INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

IJARIIT

ISSN: 2454-132X

Impact factor: 4.295

(Volume3, Issue3)

Available online at www.ijariit.com

Review on OFDM-Mimo Channel Estimation by Adaptive and Non-Adaptive Approaches

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Abstract: With this paper, review the several routes in MIMO-OFDM with predictive estimation on a different kind of modulation because of OFDM turns a frequency-selective route into a parallel assortment of frequency even substations. The subcarriers possess the minimum frequency parting necessary to maintain orthogonally of the corresponding time site waveforms, the signal spectra matching to the several subcarriers overlap in occurrence. Hence, the available bandwidth is employed very proficiently so the review is real as the important view of under position different prediction evaluation, which surrender table.

Keywords: OFDM, MIMO, Frecy, optimization.

I. INTRODUCTION

Orthogonal frequency division multiplexing (OFDM) has become a popular technique for transmission of signals over wireless channels. OFDM has been adopted in several wireless standards such as digital audio broadcasting (DAB), digital video broadcasting (DVB-T), the IEEE 802.11a local area network (LAN) standard and the IEEE 802.16a metropolitan area network (MAN) standard. OFDM is also being pursued dedicated short-range communications (DSRC) for roadside to vehicle communications and as a potential candidate for fourth-generation (4G) mobile wireless systems. OFDM converts a frequency-selective channel into a parallel collection of frequency flat subchannels. The subcarriers have the minimum frequency separation required to maintain orthogonality of their corresponding time domain waveforms, yet the signal spectra corresponding to the different subcarriers overlap in frequency. Hence, the available bandwidth is used very efficiently. If knowledge of the channel is available at the transmitter, then the OFDM transmitter can adapt its signaling strategy to match the channel. Because OFDM uses a large collection of narrowly spaced subchannels, these adaptive strategies can approach the ideal water pouring capacity of a frequency-selective channel [1]. HIGH-DATA rate techniques in communication systems have gained considerable interest in recent years. A technique that has attracted a lot of attention is orthogonal frequency division multiplexing (OFDM), which is a multicarrier modulation technique. This is due to its simple implementation, and robustness against frequency-selective fading channels, which is obtained by converting the channel into flat fading subchannels. OFDM has been standardized for a variety of applications, such as digital audio broadcasting (DAB), digital television broadcasting, wireless local area networks (WLANs), and asymmetric digital subscriber lines (ADSLs). Combining OFDM with multiple antennas has been shown to provide a significant increase in capacity with transmitter and receiver diversity [2]. The growing demand for higher data transmission rate over fading channels requires multicarrier transmission, popularly known as orthogonal frequency division multiplexing (OFDM). The multiple input multiple outputs (MIMO) with OFDM system is a promising solution to achieve high data rate and diversity in a fading environment. The digital audio broadcasting (DAB), digital video broadcasting (DVB), HIPERLAN/2, IEEE 802.11a, IEEE 802.16e, and 4G telecommunication systems are a few of the application areas of MIMO-OFDM. A system with multiple transmits and multiple receive antennas increases the channel capacity and data throughput without any expansion in the required bandwidth or increase in the transmit power [3]. High Data-Rate wireless access is demanded by many applications. Traditionally, more bandwidth is required for higher data-rate transmission. However, due to spectral limitations, it is often impractical or sometimes very expensive to increase bandwidth. In this case, using multiple transmit and receive antennas for spectrally efficient transmission is an alternative solution. Multiple transmit antennas can be used either to obtain transmit diversity or to form multiple-input-multiple-output (MIMO) channels. Many researchers have studied using multiple transmit antennas for diversity in wireless systems. Transmit diversity may be based on linear transforms or space–time coding, In particular, space–time coding is characterized by high code efficiency and good performance; hence, it is a promising technique to improve the efficiency and performance of orthogonal frequency division multiplexing (OFDM) systems.

