BER Performance of NLMS Adaptive Channel Estimation Technique for MIMO-OFDM Systems

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Abstract - An adaptive, blind multiuser detector with integrated channel estimation for digital wireless networks in binary phase shift key (BPSK) with normalized least mean square (NLMS) is developed and analyzed. The detector is formed iteratively from the received signals using the minimum output energy criterion. The more accuracy of the technique more will be the accurate performance of the system. On this paper an stronger adaptive channel estimation using normalized least suggest rectangular (NLMS) method has been proposed. This approach offers higher overall performance which can be judged by the BER performance as compared than the existing algorithm i.e. least mean square (LMS) and recursive least square (RLS).

Keywords-Least Mean Square (LMS), Adaptive Channel Estimation, Convergence Speed

I. INTRODUCTION

In the present scenario of communication systems, wireless devices like smart phones, laptops and tablets have become ubiquitous. These devices are used for applications that require large bandwidth, like High Definition (HD) video streaming. An obvious way to increase bandwidth would be to decrease the symbol rate. But this leads to Inter Symbol Interference (ISI) [1]. Multichannel modulation technique like Orthogonal Frequency Division Multiplexing (OFDM) [1] could be used to counter ISI. An introduction to OFDM is given in Appendix-A. The advantage of OFDM is that, by using Fast Fourier Transform (FFT) algorithm it can be implemented with low complexity. OFDM is the preferred modulation technique for the downlink of a Long Term Evolution (LTE) system [2]. Some of the latest research in wireless communication is in the field of relay based systems. Relay based communication finds wide scale use in LTE systems [3]. Relay based communication is also known as cooperative communication [4]. It is not possible the direct communication between source to destination in wireless communication and very shadowing, wall effect to the destination time. If a third party device or a dedicated relay is present between source and destination that has low shadowing effect, then this device can help in forwarding the data to destination [5]. In a wireless device like mobile phone the presence of multiple antennas is not feasible due to space constraint. Cooperative communication can be used to form diversity between the communicating nodes. This is known as virtual MIMO. Another important use of relaying is to conserve the power in the communicating devices by helping to forward the data to the destination.

Within the present situation of wireless communiqué, OFDM is a distinguished modulation method due to its potential to provide high records charge, robustness to Inter symbol Interference (ISI) and simplicity of implementation [6]. For coherent detection of records, the channel facts are needed at the receiver [1]. There is considerable studies material to be had on the subject of OFDM channel estimation. In channel estimation based on time domain channel records had been brought.

Nowadays, consumer demands for high data rates under noisy and congested environment, which led researchers to look into upcoming techniques that could help to fulfill the customer demands. The usage of a couple of antennas at the transmitter and receiver quit is the viable option to obtain better facts prices beneath fading environment. Multiple-input multiple-output (MIMO) integrated with OFDM provides higher data rate without any additional power requirement and bandwidth expansion. The major issues across MIMO-OFDM system are encoders' complexity, high peak-to-average power ratio (PAPR), antennas design, equalization, channel estimation and so on. MIMO-OFDM signals with a high envelope fluctuation require highly linear power amplifiers to evade excessive inter-modulation distortion. Equalization of MIMO-OFDM signal is also important to mitigate the impact of ISI brought on because of channel delay spread.

II. 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 input random binary sequence is applied to the modulation block; this block is change the input sequence to binary block. After than the output of the modulation is applied to the encoder block, this block is all binary information divided into the block and each block are add some parity check bit. So basically eight by eight blocks are made and going to 8-point inverse fast fourier transform (FFT) with the help of serial to parallel converter.

A scientific block diagram of (N_{Tx} × 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. The enter bit stream Nc sub-vendors is modulated into facts symbols via quadrature segment shift keying (QPSK) modulation technique. The transmitted QPSK image is proven in Figure 2. The modulated QPSK symbols are encoded through an Alamouti's encoder and fed into an OFDM modulator. The output of the encoder is a code phrase matrix M with measurement of N_{Tx} × T, where T is the quantity of symbols for each OFDM blocks such as Nc sub-channels.

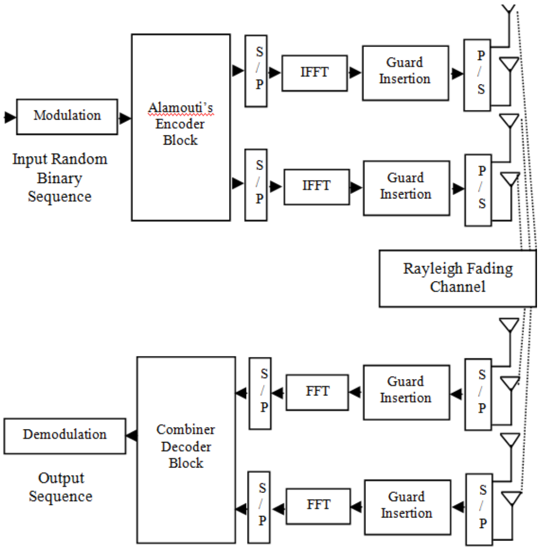

Figure 1: System Model of MIMO-OFDM system

The received signal at j[th] antenna can be expressed as

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

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 ith transmit antenna, nth time slot and kth 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:

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

(2)

Equation (2) shows the output data vector is represented by Z, the channel matrix is represented by H, A and M represented by input data vector and noise vector 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.

