INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 4, Issue 1)
Available online at www.ijariit.com

Performance Evolution and Comparison Analysis of OFDM System for Channel Estimation

Anjani Kumari
anjanibtechece@gmail.com
PM College of Engineering, Sonipat, Haryana

ABSTRACT

A Multiple inputs multiple output (MIMO) structures in wireless communication exchange are referred as a wireless communication system where a couple of antennae is used in both aspects of the communication exchange route i.e. Transmitter side and Receiver aspect. The communication exchange structures, which use more than one transmit and multiple obtain antennas are commonly referred to as a couple of input more than one output (MIMO) structures. The coverage place and the transmission ability of a wireless communication exchange system can be progressed by way of the usage of this Wi-Fi networking generation. In digital signal processing, the processing algorithms for interference suppression are becoming complicated with a couple of antenna at each end of the transmission channel. Additionally, the growing demand for those networks has become the frequency spectrum into a treasured aid. For that reason, there is a sturdy need for a method which could pack more and more bits/Hz. Any such device is known as multiple inputs multiple output (MIMO) gadget. The uplink insurance and capacity of OFDM structures with the traditional multi-user detector receiver are interference restricted. In particular, at some stage in the rollout segment, the coverage of OFDM machine is uplink restricted. A less expensive answer to improving the general overall performance is using serial interference cancellation (SIC) at the base station. In this research work, a sophisticated receiver structure for interference cancellation primarily based on advanced Least Square Error Algorithm set of rules for multiple inputs multiple outputs orthogonal frequency division multiplexing (MIMO-OFDM) structures is proposed. The proposed method no longer simplest increases the capability of the device but additionally low down the Bit Error Rate. It could make full use of the channel correlations in the area, time, and frequency to estimate the channel state information for diverse systems, together with pilot-image assisted structures, pilot-embedded structures, and blind structures. MATLAB R2013a has been used to evaluate the performance of proposed algorithm the usage of Wireless Communication toolbox and preferred MATLAB toolbox. The overall performance of the proposed technique and existing technique is measured using BER. Keywords- Channel Estimation, MIMO-OFDM, MSME estimation, Least Square estimation.

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1. INTRODUCTION

Channel estimation is required for analyzing the effect of the channel on the transmitted symbols. Channel estimation is used to obtain the channel state information to know the channel properties [1]. Channel is estimated by using these technologies:

A. Least square
B. Minimum mean square
C. LS-MME (Linear Minimum Mean Square Estimator):

A. Least Square Estimation Technique

The least square method is the simplest way to estimate the channel and it has low complexity, but its performance is not so good. The least square estimation technique is based on a common method which is pilot-based channel estimation, and it gives good performance and with complexity [10]. Least square estimation is modeled such that the weighted errors between the channel estimation measurement and the model are minimized.

At least square technique estimation of channel attenuation for the different signal can be calculated by talking the ratio of observed outputs to the input of each of the subcarrier symbols. The least square method is easiest and simplest methods in the channel estimation method.

This pilot based channel estimator is designed for a MIMO-OFDM [11]. We can express the Least squares estimation of the channel as follows [9]:

$$\hat{H}_{LS} = \arg\{\min\{(Y-X\hat{H}_{LS})H(Y-X\hat{H}_{LS})\}\}$$

Where $\hat{H}_{LS}$ is the channel estimate for the LS method

Hence,

$$\hat{H}_{LS} = \frac{Y}{X} = H + \frac{N}{X}$$

Here AWGN is additive Gaussian noise where $\hat{H}_{LS}$ are the LS channel estimation [6] of the system, Y is the received data and X is the transmitted symbols. Matrix X has transmitted symbol in each of the N subcarriers in its diagonal. Here H is channel frequency response Adaptive filter is also used in LMS estimator at each pilot frequency. With LS one thing is good that it can give the first value directly and the rest values are computed based on the previous estimation and the current channel output, in this technique the word d (n) is the desired response of the adaptive filter, and word e(n) is error signal[5].

B. MMSE Estimation Technique

The minimum mean square gives a more accurate estimate using channel statistical properties but is computationally complex. MMSE is better than LS because having high complexity it gives better performance because it gives less BER as compared to LS [2]. We can say that MMSE estimator has good performance but high complexity. To achieve better performance Modifications of both MMSE and LS [3] estimators is more suitable. In MMSE estimator it uses the “second-order statistics of the channel conditions” and this is taken only for the minimization of the mean-square error. The MMSE channel estimation is expressed as [4]