On the other hand, the system capacity can be significantly improved if multiple transmit and receive antennas are used to form MIMO channels. It is proven in that, compared with a single-input-single-output (SISO) system with flat Rayleigh fading or narrowband channels, a MIMO system can improve the capacity by a factor of the minimum number of transmitting and receive antennas. For wideband transmission, space–time processing must be used to mitigate inter-symbol interference (ISI). However, the complexity of the space–time processing increases the bandwidth, and the performance substantially degrades when estimated channel parameters are used. In OFDM, the entire channel is divided into many narrow parallel sub-channels, thereby increasing the symbol duration and reducing or eliminating the ISI caused by the multipath. Therefore, OFDM has been used in digital audio and video broadcasting in Europe and is a promising choice for future high-data-rate wireless systems. Multiple transmit and receive antennas can be used with OFDM to further improve system performance [4]. Multicarrier transmission for wireline channels has been well studied. The main advantage of Orthogonal Frequency Division Multiplexing (OFDM) transmission in time-invariant channels is because the Fourier basis forms an eigenbasis for time-invariant1 channels. This simplifies the receiver in OFDM schemes, where the equalizer is just a single-tap filter in the frequency domain. Therefore, OFDM-based schemes have been combined with multiple antennas for wireless channels where it is assumed that the channel is time-invariant within a transmission block. This allows for inexpensive hardware implementations, making OFDM modems attractive for high data rate wireless networks (Wireless LANs and Home Networking). However, the block time-invariance assumption may not be valid in high-mobility applications or when there are impairments such as synchronization errors (e.g., frequency offset) [5]. Orthogonal Frequency Division Multiplexing (OFDM) has become popular for wireless communications. A multicarrier system can be efficiently implemented in discrete time using Inverse Discrete Fourier Transform (IDFT) to act as a modulator. The actual data to be transmitted; now represent “frequency” domain coefficients of the signal and the samples at the output of the IDFT stage are in the “time” domain. OFDM requires synchronization in both the time and frequency. Time synchronization involves finding the best possible time instant for the start of received and downconverted OFDM frame. Frequency synchronization deals with finding an estimate of the difference in the frequencies between the transmitter and receiver local oscillators. The frequency offset estimation in OFDM is critical since any frequency offset causes a loss of sub-channel orthogonality which results in Inter Carrier Interference (ICI) and hence performance degradation. Synchronization schemes based on training symbols must be efficient in terms of performance and overhead. In addition, they must be able to operate in both burst and continuous modes. The structure should also aide in channel estimation since channel estimation is an integral part of the OFDM demodulation. Numerous techniques have been suggested in the literature for OFDM time and frequency synchronization, however, none of them can be applied without major modifications to Multi Input Multi Output (MIMO) systems. The techniques that are described in the literature suggest training symbol structure specialized for synchronization but do not take into account the channel estimation that also needs to be done. Hence, additional training symbols are needed for channel estimation [6].

II. LITERATURE REVIEW

GORDON L. STÜBER et.al [1] this paper explores various physical layer research challenges in MIMO-OFDM system design, including physical channel measurements and modelling, analog beamforming techniques using adaptive antenna arrays, space–time techniques for MIMO-OFDM, error control coding techniques, OFDM preamble and packet design, and signal processing algorithms used for performing time and frequency synchronization, channel estimation, and channel tracking in MIMO-OFDM systems. Finally, the paper considers a software radio implementation of MIMO-OFDM.

Imad Barhumi et.al [2] this paper describes the least squares (LS) channel estimation scheme for multiple-input-multiple-output (MIMO) orthogonal frequency division multiplexing (OFDM) systems based on pilot tones. It first computes the mean square error (MSE) of the LS channel estimate. It then derives optimal pilot sequences and optimal placement of the pilot tones with respect to this MSE. It is shown that the optimal pilot sequences are equip were, equispaced, and phase shift orthogonal. To reduce the training overhead, an LS channel estimation scheme over multiple OFDM symbols is also discussed. Moreover, to enhance channel estimation, a recursive LS (RLS) algorithm is proposed, from which we derive the optimal forgetting or tracking factor. This factor is found to be a function of both the noise variance and the channel Doppler spread. Through simulations, it is shown that the optimal pilot sequences derived in this paper outperform both the orthogonal and random pilot sequences. It is also shown that a considerable gain in signal-to-noise ratio (SNR) can be obtained by using the RLS algorithm, especially in slowly time-varying channels**.**

Khushboo Pachori et.al [3] in this article, a combinational scheme, active partial sequence (APS), is proposed to combat PAPR in MIMO-OFDM under Rayleigh fading environment. The key idea of the APS method is to combine the approximate gradient project followed by partial transmit sequence technique. The simulation results show that the proposed method achieves a significant reduction in PAPR and maintains the same data rate without sacrificing the BER performance over other conventional techniques.

