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Analysis of Block and Comb Type Pilots Patterns in Channel Estimation in OFDM

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***Abstract**— Now a days, because of wireless communication, worlds became a family. That is due to change of fast technology. OFDM system is very powerful modulation technology which can transmit and receive large number of data. Performance of system can be increased using channel estimation. The pilot aided channel estimation is very much useful method in OFDM. Different types of pilot patterns have special uses. But mainly two pilot patterns are very much useful. One is block type and other is comb type pilot arrangement. Using these patterns with LS and MMSE channel estimation techniques, reduce the BER and SER and increase the efficiency.*

***Key words**— Block type pilot pattern, comb type pattern, channel estimation, Least Square, Minimum Mean Square Error.*

I. INTRODUCTION

Orthogonal Frequency Division Multiplexing (OFDM) is a multicarrier modulation technology. Using this technology, no interference, reduce ISI and modulation technology, multiplexing technology both are available. It is suitable for frequency selective fading for high speed data transmission. This technology convert serial to parallel data. The original bandwidth of the signal is divided in to N number of subcarriers [1]. In this system, pilot insertion between data sequence at the transmitter. After the result data is modulated by inverse discrete Fourier transform [IDFT] on N parallel subcarriers. Then after receiving signal at receiver transformed back to frequency domain by DFT. Converts frequency domain data into time domain by IDFT. The number of points of the IDFT/DFT is equal to the total number of sub-carriers. Now because of DSP, it is became so easy to implement [2][3].

Using OFDM, it has so many advantages like high spectral efficiency, easy implementation, robustness against narrowband interference and scalability, using fast Fourier transforms (FFT). Disadvantage is that it has amplitude fluctuations that produce large peak-to-average power ratios.

Application of OFDM is IEEE 802.11a, IEEE 802.16e, Mobile Broadband Wireless Access, DVB terrestrial TV systems, Long term evolution, power line communication, etc. [4].

II. CHANNEL ESTIMATION

When any signal is modulated is transmitted in channel, because of many reasons it is distorted. Mainly divided in three effects. One reason is because of fading effect, signal is distorted. Second is because of different types of noises like background noise, impulse noise superimposed on the signals and directly effects on amplitude, phase and frequency of the signals. Third is due to reflection, refraction or spreading signal during different paths transmission, with additive effects signals will interfere with each other. At end bit error rates will be increased.

Using channel estimation BER will be reduced. For designing channel estimation, there are two main problems. First is choice that selection of pilot and second is channel estimation has good pilot tracking capacity and low complexity. Inter-related the choice of pilot information and the design of estimator. Performance of channel estimation is reduced if pilot information are more so trade-offs is required between two.

Mainly three classifications of channel estimations which are pilot based, semi blind and blind. For training based scheme, a long training is necessary to channel estimate. Because of that reduces system bandwidth efficiency. In blind method, no training symbols are used. It has channel state information is obtain by dependant on the received signal statistics. But it has very high computational complexity. Combination of training based channel estimation and blind method is known as semi-blind channel estimation [5]. For demodulating OFDM, dynamic channel estimation is required [6].

III. PILOT BASED CHANNEL ESTIMATION

Pilot-symbol aided channel estimation (PACE), using comb-type and block-type pilot subcarrier arrangements are shown here. These two pilot arrangement are so much useful in channel estimation.

COMB-TYPE PILOT

By periodical pilots inserting at subcarrier in every OFDM block called a Comb-type shows that figure 1.

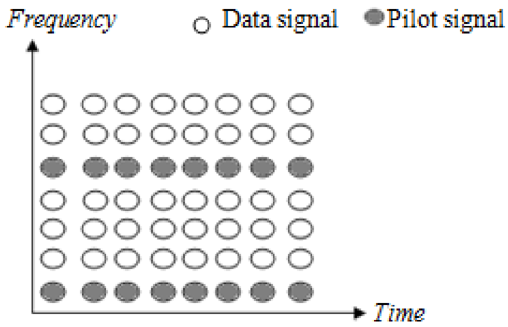

Figure 1: Pilot arrangement of comb-type.

In fast fading comb type pilot is useful but not for slow fading [7].

