shown in figure 4. The complex parallel facts stream must be transformed into an analogue signal appropriate for transmission. The complex parallel data stream must be converted into an analogue signal appropriate for transmission over the transmission channel. Since the baseband signal does not overlap, the cyclic prefix is added to the baseband modulation signal. The signal is then split into two or more sections, depending on the requirements.

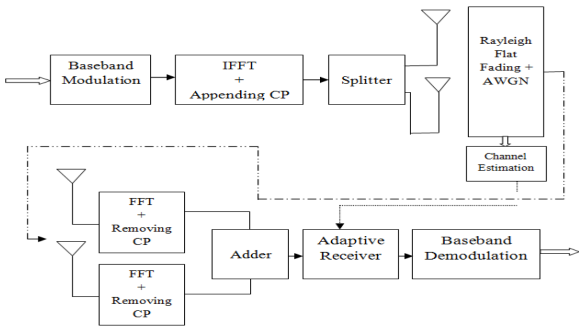

Fig -4: 2x 2 MIMO-OFDM System Models with Adaptive Filters

5. SIMULATION RESULTS

In simulations, the system is believed to be completely synchronized. SNR values of various magnitudes are used to assess results.

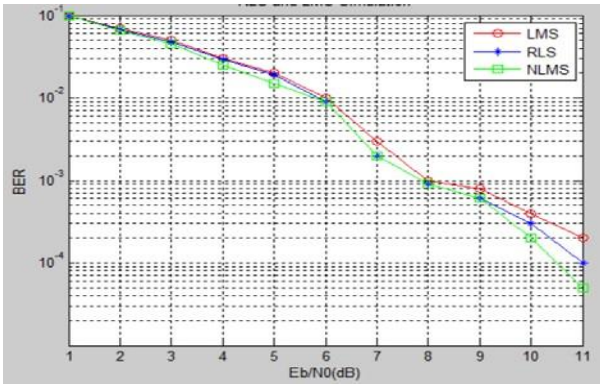

Fig -5: Performance BER in Different Algorithm

The proposed algorithm is used in a MIMO OFDM framework with BPSK modulation for channel estimation. The channel that was used was a Gaussian channel. Above figure 5 shows the BER vs. E_b/N_o plot for the NLMS set of rules, RLMS set of rules and LMS algorithm. When comparing the NLMS set of rules to the LMS set of rules, it can be shown that the curve for NLMS shows a decrease in BER. To begin with, the BER overall output isn't very good, but as the E_b/N_o cost rises, so will the BER performance.

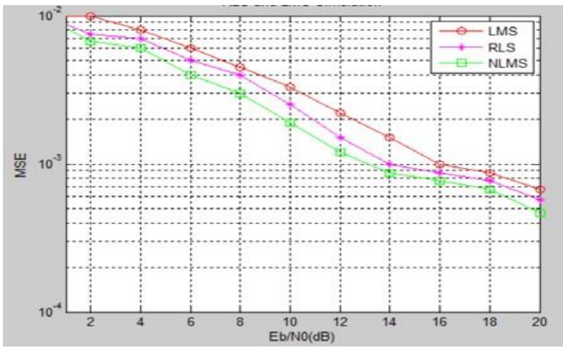

Fig -6: Performance MSE in Different Algorithm

In addition, the MIMO OFDM computer is checked for channel estimation using the LMS, RLS, and NLMS algorithms, respectively. The modulation used is QPSK, as shown in Figure 7. The BER efficiency of M- PSK decreases as the fee of M increases, while the power increases. The overall efficiency of the BER is lower than it was previously for BPSK modulation. However, the NLMS set of rules performs well than the RLMS set of rules in this case.

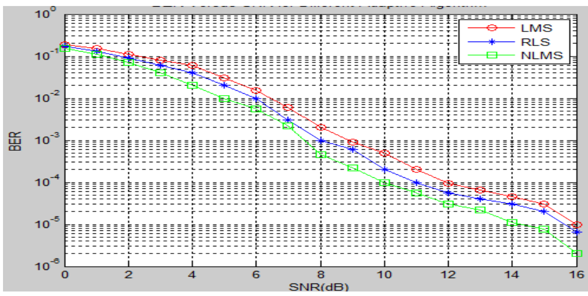

Fig -7: Performance BER versus SNR in Different Adaptive Algorithm

6. SIMULATION RESULTS

Any wireless system's primary goal is to achieve high convergence speeds. There are several different types of algorithms that have been developed, but they all increase the convergence speed as well as the bit error rate (BER). Maintain the BER, signal to noise radio (SNR), and convergence speed in this article. The proposed algorithm maintains all parameters in a MIMO-OFDM scheme using normalized least square error. However, the proposed algorithm's key disadvantage is its high complexity. The proposed algorithm was implemented using MATLAB software and generated satisfactory results as compared to the current algorithm.

REFERENCES

[1] Mel Li, Xiang Wang and Kun Zhang, "Comparative Study of Adaptive Filters Channel Estimation Technique in MIMO- OFDM System Based on STBC", Proceedings of the 2014 International Conference on Machine Learning and Cybernetics, Lanzhou, 13-16 July, 2014.

[2] Biswajit Sahoo, Ravi Ranjan Prasad, and P. Samundiswary, "BER Analysis of Mobil WiMAX System using LDPC Coding and MIMO System under Rayleigh Channel", International conference on Communication and Signal Processing, April 3-5, 2013, India.

[3] Mukesh Patidar, Rupeshdubey, Nitinkumar Jain and Saritakulpariya, "Performance Analysis of WiMAX 802.16e Physical Layer Model", 978-1-4673-1989-8/12/$31.00 ©2012 IEEE [2].

[4] B. Sklar, "Digital Communications Fundamentals and Applications," Prentice Hall, Upper Saddle River, NJ, 2000.

[5] Wei Jiang and Daoben Li, "Convolution Multi-code Multiplexing for OFDM Systems", Beijing University of Posts and Telecommunications Beijing 100876, China (2007).

[6] Ke Chen and Xiaojing Huang, "A Novel Approach for Interference Suppression in Multi-Sub band Convolution Coded OFDM System", School of Electrical, Computer & Telecommunications University of Wollongong, Australia (2010).

[7] Chin-Liang Wang and Shun-Sheng Wang† and Hsiao-Ling Chang, "A Low-Complexity SLM Based PAPR Reduction Schema for SFBC MIMO-OFDM Systems", 978-1-61284- 254-7/11/$26.00 ©2011 IEEE.

[8] Sen-Hung Wang, Student Member, IEEE, and Chih-Peng Li, Member, IEEE, "A Low-Complexity PAPR Reduction Schema for SFBC MIMO-OFDM Systems", IEEE SIGNAL PROCESSING LETTERS, VOL. 16, NO. 11, NOVEMBER 2009.

[9] Yang Zhou and Tao Jiang, "A Novel Multi-Points Square Mapping Combined With PTS to Reduced PAPR of OFDM Signals Without Side Information", IEEE TRANSACTIONS ON BROADCASTING, VOL. 55, NO. 4, DECEMBER 2009.

[10] Yuan Jinsha, and Shi Hongmei, "A Modified Symbol Timing Synchronization Algorithm for WiMAX OFDM Systems", 2008 IEEE Pacific-Asia Workshop on Computational Intelligence and Industrial Application.