Improving Channel Estimation Accuracy in OFDM System Using MATLAB Simulation

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Abstract
The objective of this study is improving channel estimation accuracy in OFDM system because channel state information is required for signal detection at receiver and its accuracy affects the overall performance of system and it is essential to improve the channel estimation for more reliable communications. OFDM system was chosen in this study because it has been widely used today due to its high data rate, channel capacity and its adequate performance in frequency selective fading channels .The pilots were inserted among subcarriers in transmitter with distances emerged of sampling theory then Least Square (LS) method & minimum mean-square error (MMSE), was chosen for initial channel estimation in pilots at receiver, using applicable proposed receiver, which has simple and usable structure, then channel state information was estimated by linear interpolator in information subcarriers, which uses two adjacent channel estimation in pilots to compute channel in another subcarriers and an LMS iterative algorithm, including a feedback of output is added to system. This algorithm uses the channel estimation of last iteration in current estimation. Adding a LMS iterative algorithm to system, improves the channel estimation performance. Simulation results proved the acceptable BER performance of iterative channel estimation algorithm, which is closed to the ideal channel .

Key words:
OFDM , Channel Estimation , LMS , LS ,MMSE , BER..

1. Introduction

The low complexity proposed receiver including LMS algorithm, has a higher efficiency than conventional methods(without channel estimation & LMMSE) and it can work in lower amount of SNRs. Channel estimation is an important issue in any OFDM system for demodulation and decoding. Channel estimators find the state information required for signal detection at receiver using algorithms . Most research on channel estimation has been done for the downlink. However, there is still much investigation to be done on the uplink, where it is more difficult to estimate channel characteristics. The reason for this difficulty is that on the uplink, each signal from each mobile station (MS) that arrives at the base station (BS) is affected by a different fading channel. There are two main problems in designing channel estimators for wireless OFDM systems.

2. The first problem is the arrangement of pilot information, where pilot means the reference signal used by both transmitters and receivers.
3. The second problem is the design of an estimator with both low complexity and good channel tracking ability. The two problems are interconnected.

2. Results and Discussion

2.1 Simulation Setup and Description

2.1.1 Simulation of channel estimation for the OFDM using MATLAB

In general, the 2D channel estimation schemes outperform the 1D schemes by exploiting the 2D correlations at the expense of higher computational complexity and larger time delay. Also, the block-type pilot channel estimation schemes[2] are more suitable for the slow fading channels, and the comb-type pilot channel estimation schemes are more suitable for the middle and fast fading channels. In addition, block-type pilot schemes are used over middle or fasting fading channels, the channel estimation error may vary considerably as a function of the location of the data blocks with respect to the pilot block. The result may be a periodic variation of the decoding error rates for different OFDM blocks. Table I show Bit Error Rate (BER) Vs Signal to noise ratio(SNR) while apply no channel estimation & by applying least square (LS), minimum mean-square error (MMSE) as table clearly indicated that LS method will produce better signal o noise ratio by considering BW=8.75Mhz, FFT Size=1024, Ts=1e-7 where as CP is fixed at 1/8

Sr. No	SNR	BER		
		Without Channel Estimation	LMMSE	LS
1.	1	0.2300	0.2040	0.1965
2.	2	0.2266	0.1927	0.1834
3.	3	0.2221	0.1850	0.1672
4.	4	0.2134	0.1770	0.1582
5.	5	0.2096	0.1715	0.1421
6.	6	0.2093	0.1667	0.1347
7.	7	0.2008	0.1578	0.1296
8.	8	0.1991	0.1568	0.1174
9.	9	0.1994	0.1521	0.1115
10.	10	0.1980	0.1493	0.1102
11.	11	0.1971	0.1487	0.1053
12.	12	0.1931	0.1466	0.1039
13.	13	0.1944	0.1484	0.1036
14.	14	0.1952	0.1463	0.1007
15.	15	0.1964	0.1442	0.0994
16.	16	0.1968	0.1445	0.1000

Table I: BER Vs SNR for diff Channel Estimation Techniques

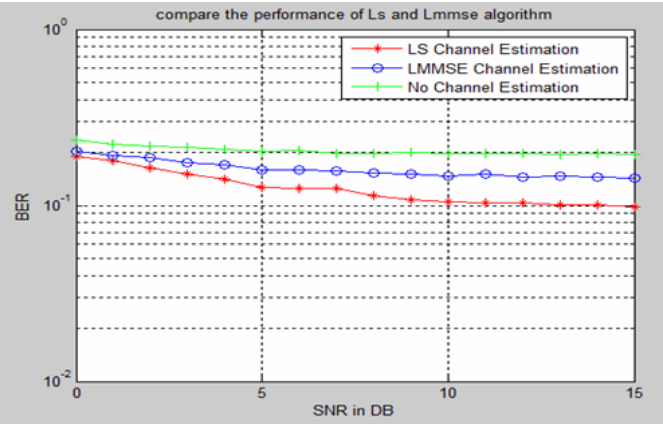

Fig. SNR (db) Vs BER performance of different channel estimation (LS, LMSSE & No Channel)