BLOCK-TYPE PILOT.

Here sending periodically estimation symbols, so pilots are used as all sub-carriers awhich are shown in figure 2.

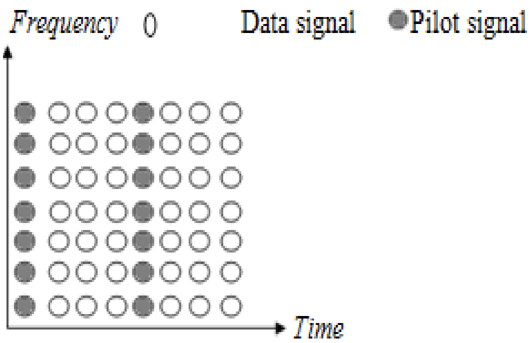

Figure 2: Pilot arrangement of block type.

From the figure, it is used for slow fading channel but not fast fading [7].
Here many types of channel estimations are available. From many types, LS and MMSE method are most useful methods. LS method is very simple but high mean square error (MSE) [8][11].
The algorithms used there are based on the least squares (LS) and the minimum mean-square error (MMSE).

LS ESTIMATOR:

Here estimate the system with the least square error (LSE) estimation method. Here h[m] by minimizing the squared error between estimation and detection $X_i[n]$.

$$X_i[n] \longrightarrow h[m] \longrightarrow Y_o'[n]$$

With matrix form,

$$y_o = X_i h \qquad (1)$$

Error 'e' can be written as

$$e = y_o'' - y \qquad (2)$$

Here the expected output is y_o''.
E is squared error defined as

$$E = | e |^2$$
$$E = (y_o'' - y_o)^2$$
$$E = (y_o'' - y_o)^*(y_o'' - y_o)^t \qquad (3)$$

Where 't' is a complex transpose of a matrix.

$$E = (y_o'' - X_i h) * (y_o'' - X_i h)^t \qquad (4)$$

Taking its derivative w.r.t 'h' and equating it equal to zero for minimizing equation. The final equation we get is:

$$h'' = (X_i^t X)^{-1} X_i^t y_o \qquad (5)$$

So it is written as

$$h'' = X_i^{-1} y_o \qquad (6)$$
$$hls = X_i^{-1} y_o \qquad (7)$$

The above equation useful for SISO and also MIMO systems [10]. Interpolation is required in LS channel estimation algorithms [9].

MINIMUM MEAN SQUARE ERROR (MMSE)

The MMSE estimator minimizes the mean-square error.

If 'XI' is transmitted over a channel 'h' such that

$$Yo = Xi\ h \quad (8)$$

Error is given as

$$e = yo'' - yo \quad (9)$$

Where yo" is expected output.

$$\text{Mean Square Error} = \text{mean}\{(yo''- yo)^2\} = E\ \{(yo''- yo)^2\} \quad (10)$$

Where 'E' is the operator for expected value

For finding the channel response, correlation and expected value can be used to derive the equations.

Rgg is auto covariance matrix of 'g'

RYoYo is auto covariance matrix of 'Yo'

RgYo is cross covariance matrix of 'g' and 'Yo'

The Hmmse estimated channel can be found by below equation.

$$Hmmse = F * (RgYo * RYoYo^{-1} * Yo) \quad (11)$$

Where F is a noise matrix

$$Rgy = Rgg * F' * Xi' \quad (12)$$

$$RYoYo = Xi * F * Rgg * F' * Xi' + \text{variance of noise} * \text{Identity Matrix} \quad (13)$$

The above equation can be used for both SISO and also MIMO systems [10].

In MMSE matrix properties don't include simple matrix operations.

IV. RESULTS AND DISCUSSION:

The MATLAB simulation is shown the difference between without channel estimation and with channel estimation. With channel estimation, BER is reduced that we can see in figure 3. It is using comb type pilot arrangement in LS channel estimation. BER remains constant in without channel estimation.

