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Design and Implementation of RLS Algorithm for MIMO-OFDM in Wireless Communication

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ABSTRACT: Wireless communication is playing a major part in our day to day life due to its high demand it's needed to give information at high data rate. The two technologies that have got further attention for below problems are multiple input multiple output (MIMO) and orthogonal frequency division multiplexing (OFDM). OFDM has been considered as a digital modulation technique, and not a multi-user channel access method. MIMO is a wireless technology that uses multiple transmitters and receivers to transfer further data at the same time. These two ways are combined to upgrade the performance. In this, adaptive equalizer algorithms are used. LMS algorithm has low complexity and computational cost but the disadvantage is its takes longer to converge. To overcome that RLS algorithm is used, it has faster convergence and increases the complexity. Mean Square Error (MSE) and Bit Error Rate (BER) can also be attained.

KEYWORDS: MIMO, OFDM, BER, RLS, Equalizer.

I. INTRODUCTION

In wireless communication system, using the available spectrum is one of most critical design issues. Therefore, the main aim of communication in wireless medium is to transmit data at high speed but inter symbol interference occurs when high speed data is transmitted over the given channel. The high-speed efficiency can be achieved by MIMO and OFDM. MIMO stands for multiple input multiple output takes advantage of multipath because it uses more than one antenna to transmit the signal from the transmitter. OFDM stands for orthogonal frequency division multiplexing mostly used in wide bandwidth and high-speed data in wireless communication including WIFI, cellular telecommunication and many more. OFDM is a form of multicarrier modulation fashion. Equalization purpose is to resolve inter-symbol interference caused by signals overlapping with each other in channel they are used by equalization at the front of the receiver. The equalizer which recursively updates the time varying channel samples that is known as adaptive equalization. It is frequently used with coherent modulations such as phase-shift keying, mitigating the effects of multipath propagation. MIMO-OFDM considered as innovation that combines both the technologies together to transmit information in wireless communication so as to manage with frequency selective channel effect. MIMO-OFDM are able to increase channel capacity even when channel experiences severe conditions and it even gives data throughput and highest capacity. Adaptive Equalizer has an advantage to adapt the time varying for unknown channels, it requires a special algorithm for better coefficient to trace the changes in the channel. The equalizer uses different algorithm like LMS and RLS.

II. RELATED WORK

1. Performance analysis of MIMO OFDM system for different modulation schemes under various fading channels

The performance is calculated in terms of Bit Error Rate versus the Signal to Noise Ratio. In this paper we discuss the BER performance of the MIMO-OFDM system with two different equalizers for various modulation techniques using multipath fading channels. The multicarrier modulation is employed, which gives advantages like inter symbol interference (ISI) reduction, high data rate, higher reliability, and better performance in multipath fading.

2. On limits of wireless communications in a fading environment when using multiple antennas

Exploitation of multi-element array technology, that is processing the spatial dimension to improve wireless capacities in certain applications. Specifically, using MEAs in wireless LANs and building to building wireless communication links. Fixing the overall transmitted power, we express the capacity offered by MEA technology and we see how the capacity scales with increasing SNR for a large but practical number, n , of antenna elements at both transmitter and receiver.

3. Linear and Nonlinear preequalizer for MIMO systems for long term channel state information at the transmitter

The structure generalizes different techniques known from the literature, such as BLAST, linear preequalization and equalization, and Tomlinson-Harashima precoding (THP). Simulations show that relevant benefits can be obtained by exploiting the long term channel state information at the transmitter in both dense multipath channels with relatively large correlation at the transmitter side and in sparse multipath channels.

III. PROPOSED SYSTEM

In this proposed system, we have chosen RLS algorithm to design MIMO-OFDM in wireless communication. The given signals are deterministic in the derivation of RLS on the other hand for LMS and similar algorithm they are known as stochastic. The convergence rate of gradient based LMS algorithm is considered slow, mostly when it has large spreading Eigen values (R_{NN}), i.e., $\lambda_{\max} / \lambda_{\min} \gg 1$. which computational complexity increases.

$$J(n) = \sum_{i=1}^n \lambda^{n-i} e^*(i, n) e(i, n)$$

\hat{w}_N is the RLS equalizer optimal tap gainvector

$$\frac{\partial}{\partial \omega} J(n) = 0$$

$$e(i, n) \text{ and } \frac{\partial}{\partial \omega} J(n) = 0$$

$$R_{NN}(n) \hat{w}_N(n) = p_N(n)$$

$$R_{NN}(n) = \sum_{i=1}^n \lambda^{n-i} y_N^*(i) y_N^T(i)$$

$$P_N(n) = \sum_{i=1}^n \lambda^{n-i} x * (i) y_N(i)$$

$R_{NN}(n)$ is known as matrix of the deterministic correlation of the data transmitted to the equalizer $y_N(i)$.

