International Journal of Electronics and Communication Engineering and Technology (IJECET)
Volume 7, Issue 3, May–June 2016, pp. 68–74, Article ID: IJECET_07_03_009
Available online at
http://www.iaeme.com/IJECET/issues.asp?JType=IJECET&VType=7&IType=3
Journal Impact Factor (2016): 8.2691 (Calculated by GISI) www.jifactor.com
ISSN Print: 0976-6464 and ISSN Online: 0976-6472

ESTIMATION OF CHANNEL IN OFDM WIRELESS CHANNEL USING LS AND MMSE TECHNIQUES

R Srinivasa Aditya Varma
Dept. of ECE, GITAM UNIVERSITY, India

Marthy Siva Sai Krishna
Dept. of ECE, GITAM UNIVERSITY, India

ABSTRACT

In recent years with the increase in digital data communication, the need for high data rates with less information loss or distortion is being a continuous research area and new techniques are being invented in this area. Large amount of people are using the air interface for proper communication which also have a lot of drawbacks which include multipath fading, Inter symbol interference (ISI), Doppler shift etc..This paper is being presented on basis of channel estimation of wireless mobile OFDM channels using known pilot symbols. Channel estimation is a technique generally used to design a channel in a particular environment based on the variation of known symbols which are inserted in the input at transmitter end and examined at the receiver end. Based on the received data various algorithms are used to compare the input and output data symbols to effectively estimate an OFDM channel. Out of many algorithms used in channel estimation we used LS (Least Square) and MMSE (Minimum Mean Square Error) to estimate a channel and compared those two techniques.

Key words: OFDM, LS, MMSE, Pilot Symbols, Channel Estimation.

Cite this Article: R Srinivasa Aditya Varma and Marthy Siva Sai Krishna, Estimation of Channel In OFDM Wireless Channel Using Ls and MMSE Techniques, *International Journal of Electronics and Communication Engineering & Technology*, **7**(3), 2016, pp. 68–74.
http://www.iaeme.com/IJECET/issues.asp?JType=IJECET&VType=7&IType=3

1. INTRODUCTION

Air interface is the main channel for the communication. In order to have proper communication between the transmitter and the receiver there are many barriers that we have to overcome. These barriers include noise, Doppler shift, interference, signal fading etc: - As the number of users using air interface for wireless communication purposes has been increasing day by day, the effective usage of bandwidth has become a great challenge for service providers. As the bandwidth available is limited to the each service provider for different applications and the increase in number of users demand more bandwidth. So communication engineers have come with many techniques such as FDMA, TDMA, and CDMA etc: - for effective utilization of bandwidth. But many of these are somehow tackled noise effects in communication. The need for frequency reuse and multi carrier transmission has been increasing. In this modern world engineers came up with another sophisticated model which is OFDM (orthogonal frequency division multiplexing) model. The Channel estimation in OFDM wireless channel can be done using least square and minimum mean square error. The following information shows how this estimation can be done using these algorithms.

2. DESCRIPTION

OFDM is a digital multi carrier modulation scheme which has the capability of transmitting large data with low bandwidth. The given high bandwidth data is divided into different number of sub-carriers as shown in figure 2.The combined bandwidth occupied by these sub carriers (fig.2) is less when compared to the one used in frequency division multiplexing (fig.1).Although the overlapping takes place between the signals they can still be received without interference because these subcarriers are orthogonal to each other Thus we can save the bandwidth and can be used for other purposes. If any issues are arise due to interference or any other perturbations at some frequency band, only that frequency band of the signal will get damaged rather that the whole signal. Generally during the encoding of the signal the information bits are combined with some overhead which includes parity bits for error correcting sequences i.e. if some part of signal got damaged in the channel due to various reasons the signal can be recovered at the receiver side. Thus OFDM signal can overcome many tasks by saving bandwidth, effective transmission of the date with high speed rates with more information. OFDM has immunity to interference, noise, fading of the signal. Thus OFDM technology is preferred to transmit signals in various technologies. Emerging technologies like LTE are using OFDM data model and achieved high data rates up to 100mbps.In block type pilot insertion, pilot Symbols are inserted in every sub channel at regular intervals between the data symbols.