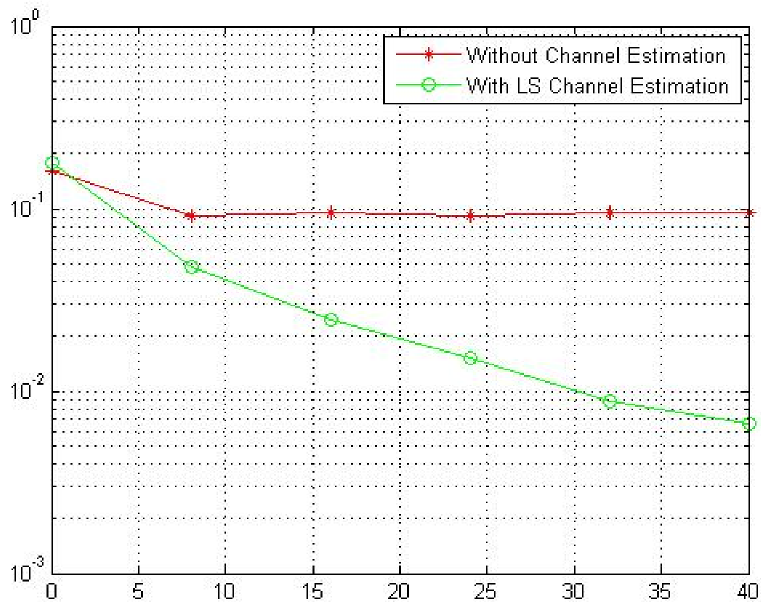

Fig.1. BER Vs SNR of with and without channel estimation

Using MATLAB simulation, various parameters which are being considered in presence of AWGN. Here using block type pilot arrangement. Using channel estimation done with LS and MMSE algorithms. The simulation results are shown in figures. QAM with different modulation scheme are shown Fig.2. If we change 4-QAM to 128-QAM scheme than BER increase with increase in SNR.

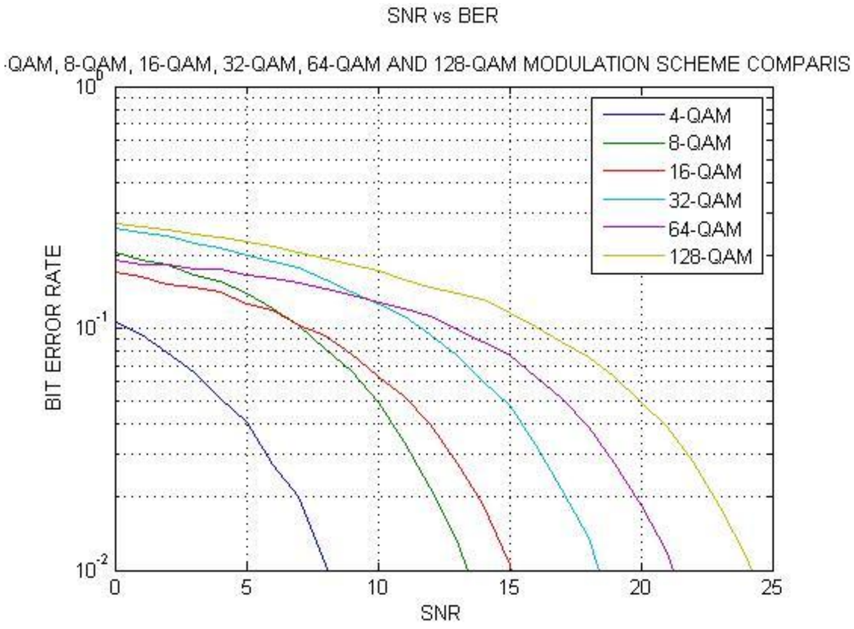

Fig.2. BER Vs SNR with different QAM scheme

Using block type pilot arrangement with the LS and MMSE channel estimation, Symbol Error Rate is high in LS where MMSE has less SER. So MMSE technique is good compare to LS technique but complexity is high. It is shown in Fig.3.

