Review paper on Comparison and Analysis of Channel Estimation Algorithm in MIMO-OFDM System

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Abstract-The main objective of the paper is to preview the work that has already been done related to channel estimation techniques in MIMO-OFDM system. Channel estimation algorithm i.e. Block type, Comb type, etc, are discussed. In communication systems MINO-OFDM, channel estimation plays a major role. Channel estimation is the estimation of transmitted signal bits using received signal bits. In this paper a review on different channel estimation methods like Least Square and Minimum Mean Square Error, Least mean Square methods are discussed.

Keyword — Channel estimation, MIMO, OFDM, MMSE, LLMS.

I. Introduction

In mobile communication systems bits of information is transmitted by making changes in amplitude or phase of radio waves. On the receiving side, amplitude or phase varies dramatically. The performance of receiver is highly dependent on the accuracy of the estimated instantaneous channel so as a result system quality is degraded. Due to this reason channel estimation technique is introduced so that the accuracy of the received signal is improved. The radio channels are usually multipath fading channels which causes Inter Symbol Interference (ISI) in the received signal. Many a kind of detection algorithms are used at the receiving side to remove ISI from the signal. A separate channel estimator provides knowledge on channel impulse response. The channel estimator is based on the known sequence if bits which are unique for certain transmitter. Thus channel estimator estimates CIR separately for each burst from the transmitted bits which are known. OFDM (Orthogonal frequency division multiplexing) is a multicarrier modulation technique used to transmit high rate data stream through wireless medium. A high rated data stream is divided into parallel lower rate data streams which are transmitted simultaneously over a number of separate subcarriers. This technique also eliminates Inter Symbol Interference. In OFDM implementation is performed by making use of Fast Fourier Transform (FFT)/Inverse Fast Fourier Transform (IFFT) algorithms. It improves the frequency spectral efficiency and minimizes the complexity of the receiver by converting the frequency selective channel into collection of parallel frequency flat sub channels. MIMO (Multiple Input Multiple Output) uses multiple antennas in the transmitter and receiver sides at the

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same time, increasing the transmission rate. Use of multiple antennas or antenna systems at both ends of the wireless link is a solution to enhance the bandwidth efficiency and reliability of communication system without any need of extra bandwidth or transmitting power. MIMO technology helps in maximizing the signal to noise ratio for wireless channel and further reduces the interference and improves the quality of service.

Introduction Of MIMO–OFDM System

Traditional wireless communication systems provided constant bandwidth, no possibility of increasing the sending rate of information. Bandwidth, information sending rate and software-hardware complexities are the important parameters to design a communication system. Methods such as MIMO, OFDM and integrating them as MIMO-OFDM are suggested to expand the new generation of communication system. OFDM's high resistance against the ISI event and its function against fading, besides the high rate of information sending of MIMO create an efficient complex in accession towards the fourth generation of wireless communication's demand. The increase in number of unknowns makes estimating the channel in these systems more complex than estimating channel in one antenna systems. Block diagram of one kind of MIMO-OFDM is

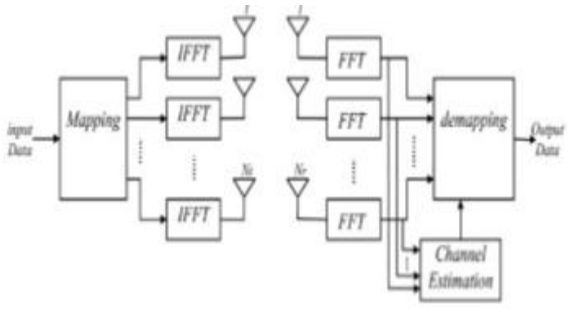

Fig. 1: Block Diagram of System

shown in the figure. MIMO communication system with Nt transmitting antennas and Nr receiving antennas According to the figure the information in each antenna goes under IDFT action and cyclic prefix is added and then sent. Each receiver antenna receives sum of noises and signals sent by the transmitter antenna. In each receiver antenna revealing is done only after removal of CP and DFT action

II. Channel Estimation

Channel estimation is a very important task in coherent communication systems. As well as it is a major issue for coherent OFDM systems [7]. Channel estimation is more difficult because of the increased number of channels to be estimated as compared to SISO systems. Channel estimation method is developed based on the signals correlation and MAI suppression. The quality of the channel estimation method has an intense impact on the overall bit error rate (BER) performance of the receiver. There are two major types of channel estimation schemes, (1) Pilot assisted schemes, in which a portion of the bandwidth is assigned to training symbols and, (2) Blind approach, which can be implemented by using statistical properties. At receiver side, channel estimation can be done by adding pilot signals into the transmitted signals. Pilot tones, along with OFDM symbol are used to estimate the channel. Block type and comb type pilot arrangements are the two types of pilot channel insertions.

III. Literature Survey

A. Channel Estimation using Adaptive filters in MIMO-OFDM systems [4] in this paper channel estimation method is done by using adaptive filters in MIMO-OFDM systems. The method exploits pilots and adaptive filters to estimate channel.