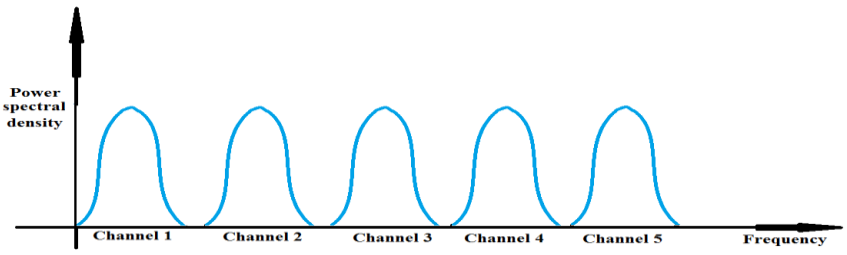

Figure 1 Channels in FDM

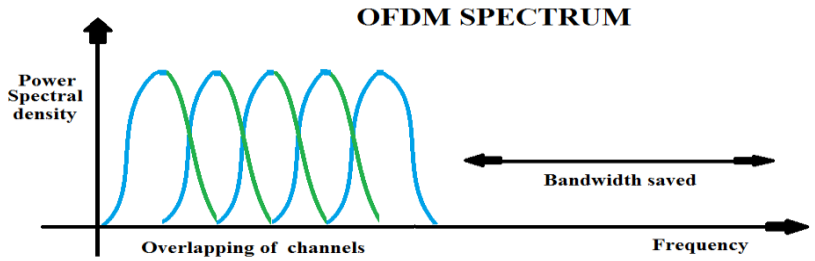

Figure 2 overlapping of channels in OFDM

The orthogonal property helps the overlapping channels not to interfere with each other. OFDM is sensitive to the carrier offset and carrier drift. From this we can say that OFDM is a special case of FDM.

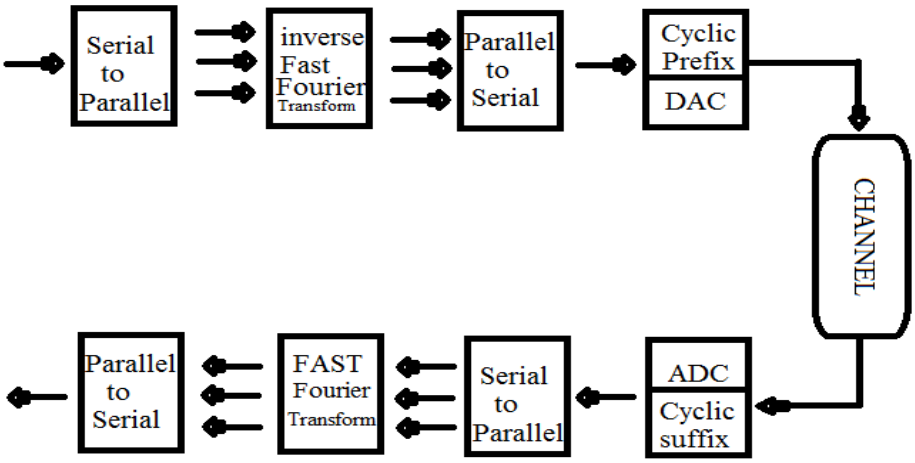

Figure 3 Basic OFDM block diagram

Here the input data bits are divided into subcarriers as shown in which are orthogonal to each other and they should be arranged in frequency domain and are allowed to inverse Fourier transform where we will obtain the sub carrier information in frequency domain to time domain. Here, from the spectral information before performing IFFT we can see that there is a case of overlapping of signals. But the interference case is ruled out due to their orthogonal nature. This data should be allowed to pass through parallel to serial converter so that all this data is in a single signal combined format. In cyclic prefix the last part of the signal in guard band is attached to the front part so that we can save the signal from intersymbol interference. This Digital data has to be converted to analog as only the analog transmission of data is possible through air interface (channel).At the receiver side the same thing happens in reverse procedure as occurred in the transmitter form. The received signal is processed to obtain the information. Cyclic suffix is used to place the part that is attached to the front (during cyclic prefix) to its initial place.