$$\hat{H}_{MMSE} = F\hat{h}_{MMSE} = FR_{hy}R_{YY}^{-1}Y$$

Where

$$R_{hy} = E[hY^H] = R_{hh}F^H X^H$$

$$Ryy = E[YY^H] = XFR_{hh}F^H X^H + \sigma_n^2 I_N$$

$$\hat{H}_{MMSE} = FR_{hh}F^H X^H (XFR_{hh}F^H X^H + \sigma_n^2 I_N)^{-1} Y$$

Where $R_{hh} = E[hh^H]$ is the channel auto-correlation matrix, σ_n^2 is the noise variance $F = [W_K^{nk}]$ is The DFT matrix with

$$W_K^{nk} = \frac{1}{\sqrt{K}} e^{-j2\pi\frac{nk}{K}}$$

C. LS-MME (Linear Minimum Mean Square Estimator)

The LS-MSE channel estimator [1] tries to minimize the mean square error between the actual and estimated channels, obtained by applying the Wiener–Hof equation:

$$h_{lmmse} = R_{hy}R_{yy}^{-1}y$$

Where the cross-correlation matrix is:

$$R_{hy} = E[hy^H] = R_{hh}X^H$$

The autocorrelation of received signal y is:

$$R_{yy} = E[yy^H] = XR_{hh}X^H + \sigma_n^2 I$$

The LMMSE estimator can be obtained as:

$$h_{lmmse} = R_{hh}[R_{hh} + \sigma_n^2 (XX^H)^{-1}]^{-1} h_{ls}$$

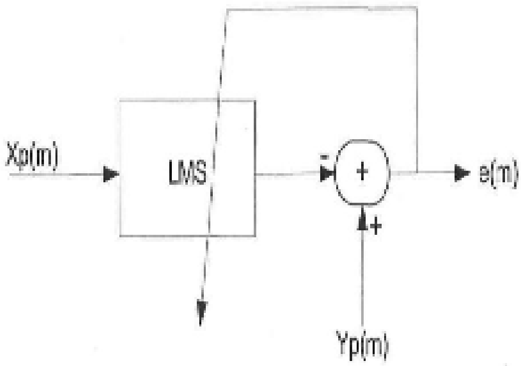

Figure 1: LMS Adaptive Filter

The LMS estimator uses a one-tap LMS adaptive filter at each pilot frequency. The first value is found directly through LS and the following values are calculated based on the previous estimation and the current channel output as shown in figure e(m) is the error signal which is formed by taking the difference between the received pilot symbol Y P (m) and transmitted pilot symbol X P (m) [7].

LMMSE channel estimation requires knowledge of the channel frequency correlation and the operating SNR.
As the operating SNR varies, the inverted matrix should be changed for reliable Estimation. On this point of view, the LMMSE channel estimation needs the matrix inversion and Complex multiplication in an efficient implementation [8].

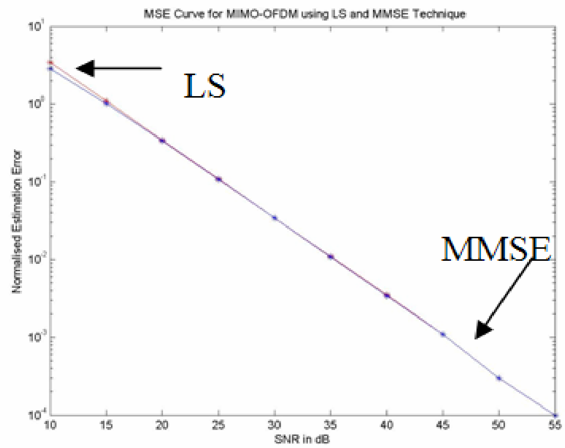

Figure 2: Comparison of LS over MMSE Channels Estimation Technique

2. PROPOSED METHODOLOGY

Here are the few steps of implementation for proposed methodology.

1. Declaration of input parameter for system set up
   - Total number of sub channel
   - Total number of Pilot bits
   - Total number of data sub channels
   - Guard interval length
   - Modulation size
   - Pilot position interval
   - Channel length
   - Number of iteration in each evaluation
2. Generation of Input signal to noise ratio vector in db
3. Initializing dummy matrix for output bit error rate according to Input SNR