B. Pilot aided LS channel estimation in MIMO-OFDM system [7] LS estimates to the channel condition at the pilot subcarrier H^P are calculated by:

$$\hat{H}_{LS}^{P} = [Y(P_0)/X_0^P, Y(P_1)/X_1^P, ..., Y(P_{N_P-1})/X_{N_P}^P]^T$$

C. Channel estimation analysis in MIMO-OFDM wireless systems [9] in this paper research have analyzed channel estimation on MIMO-OFDM system for Rayleigh fading channel. The two different algorithms such as LS and MMSE channel estimation algorithms are applied and simulation is performed.

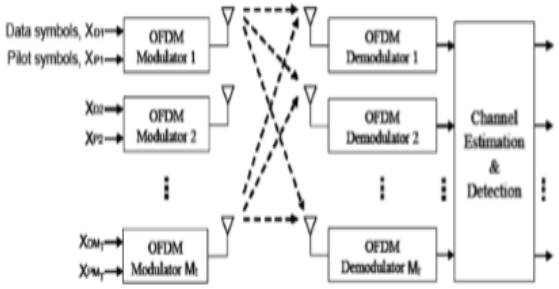

Fig.2: Block Diagram of MIMO OFDM System

D. A new derivation of LS fitting principle for OFDM channel estimation [8] Main–Xian Chang, IEEE. 2006. Channel estimation and data detection algorithms of OFDM system has presented in this paper. Proposed algorithm is based on LMMSE estimation..

E. Detection of OFDM signals in fast varying channels with low-density pilot symbols [3] Ming-Xian Chang, IEEE. 2007. In this paper a pseudo pilot algorithm for data detection in fast varying channel without increasing pilot density is proposed. This algorithm is based on regression model based LS fitting approach..

F. Efficient MIMO channel estimation with optimal training sequences [6] In the paper efficient MIMO channel estimation with optimal training sequences are presented. The minimum mean square error of the channel estimate is achieved with optimal training sequences. Optimal training sequences of minimum length are determined on the basis of the required accuracy of the estimate.

G. Enhanced Adaptive channel estimation technique for MIMO-OFDM wireless systems [5] an enhanced technique for channel state information estimation in MIMO-OFDM system has been presented. It is concluded that RLMS algorithm outperforms LLMS but RLMS has a disadvantage that it is more complex than LLMS.

Linear interpolation:

The channel estimation at the data- carrier

$$k,\ mL < k < (m+1)L,$$

Using linear interpolation is given by

$$\begin{aligned} H_e(k) &= H_e(mL+l) \\ &= (H_p(m+1) - H_p(m))\frac{l}{L} + H_p(m) \end{aligned}$$

Second order interpolation:

The channel estimated by second order interpolation is given by:

$$\begin{aligned} H_e(k) &= H_e(mL+l) \\ &= c_1 H_p(m-1) + c_0 H_p(m) + c_{-1} H_p(m+1) \end{aligned}$$

$$\text{Where} \begin{cases} c_1 = \frac{\alpha(\alpha-1)}{2} \\ c_0 = -(\alpha-1)(\alpha+1), \quad \alpha = \frac{1}{N} \\ c_{-1} = \frac{\alpha(\alpha+1)}{2} \end{cases}$$

H. Channel estimation techniques based on pilot arrangement in OFDM system [1] the researchers in this

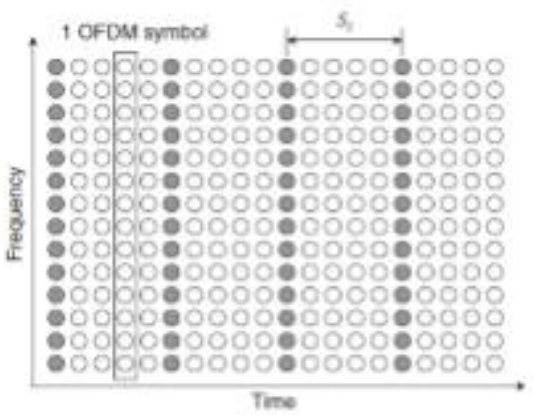

Fig.3: Blok Type Pilot Arrangement

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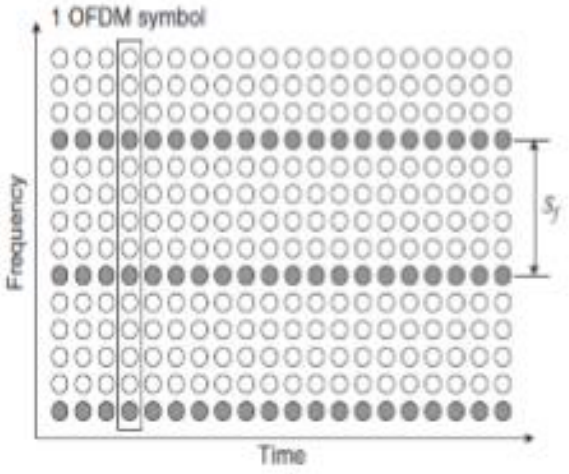

Fig.4: Comb Type Pilot Arrangement

Paper has given a full review of block type and comb type pilot based channel estimation. Also channel estimation based on comb type pilot arrangement is presented by giving channel estimation methods at the pilot data frequencies.

VI. Conclusion

In the paper, the various channel estimation techniques for MIMO-OFDM are studied. Channel estimation algorithms have been compared and results show that least square algorithm is the simplest amongst all but has low performance. It is also found that comb type pilot system performs better than block type system.

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