3. ESTIMATION OF CHANNEL LS AND MMSE

When the signal is transmitted through the channel, the receiver receives small amount of signal which is very low in power. There is loss of signal as it is passed through the channel. The loss of signal can be recovered some times by inserting parity kind of bits before transmission at the receiver side. And the channel which we are allowing our data to pass through consists of much kind of barriers that degrades our message signal. . This channel can be estimated by using pilot symbols which are to be inserted at the transmitter side. When the signal is received at the receiver side the channel estimation can be done using these symbols through least square and minimum mean square algorithms as follows.

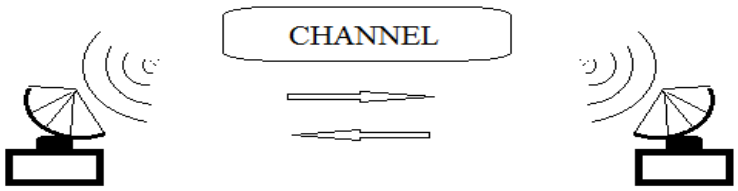

Figure 4 Transmitter and Receiver stations

If data is alone transmitted, the amount of fading that may occur cannot be tracked accurately at the receiving end .so some additional symbols are inserted in OFDM sub channels to effectively estimate the channel. These additional symbols are known as pilot symbols. Pilot symbols are known symbols that are inserted and sent along with the transmission signals to track the changes caused by the channel on the transmitted data. The number of pilots to be inserted depends on how accurately the channel must be estimated. As the number of pilot symbols increases the efficiency to estimate the channel and the capacity of the channel increases. There are two types of pilot symbols: block type and comb type in block type pilot based channel estimation, all the sub carriers are used as pilots and the symbols are transmitted periodically in each sub carrier. Where as in comb type pilot based channel estimation, a part of sub carriers are always dedicated for pilot symbols. Block type pilot based channel estimation is simpler when compared to comb type based estimation because estimation is done only once per block in block type and in comb type estimation should be done for every OFDM symbol. When compared to different channel estimation techniques, pilot based channel estimation will minimize the mean square error of the frequency selective channels.