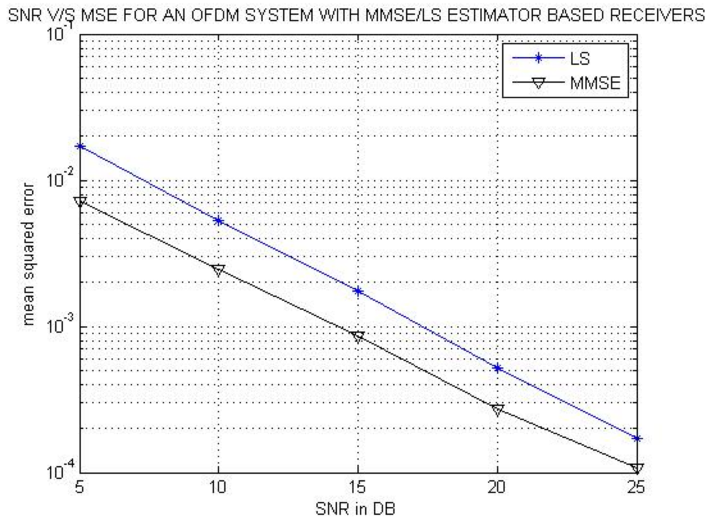

Fig.3. MSE Vs SNR in LS and MMSE estimator

V. CONCLUSIONS

We have checked the results without channel estimation and with estimation. We have also observed a BER and SNR for different cases and suggested algorithm provides a better results. We are concluding that our propped algorithm provide better abd efficient result with channel estimation.

REFERENCES

[1] Jeba Inbaraj Nadar, Jayasudha Koti, Deepak Jayaswal 'OFDM Pilot based Channel Estimation, IEEE International Conference on Advances in Engineering &Technology Research (ICAETR - 2014), August 01-02, 2014, 978-1-4799-6393-5/14/2014 IEEE.

[2] First R. Hajizadeh, Second K. Mohamedpor, and Third M.R. Tarihi.: Channel Estimation in OFDM System Based on the Linear Interpolation, FFT and Decision Feedback .In: 18th Telecommunications forum TELFOR 2010 Serbia, Belgrade, November 23-25, 2010, pp 484-488(2010).

[3] Li Xiao-min, Li Xiao-ling, Liang Bing "Research on Channel Estimation of OFDM System" 978-1-4577-0321-8/11/ 2011 IEEE, pp: 994-997.
[4] Latif Ullah Khan, M. Haseeb Zafar, M. Irfan Khattak, Naeem Khan "A Novel Channel Estimation Error Minimizing Interpolation Technique for OFDM Systems " 9th Symposium on Communication Systems, Networks & Digital Sign (CSNDSP), 2014.
[5] Jaymin Bhalani "Analysis, Design & Implementation of Reduced Complexity & Near Optimal Performance Semi-Blind Channel Estimation Techniques for Wireless MIMO Communication System" a thesis Maharaja Sayajirao University of Baroda, 2012.
[6] Md. Nazmul Islam Khan, Md. Jobayer Alam" Efficient Scheme for Channel Estimation in OFDM System" Journal Of Networks, Vol. 9, No. 12, December 2014, pp: 3192-3199.
[7] A B Bambhaniya, J M Rathod" Research on Various Pilot Pattern Design for Channel Estimation in OFDM System" International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 24 (2017) pp. 14403-14407.
[8] A B Bambhaniya, J M Rathod, J. M., 2013, "Channel Estimation Techniques used in OFDM System for Different Modulation Techniques: an overview," International Journal of Scientific Research, Vol. 2(4), 2013, pp. 48-51.
[9] Mohamad Suhaizal Abu Hassan , R. Badlishah Ahmad "Variable Pilot Channels Estimation based on Blocktype and Comb-type Pilot Arrangement in OFDM System" 2016 3rd International Conference on Electronic Design (ICED), August 11-12, 2016, Phuket, Thailand 978-1-5090-2160-4/16/2016 IEEE
[10]Yogeshwari Y Ujalmbkar, Sayad Shoaib Anwar "Minimization of Interference Using Different Equalization Techniques" International Journal of Engineering Development and Research, 2014 IJEDR | Volume 3, Issue 1 | ISSN: 2321-9939, pp: 65-69.
[11]N.S. Sai Srinivas "OFDM System Implementation, Channel Estimation and Performance Comparison of OFDM Signal" 13th International Conference on Electromagnetic Interference and Compatibility (INCEMIC), 22-23 July 2015 publisher: by IEEE.