$P_N(n)$ is given as cross correlation vector in between the input signal $y_N(i)$ and required output $d(i)$, where $d(i) = x(i)$.

$$R_{NN}(n) = \lambda R_{NN}(n - 1) + y_N(n) y_N^T(n)$$

$$w_N(n) = w_N(n - 1) + k_N(n) e * (n, n - 1)$$

IV. METHODOLOGY

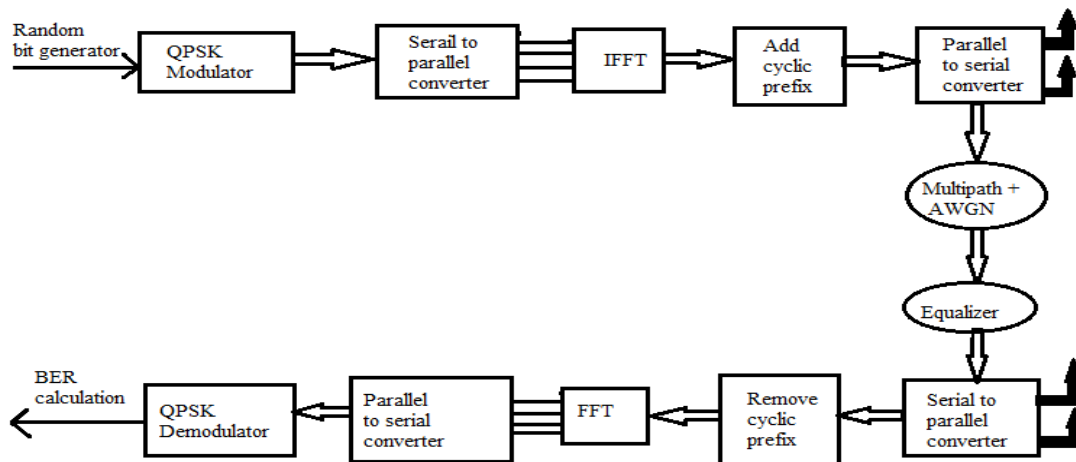
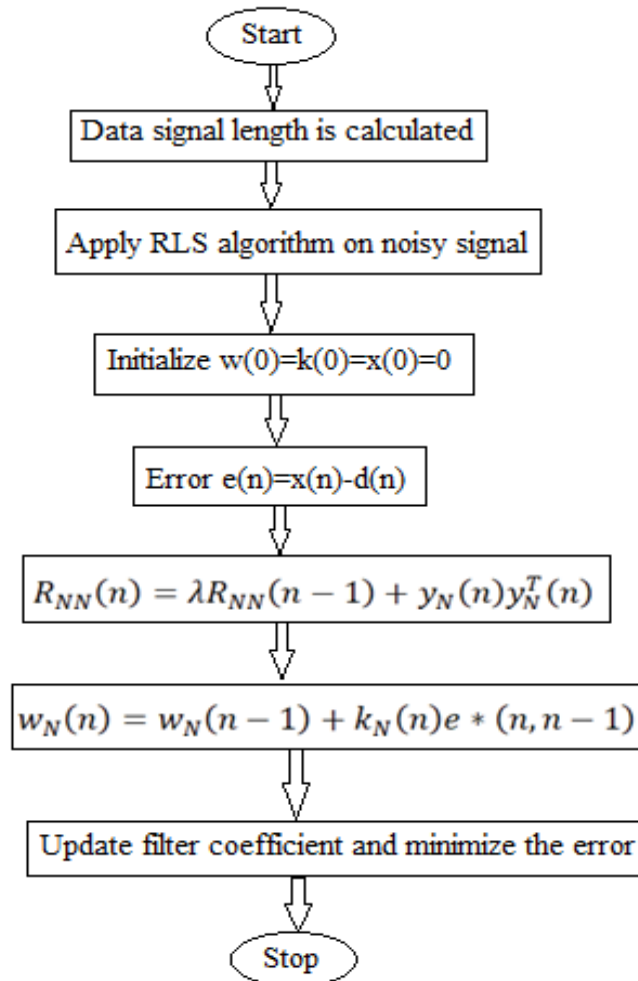


Figure 1: System Model of MIMO-OFDM

I. Flow Chart of RLS:

The length of the digital data is calculated then apply RLS algorithm to the noisy channel initially. Consider $w(n)=0$ and error are calculated by updating the coefficients of filter and errors are minimized.



Bit Error Rate (BER):

When data is transmitted over a channel, there are many chances of errors are induced into the system. If errors are combined with data transmitted, the integrity of the system decreases. BER is defined as counting the transmitted bits to the received bits and having account of errors occurred.

$$BER = \frac{\text{Number of errors}}{\text{Total number of bits sent}}$$

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V. EXPERIMENTAL RESULTS

Modulation	QPSK Modulation
FFT Size	70
Input Data	5000
Channel	Multipath Rayleigh channel
Cyclic Prefix	17
Step Size	0.008
Antennas	2x2 and 4x4
Algorithms	Proposed: RLS

Table 1: Simulation Parameters

These are the parameters used for simulation QPSK modulation is used because of its constant amplitude and fast fourier transform is considered 70,input data is 5000bits,Multiple Rayleigh channel is used when it does not have a line of sight, cyclic prefix is 17, step size is 0.008, this all parameters are considered for 2x2 and 4x4 antennas for LMS and RLS algorithms.