2.1.2 Simulation of LMS Iterative Algorithm

The 2×2 MIMO-OFDM[1] system was simulated using MATLAB program so that pilots are inserted among data for initial LS channel estimation. The channel between transmitter and receiver antennas was modeled by multipath Rayleigh fading channel using jakes spectrum type. Channel bandwidth is 1.75 MHz . The channel simulation parameters such as delay spread, tap power and Doppler frequency were chosen, using Standard University Interim channel model (SUI) . This model can be used for simulation because it is suitable for fixed broadband wireless application. A FFT with the size of 1024 was used, with a CP length of 256. In which data are in QPSK modulation and BPSK modulation was chosen for pilots. The pilots are placed in distance which fulfill the sampling theory, was mentioned in . At receiver, all of procedures such as adding CP, are reversely done and pilots are extracted after FFT operation for LS estimation and linear interpolation .

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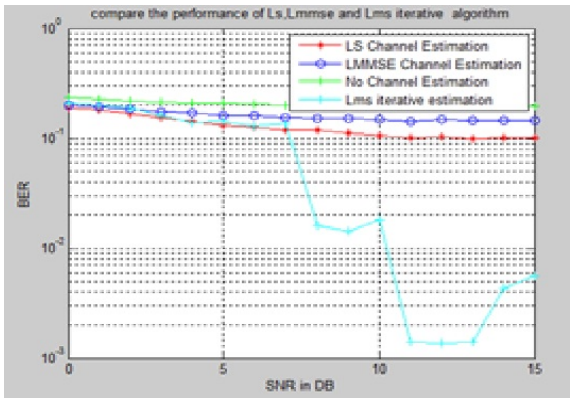

Fig. LMS Iteration 1

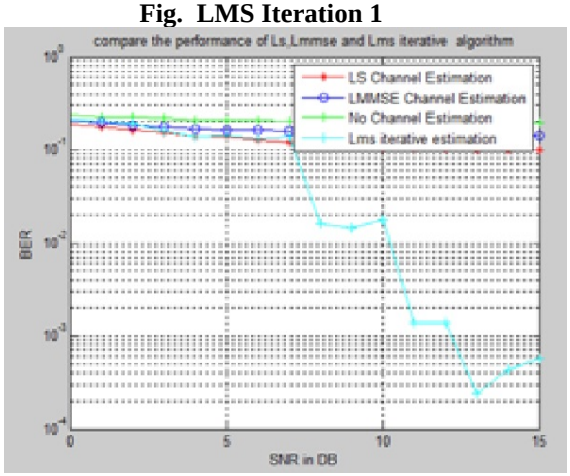

Fig. LMS iterative 3

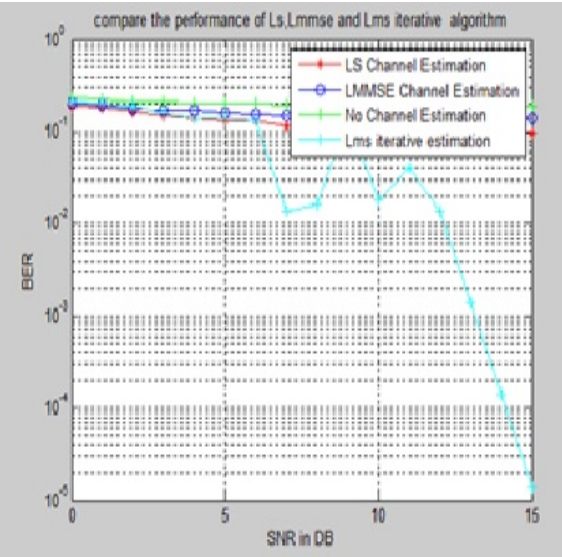

Fig. LMS iterative 4

3 Conclusions

Adding a LMS iterative algorithm to system, improves the channel estimation performance. Simulation results proved the acceptable BER performance of iterative channel estimation algorithm, which is closed to the ideal channel and we analyzed that the low complexity proposed receiver including LMS algorithm, has a higher efficiency than conventional methods and it can work in lower amount of SNR.

In this study a low complexity structure of receiver was proposed so that the LS method and linear interpolation were used for initial channel estimation. For improving accuracy of channel estimation, LMS iterative algorithm was added to receiver which includes feedback of output and improves the BER performance of system, closed to the ideal channel performance.

References

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