Ye (Geoffrey) Li et.al [4] in this paper, orthogonal frequency division multiplexing (OFDM) for MIMO channels (MIMO-OFDM) is considered for wideband transmission to mitigate inter-symbol, interference and enhance system capacity. The MIMO-OFDM system uses two independent space-time codes for two sets of two transmit antennas. At the receiver, the independent space–time codes are decoded using whitening, followed by minimum-Euclidean-distance decoding based on successive interference cancellation. Computer simulation shows that for four-input and four output systems transmitting data at 4 Mb/s over a 1.25 MHz channel, the required signal-to-noise ratios (SNRs) for 10% and 1% word error rates (WER) are 10.5 dB and 13.8 dB, respectively, when each codeword contains 500 information bits and the channel’s Doppler frequency is 40 Hz (corresponding normalized frequency: 0.9%). Increasing the number of the receive antennas improves the system performance. When the number of receive antennas is increased from four to eight, the required SNRs for 10% and 1% WER are reduced to 4 dB and 6 dB, respectively. Therefore, MIMO-OFDM is a promising technique for highly spectrally efficient wideband transmission.

Suhas Diggavi et.al [5] in this paper, examine multicarrier transmission over time-varying channels. Develop the model for such a transmission scheme and focus particularly on OFDM-based schemes. It analyze the impact of time-variation within a transmission block which could arise both from Doppler spread of the channel and from synchronization errors. It proposed a time-domain approach to mitigate the effects of such time-variations. This approach reduces to the familiar single-tap frequency-domain equalizer when the channel is blocked time-invariant. It also develops this in the context of multiple transmit and receive antennas and specialize the receiver to space-time block-coded systems.

Apurva N. Mody et.al [6] this paper proposes a time and frequency synchronization technique for a Q transmit and L receive (Q× L), MIMO-OFDM system. The synchronization is achieved using training symbols which are simultaneously transmitted from Q transmit antennas. The training symbols are directly modulate orthogonal polyphase sequences. The synchronization algorithm shows satisfactory performance even at a low SNR and in a frequency selective channel. The training sequence structure is specialized such that channel parameters in terms of channel coefficients and noise variance can be estimated once synchronization is achieved.

Hongwei Yang et.al [7] in this article it gives a brief technical overview of MIMO-OFDM system design. Its focuses on various research topics for the MIMO-OFDM-based air interface, including spatial channel modeling, MIMOOFDM transceiver design, MIMO-OFDM channel estimation, space-time techniques for MIMO-OFDM, and error correction code. The corresponding link-level simulation results are encouraging and show that MIMO-OFDM is a promising road to future broadband wireless access.

Ingmar Hammerström et.al [8] it considers a two-hop MIMO-OFDM communication scheme with a source, an amplify-and-forward relay, and a destination. Examine the possibilities of power allocation (PA) over the sub-channels in frequency and space domains to maximize the instantaneous rate of this link if channel state information at the transmitter (CSIT) is available. It considers two approaches: (i) separate optimization of the source or the relay PA with individual per node transmit power constraints and (ii) joint optimization of the source and the relay PA with joint transmit power constraint. It provides the optimal PA at the source (or the relay) with a node transmit power constraint that maximizes the instantaneous rate for a given relay (or source) PA. Furthermore, show that repeating this separate optimization of the source and the relay PA alternately converges and improves the achievable rate of the considered link. Since the joint optimization of the source and the relay PA is analytically not tractable, we use a high SNR approximation of the SNR at the destination. This approximation leads to rates, which are quite tight to the optimum.

Rick S. Blum et.al [9] improved MIMO-OFDM techniques were studied for wireless systems using QPSK modulation for four transmit and four receive antennas. It first considered such a system employing two 16-state, 2-antenna space–time codes with successive interference cancellation and channel estimation. Furthermore, it proposed a 4-antenna, 16-state code that achieves an additional 2-dB improvement with lower complexity and a 256-state code that achieves an additional 2-dB gain. The 256-state code performed within 3 dB of outage capacity (and within 2 dB with perfect channel estimation).

Helmut Bölcskei et.al [10] In this paper, using a broadband MIMO channel model taking into account Ricean K-factor, transmit and receive angle spread, and antenna spacing, study the impact of the propagation environment on the performance of space-frequency coded MIMO-OFDM. For a given space-frequency code, it quantifies the achievable diversity order and coding gain as a function of the propagation parameters. It finds that while the presence of spatial receive correlation affects all space-frequency codes equally, spatial fading correlation at the transmit array can result in widely varying performance losses. High-rate space-frequency codes such as spatial multiplexing are typically significantly more affected by transmitting correlation than low-rate codes such as space-frequency block codes. It shows that in the MIMO Ricean case the presence of frequency-selectivity typically results in improved performance compared to the frequency-flat case.