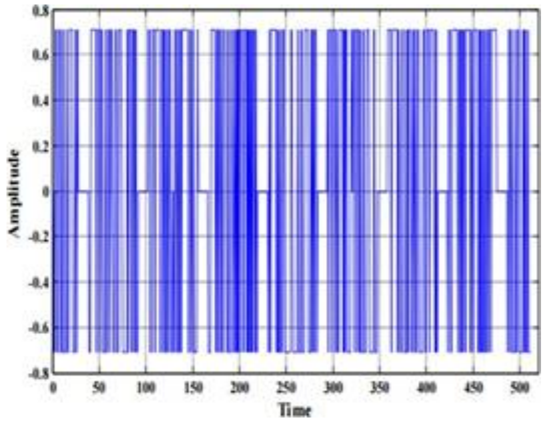

Figure 2: Transmitted QPSK symbol of MIMO-OFDM (N_{Tx} × N_{Rx}) system.

III. ADAPTIVE CHANNEL ESTINATION

The intention of an adaptive clear out is to remedy the imply rectangular optimization trouble iteratively. Adaptive filter out additionally tracks the statistical modifications within the device. All the same old literature considers the diverse algorithms of adaptive filtering to be unrelated. However in [9] it's miles shown than this isn't the case. It's far proved that any adaptive filter out may be taken into consideration to be an iterative equation solver of the Wiener-Hopf equation. The gain of viewing an adaptive filter out on this perspective is that everyone the one-of-a-kind adaptive filter out algorithms might be designed and analyzed using a unified framework. The consistent state analysis of the RLS filter designed in this bankruptcy is executed based on this principle. Subsequently our technique can be used to investigate a number of the other not unusual adaptive filters like affine projection or LMS. This unified framework for evaluation is referred to as the strength conservation method [10].

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 magnificence of adaptive clean out used to mimic a preferred filter out via locating the clear out coefficients that relate to generating the least suggest squares of the error sign (distinction among the favored and the real sign). Its miles a stochastic gradient descent approach in that the clean out is simplest adapted based on the mistake at the modern-day time. The simple concept at the back of LMS clean out is to method the most reliable clean out weights (R-1 P), via updating the clean out weights in a way to 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 propose 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:-

In the form of constructional view, the normalized LMS filter is exactly the same as the standard LMS filter, as shown in the Figure 3. Fundamental concept of both the filter is transversal filter.

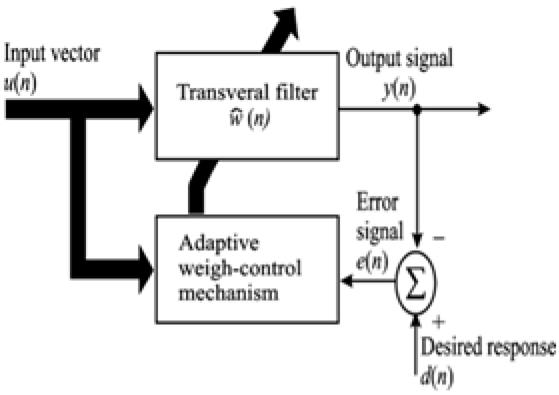

Figure 3: Block diagram of adaptive transversal filter

The normalized LMS filter gives minimal disturbance and may be stated as follows: gradually by different iterations weight vector will change in straight weight will change step by step, it is controlled by updated filter output and its proposed values.

IV. FLOW OF ALGORITHM

The MIMO-OFDM device modified into applied with the useful resource of MATLAB/SIMULINK. The execution device is binary facts this is modulated the use of BPSK and mapped into the constellation elements. The virtual modulation scheme will transmit the records in parallel by means of manner of assigning symbols to every sub channel and the modulation scheme will determine the phase mapping of sub-channels thru a complex I-Q mapping vector show in figure 4. The complicated parallel facts stream must be converted into an analogue signal this is suitable to the transmission channel. The complicated parallel facts stream has to be transformed into an analogue sign that is suitable to the transmission channel. It is performed to the cyclic prefix add to the baseband modulation signal because the baseband signal is not overlap. After than the signal is splitter the two or more part according to the requirement.