4. SIMULATION RESULTS

The following simulations are done using MATLAB

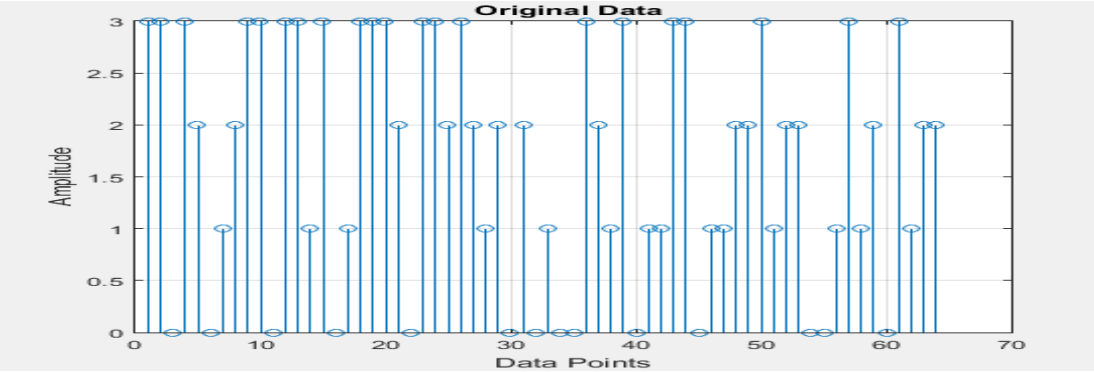

Figure 5 Input message signal

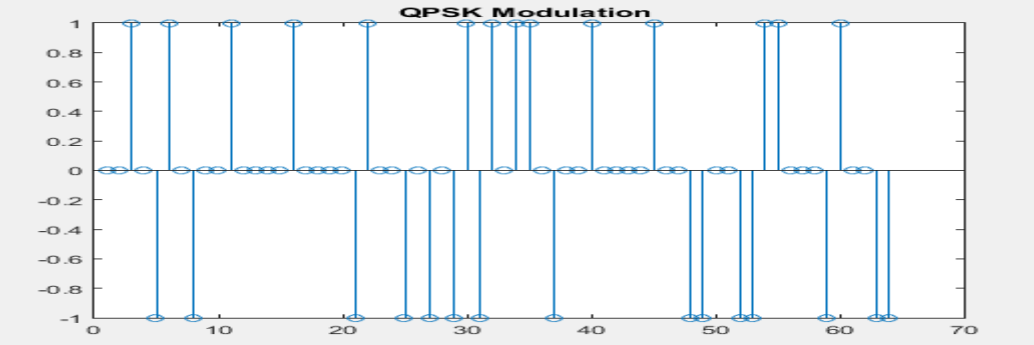

Figure 6 Modulated signal

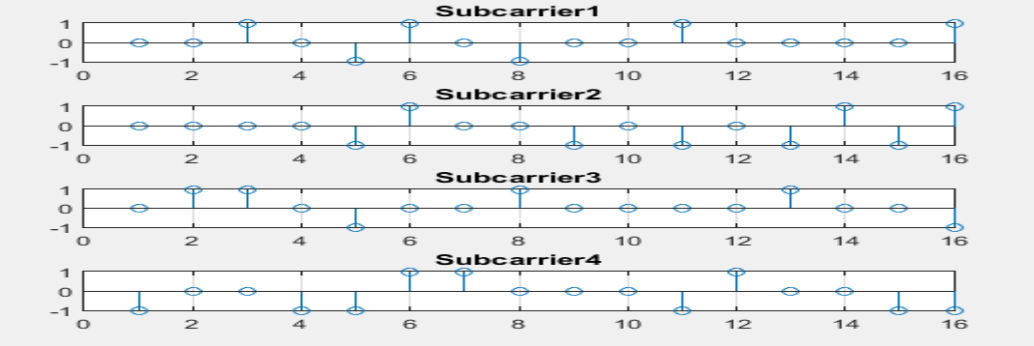

Figure 7 After dividing into subcarriers

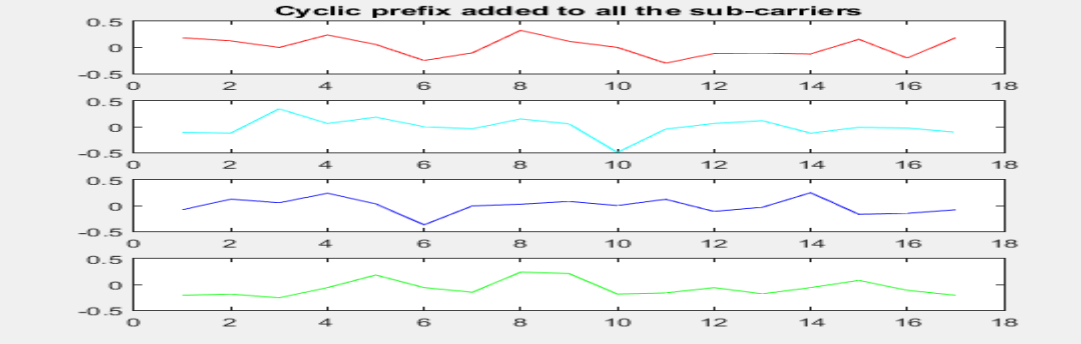

Figure 8 sub carriers after cyclic prefix

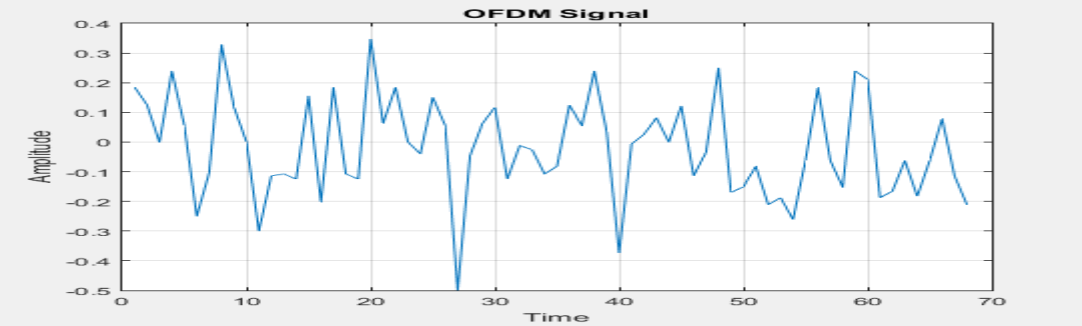

Figure 9 OFDM signal

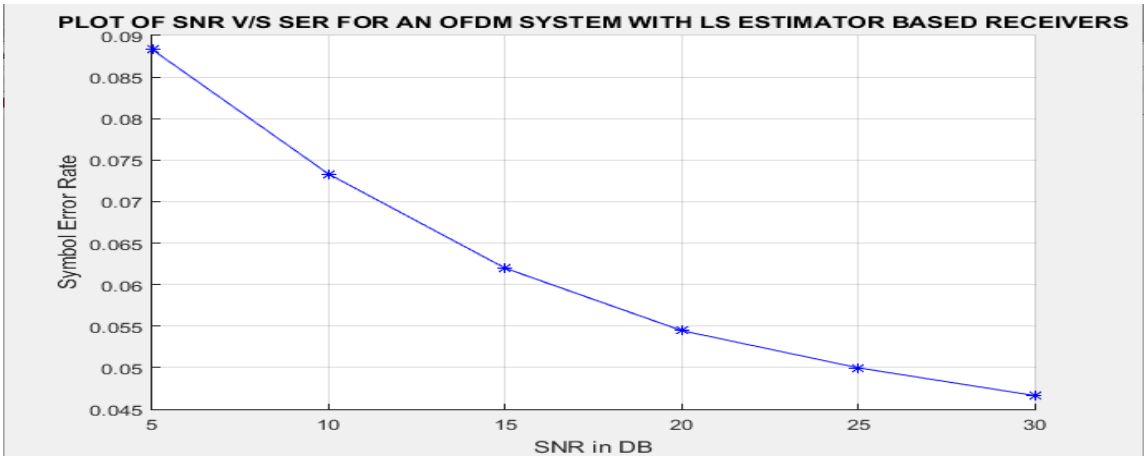

Figure 10 Output using Least square estimator

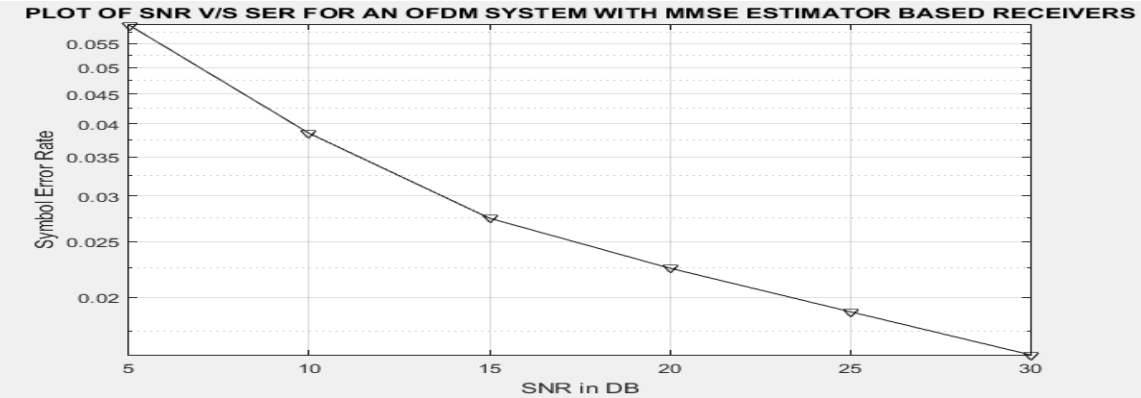

Figure 11 Output using mmse estimator

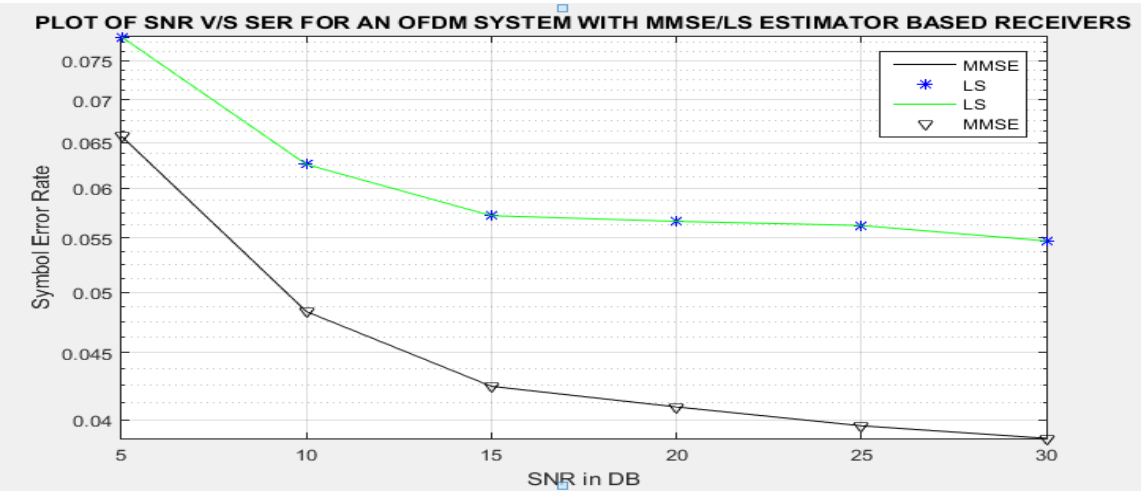

Figure 12 LS estimator vs. MMSE estimator

We also have compared performance of LSE with MMSE estimator. On comparison, we obtained gain in SER for MMSE estimator over the LS estimator.