4. Setting of Pilot Location
5. Setting of location of data (i.e. By selecting symbols which are not in their intersection)
6. Declaration of energy in pilot symbols in comparison to energy in data symbols
7. Preparation of FFT matrix
8. Declaration of a loop according to the number of input SNR values
9. Declaration of an inner loop according to the number of estimation
10. Generation of random channel coefficients matrix
11. Normalization of channel matrix
12. Generation of Random Data matrix
13. Modulation of random data matrix using QAM method and
14. According to modulation size
15. Assigning the energy to the pilot's symbols in data
16. Conversion of frequency domain data into time domain data according to total number of sub channels
17. Addition of some guard symbols with time domain signal
18. Preparation of receiver data by placing the data on to the channel
19. Preparation of AWGN noise to the channel
20. Addition of AWGN noise to the data to be received
21. Conversion of time domain data into frequency domain data
22. Channel estimation using Least Square Error Algorithm
    - Calculation of transmitted pilots symbols
    - Calculation of received pilots symbols
    - Calculation of performance degradation (G) using transmitted Pilots symbols
    - Calculation of channel impulse response or estimated channel coefficient in time domain
23. Demodulation of received symbols using QAM method and according to modulation size
24. Calculation of Bit Error Rate by comparing received and transmitted symbols
25. Display of BER Graph

3. RESULTS

MATLAB R2013a has been used to assess the performance of proposed algorithm using wireless communication toolbox and generalized MATLAB toolbox. All elements of channel matrix H are assumed to be i.e. zero mean complex Gaussian random variables with unit variance. The input SNR is described as the ratio of the anticipated received strength at each antenna to the noise power. The channel estimation errors are randomly generated from a Gaussian distribution. The overall performance of the proposed approach and present technique is measured the using BER and number of errors. A plot of BER vs. SNR is given in figure 3. It's far nearly clear from the graphs that proposed technique has an awful lot decrease BER compared to that of existing LSE and existing MMSE. This is because traditional LSE algorithm most effective considers the noise power and ignores the interference whilst producing the null weight. The effect of channel estimation error turns into more dominant as the SNR increases. As greater symbols are transmitted simultaneously, there are extra interfering signals. Therefore, if we do not consider the impact on of channel estimation mistakes, the overall performance degradation will become more significant in the system with greater spatial streams. As the SNR increases, the interference due to channel estimation errors turns into dominant and the interference plus noise level will become almost steady. It is able to be concluded from all the figures that

BER and number of errors regularly decrease as the number of transmitters and receivers increase. we've got used some input parameters i.e. Number of Sub-channels, Pilot Bits, Data Channels, Guard Interval length, Pilot Interval, length of the channel, Number of Iterations and SNR stages as a way to implement the wireless communication system.

Table I: Various Input Parameters and Their Values

S. No.	Parameter	Value
1.	Number of Sub-channels	256
2.	Pilot Bits	32
3.	Data Channels	224
4.	Guard Interval Length	64
5.	Pilot Interval	8
6.	Length of channel	16
7.	Number of Iterations	500
8.	SNR Levels	0, 3, 6, 9, 12, ...27

We have applied the same method to 256 sub channels. The values of output BER is given in Table II w.r.t. SNR. The BER performance for the same is given in figure 3.

Table II: Input SNR Vs. Output BER

S. No.	SNR Value	BER Value of Advanced LSE	BER Value of Existing MMSE	BER Value of Existing LSE
1	0	0.178	0.2946	0.2946
2	3	0.147	0.2347	0.2330
3	6	0.084	0.1831	0.1800
4	9	0.056	0.1293	0.1230
5	12	0.035	0.0807	0.0720
6	15	0.017	0.0613	0.0470
7	18	0.008	0.0361	0.0211
8	21	0	0.0226	0.0100
9	24	0	0.0150	0.0050
10	27	0	0.0113	0.0040