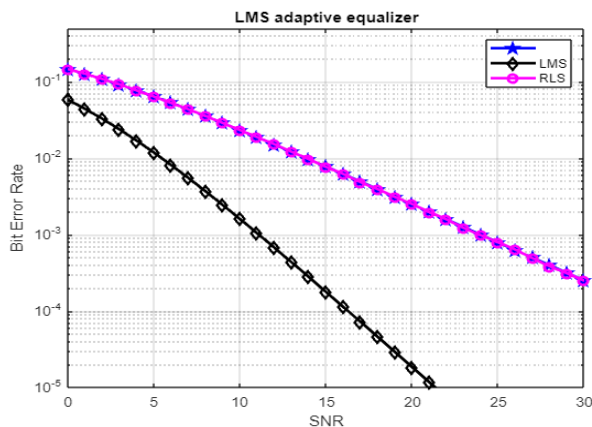


Figure2: LMS adaptive Equalizer with 2x2 and 4x4 antennas

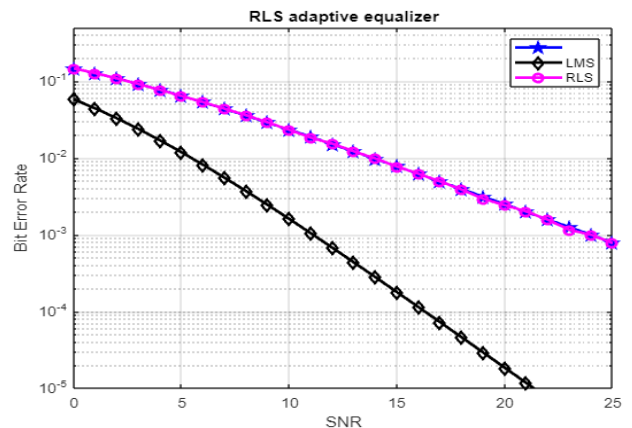


Figure3: RLS adaptive Equalizer with 2x2 and 4x4 antennas

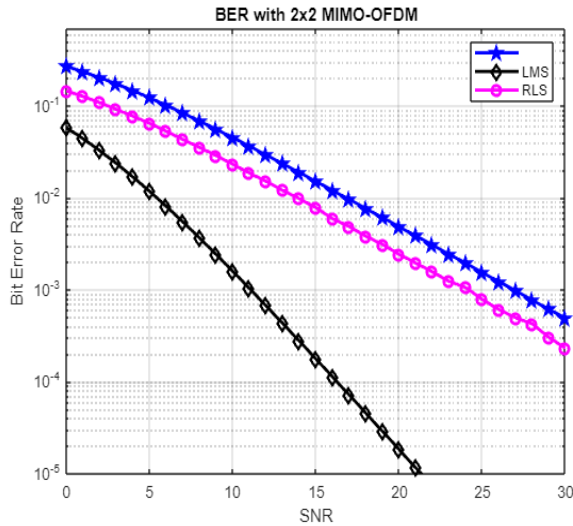


Figure4: LMS and RLS algorithms comparison for 2x2 antennas

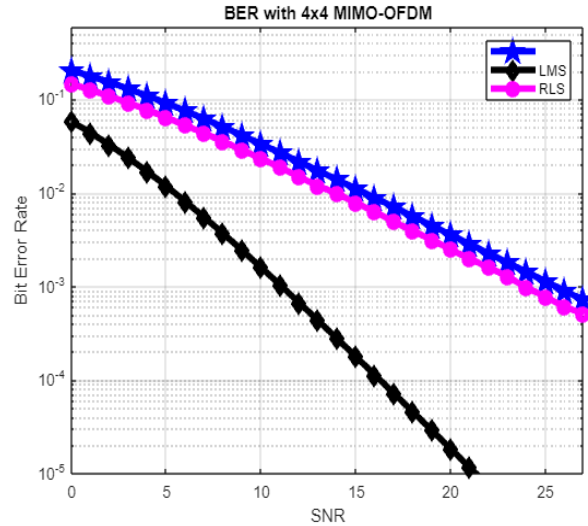


Figure5: LMS and RLS algorithms comparison for 4x4 antennas

VI. CONCLUSION

This technique is combined with MIMO and OFDM techniques. By using this it can achieve the channel capacity. A MIMO OFDM system transmit independent OFDM modulated data from multiple antennas simultaneously. There are several algorithms used for convergence. Compared to LMS, rate of convergence is faster for Recursive mean square. It has better performance even in low signal to noise ratio. RLS is highly stable for fast varying channel. In future this will consider this proposed system in terms of BER and other modulation techniques. If there many antennas used the system performance can be better than this, better BER and MSE can be seen. By using many antennas and different modulation technique the error signal can be decreased with less samples

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