5. CONCLUSION

To use the MMSE estimator, some prior knowledge of the noise variance and channel covariance must be known. Moreover, the complexity of MMSE estimator is more when compared to LS based estimator. But the MMSE estimator has good performance when compared to LS estimator. When comparing based on SNR's LS estimator has good performance at high SNR's where as MMSE estimators are efficient and good to estimate channels particularly at low SNR's.

REFERENCES

[1] A Comparative Survey on Paper Reduction Techniques For OFDM Performance Improvement, by RimpiDatta, Anirban Bhar, Arpita Barman Santra, Sohan Ghorai, IJECET publications, 6(10), Oct 2015, pp. 53–65.

[2] Research of MMSE and LS Channel Estimation in OFDM Systems, Liu Kewen and XingKe, School of Information Engineering, IEEE.

[3] Implementation of OFDM and Channel estimation Using LS and MMSE estimator, Sajjad Ahmed Ghauri , SherazAlam , AsadAli,FaizanSaleem.

[4] M. Farhan Sohail, IJCER Publications, 2(1), February 2013.

[5] Shraddha Patel, Vijay K.Patel and Dr. D.J.Shah, Performance Analysis of Pilot-Aided Mimo–OFDM Lte Downlink System Using Hybrid Ls–Lmmse Technique, *International Journal of Electronics and Communication Engineering & Technology*, **5**(3), 2014, pp. 94–101.

[6] Jaimin K. Raval, Prof. Vijay K. Patel and Dr. D. J. Shah, Research on Pilot Based Channel Estimation For Lte Downlink Using Ls and Lmmse Technique, *International Journal of Electronics and Communication Engineering & Technology*, **4**(3), 2013, pp. 70–82.