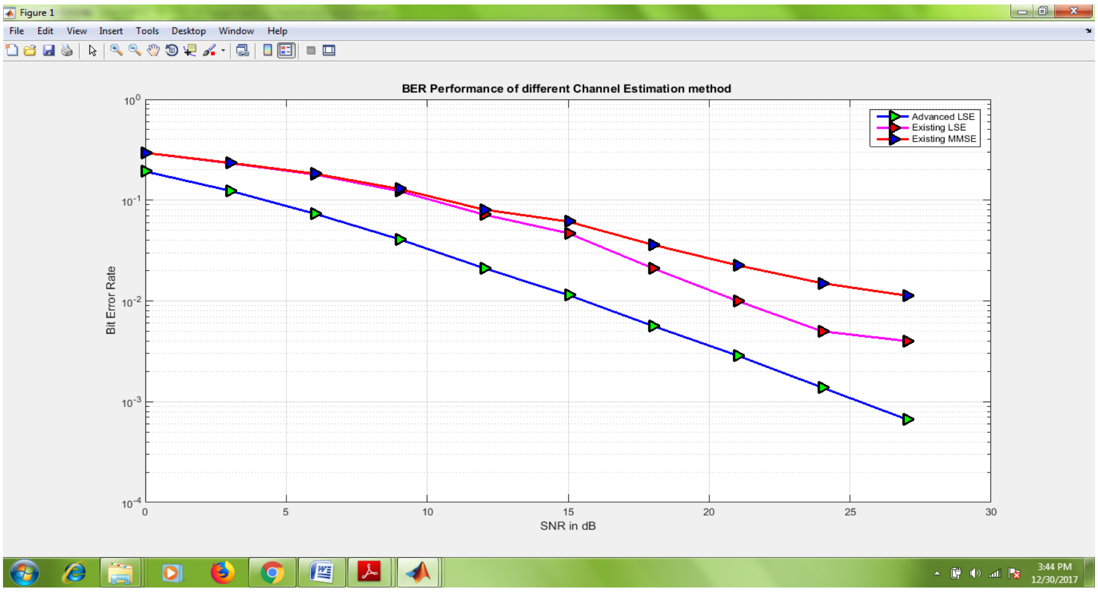

Figure 3: Snapshot of BER Performance of different Chanel Estimation methods for 256 Sub channel System

We have also applied the same method to 64 sub channels. The values of output BER is given in Table III w.r.t. SNR. The BER performance for the same is given in figure 4.

Table III: Input SNR vs. output BER

S. No.	SNR Value	BER Value
1	0	0.321
2	3	0.160
3	6	0.178
4	9	0.160
5	12	0.196
6	15	0.214
7	18	0.232
8	21	0.160
9	24	0.232
10	27	0.250

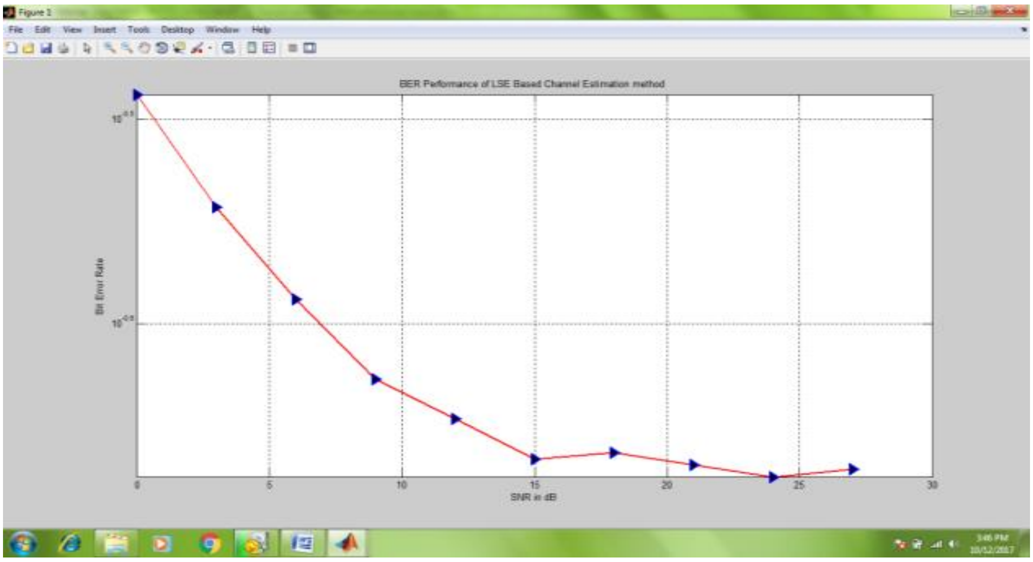

Figure 4 Snapshot of BER Performance of LSE Based Chanel Estimation methods for 64 Sub channel System

4. CONCLUSION

MIMO-OFDM can boom each the coverage area and the transmission potential of cell structures notably, within the area of wireless communications. This generation is developing very speedy and it is already provided in numerous requirements. It's far less complicated to comprise MIMO device in absolutely new standards like Wi-Max. A computationally efficient LSE channel estimation algorithm for MIMO-OFDM structures in spatially correlated multipath fading channels is supplied in this work. It is able to absolutely make the most the channel correlations over space, time, and frequency to gain the LSE estimate of the CSI in diverse structures, inclusive of pilot-image-assisted structures, pilot-embedded systems, and blind structures. In this research work, an advanced LSE receiver structure for interference cancellation for multiple-input and multiple-output orthogonal frequency division multiplexing (MIMO-OFDM) systems is proposed with considering the everyday first-rate of service necessities of blended offerings, i.e. voice and data. The overall performance of proposed approach has been evaluated and compared. The proposed method works efficaciously in terms of BER and number of errors with respective enter SNR. The proof of above statement is the snapshots given in the ultimate chapter. Additionally, it has been skilled that the combination of linear and nonlinear detection strategies can improve the BER performance of the MIMO-OFDM machine. MIMO-OFDM is a pretty promising method which can be used in the cell communications for further generations. For future work, the proposed approach can be extended to suppress noise and co- channel interference effectively.

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