Author Name	Year	Technology Used	Description
Rick S. Blum et.al	2001	Improved space-time coding	Improved MIMO-OFDM techniques were studied for wireless systems using QPSK modulation for four transmit and four receive antennas. It first considered such a system employing two 16-state, 2-antenna space–time codes with successive interference cancellation and channel estimation.
Apurva N. Mody et.al	2001	Synchronization for MIMO-OFDM	This paper proposes a time and frequency synchronization technique for a Q transmit and L receive (Q× L), MIMO-OFDM system. The synchronization is achieved using training symbols which are simultaneously transmitted from Q transmit antennas. The training symbols are directly modulate orthogonal polyphase sequences. The synchronization algorithm shows satisfactory performance even at a low SNR and in a frequency selective channel.
Ye (Geoffrey) Li et.al	2002	MIMO-OFDM	In this paper, orthogonal frequency division multiplexing (OFDM) for MIMO channels (MIMO-OFDM) is considered for wideband transmission to mitigate intersymbol, interference and enhance

			system capacity. The MIMO-OFDM system uses two independent space-time codes for two sets of two transmit antennas. At the receiver, the independent space–time codes are decoded using whitening, followed by minimum-Euclidean-distance decoding based on successive interference cancellation.
Suhas Diggavi et.al	2002	Intercarrier interference	In this paper, examine multicarrier transmission over time-varying channels. Develop the model for such a transmission scheme and focus particularly on OFDM-based schemes. It analyze the impact of time-variation within a transmission block which could arise both from Doppler spread of the channel and from synchronization errors. It proposed a time-domain approach to mitigate the effects of such time-variations.
Imad Barhumi et.al	2003	Optimal training design	This paper describes the least squares (LS) channel estimation scheme for multiple-input-multiple-output (MIMO) orthogonal frequency division multiplexing (OFDM) systems based on pilot tones. It first computes the mean square error (MSE) of the LS channel estimate. It then derives optimal pilot sequences and Optimal placement of the pilot tones with respect to this MSE. It is shown that the optimal pilot sequences are equip were, equispaced, and phase shift orthogonal.
GORDON L. STÜBER et.al	2004	MIMO-OFDM	This paper explores various physical layer research challenges in MIMO-OFDM system design, including physical channel measurements and modeling, analog beamforming techniques using adaptive antenna arrays, space–time techniques for MIMO-OFDM, error control coding techniques, OFDM preamble, and packet design, and signal processing algorithms used for performing time and frequency synchronization, channel estimation, and channel tracking in MIMO-OFDM systems. Finally, the paper considers a software radio implementation of MIMO-OFDM.
Hongwei Yang et.al	2005	MIMO-OFDM	In this article, it gives a brief technical overview of MIMO-OFDM system design. Its focuses on various research topics for the MIMO-OFDM-based air interface, including spatial channel modeling, MIMOOFDM transceiver design, MIMO-OFDM channel estimation, space-time techniques for MIMO-OFDM, and error correction code.
Ingmar Hammerström et.al	2007	Power allocation schemes	It considers a two-hop MIMO-OFDM communication scheme with a source, an amplify-and-forward relay, and a destination. Examine the possibilities of power allocation (PA) over the sub-channels in frequency and space domains to maximize the instantaneous rate of this link if channel state information at the transmitter (CSIT) is available. It considers two approaches: (i) separate optimization of the source or the relay PA with individual per node transmit power constraints and (ii) joint optimization of the source and the relay PA with joint transmit power constraint.
Khushboo Pachori et.al	2015	active partial sequence	In this article, a combinational scheme, active partial sequence (APS), is proposed to combat PAPR in MIMO-OFDM under Rayleigh fading environment. The key idea of the APS method is to combine the approximate gradient project followed by partial transmit sequence technique.

CONCLUSION

OFDM requires synchronization in both the time and frequency. Time synchronization involves finding the best possible time instant for the start of received and downconverted OFDM frame. Frequency synchronization deals with finding an estimate of the difference in the frequencies between the transmitter and receiver local oscillators. Subcarriers have the minimum frequency separation required to maintain orthogonally of their corresponding time domain waveforms, yet the signal spectra corresponding to the different subcarriers overlap in frequency

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