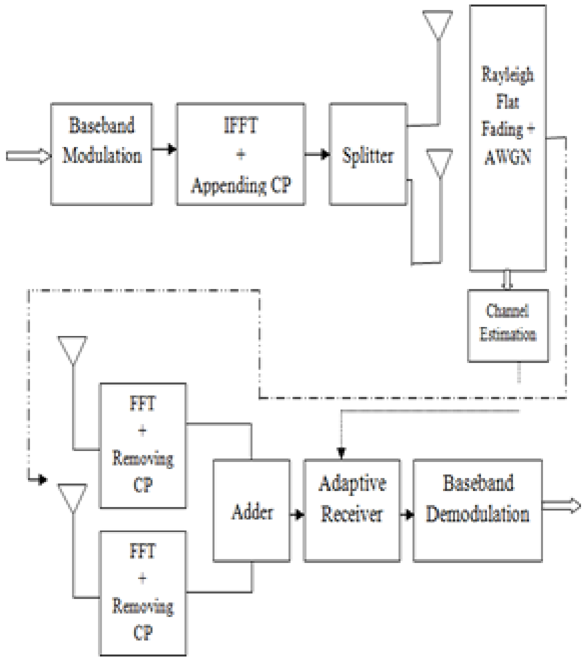

Figure 4: 2x 2 MIMO-OFDM System Models with Adaptive Filter

V. SIMULATION RESULT

In simulations it is assumed that the system is perfectly synchronized. Different values of SNR are taken and the performance is checked.

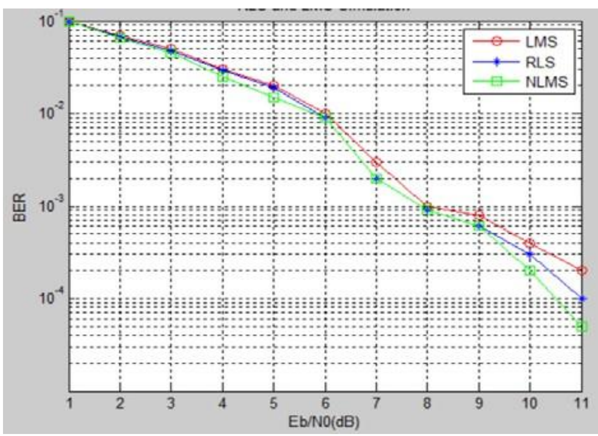

Figure 5: Performance BER in Different Algorithm

The purposed algorithm is applied for channel estimation in MIMO OFDM system using BPSK as modulation. Channel used is Gaussian channel. Above figure five shows the BER vs Eb/No plot for the NLMS set of rules, RLMS set of rules and LMS algorithm. it is seen that the curve for NLMS indicates a decrease in BER as compared to LMS set of rules. to begin with the BER overall performance isn't advanced a lot but as the Eb/No cost increases the BER performance also will increase.

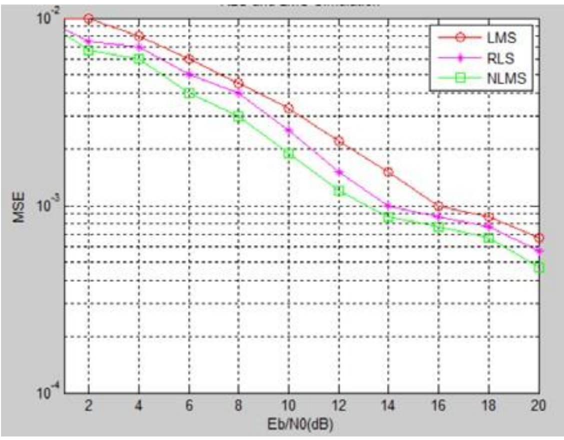

Figure 6: Performance MSE in Different Algorithm

In addition the MIMO OFDM machine is checked for channel estimation the usage of the 3 algorithms i.e. LMS, RLS and NLMS respectively. Figure 7 display that the modulation used is QPSK. As the fee of M increases in M-PSK the BER performance decreases and the capacity increases. The BER overall performance is reduced than the formerly used for BPSK modulation. But the NLMS set of rules right here again shows higher performance than RLMS set of rules.

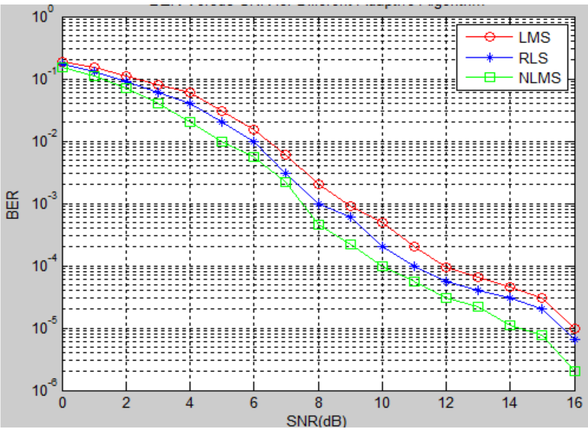

Figure 7: Performance BER versus SNR in Different Adaptive Algorithm

VI. CONCLUSION

The convergence speed is the main task of any wireless system. There are many types of algorithm developed but increase the convergence speed and also increase the bit error rate (BER). In this paper maintain the BER, signal to noise radio (SNR) and convergence speed. The proposed algorithm are normalized least square error maintain the all parameter in MIMO-OFDM system. But the main drawbacks of the proposed algorithm are complexity is high. The proposed algorithm is implemented by MATLAB software and achieved good result compared to existing algorithm.

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