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A survey of Performance Analysis in MIMO-OFDM Systems

Jitendra Kumar Daksh[1], Ravi Mohan[2], Sumit Sharma[3]

Abstract

This paper is devoted to space-time coding for multiple-input/multiple-output (MIMO) systems. The concept of space-time coding is explained in a systematic way. The performance of space-time codes for wireless multiple-antenna systems with and without channel state information (CSI) at the transmitter has been also studied. We also study about the number of antennas, the higher space time coding diversity and the related study with the advantages and disadvantages.

Keywords

MIMO, OFDM, PAPR, BER

1. Introduction

Orthogonal frequency division multiplexing (OFDM) [1] is a multi-carrier modulation technique [2, 3] which has high spectral efficiency and higher data rates. The performance of OFDM system is better than over frequency selective fading channel [4][5]. To ensure linear amplification of a signal with a large PAPR, the amplifier has to be operated with a large input back off (IBO), which means that the mean power has to be chosen sufficiently low, leading to a very low efficiency of the amplifier. If the IBO is chosen too small, the signal will be distorted.

In OFDM, frequency selective fading channel is transformed to flat fading channel by the division of the available channel bandwidth into several sub channels. Improvisation in the performance of the OFDM system can be done in the presence of frequency selective fading channel through the use of channel estimation and equalization. In single carrier communication systems, complex equalization techniques are used for inter symbol interference (ISI) cancellation; however OFDM uses cyclic prefix for ISI mitigation [6][7]. We provide here an overview of MIMO OFDM System. Other sections are arranged in the following manner: Section 2 introduces MIMO-OFDM System; Section 3 describes about Related Work; section 4 shows the problem domain. Section 5 shows the analysis; Section 6 describes Conclusion.

Jitendra kumar Daksh, SRIT Jabalpur, M.P.
Ravi Mohan, SRIT, Jabalpur, M.P.
Sumit Sharma, SRIT, Jabalpur, M.P.

2. MIMO-OFDM System

Orthogonal frequency division multiplexing (OFDM) [8] is a multi-carrier modulation technique [9][10] which has high spectral efficiency and higher data rates. The performance of OFDM system is better than over frequency selective fading channel [11]. To ensure linear amplification of a signal with a large PAPR, the amplifier has to be operated with a large input back off (IBO), which means that the mean power has to be chosen sufficiently low, leading to a very low efficiency of the amplifier. If the IBO is chosen too small, the signal will be distorted.

The main drawback of OFDM is the high peak-to-average power ratio (PAPR)[12]which is reduce the power efficiency of a HPA (High Power Amplifier) [13].OFDM is a special form of multi carrier modulation and painful Inter Symbol Interference (ISI) by multiplexing the data on orthogonal property. OFDM can be combined with MIMO [9][10] to increase the system capacity and performances many techniques to deal with the PAPR problem [14]. The techniques amplitude clipping, clipping and filtering, coding, tone reservation, tone injection, active constellation extension, partial transmit sequence, selected mapping, and interleaving.

The SLM techniques [15] achieve PAPR reductions but the power increase, bit error rate increase and computational complexity increase. Optimal bit loading and subcarrier allocation problems for multiuser OFDM have been formulated in [16][17], specifically minimization of the overall transmit power under data constraint, and maximization of the data rate under power constraint. These are non-linear optimization problems which can be broadly divided into two categories: Margin Adaptive (MA) [18] and Rate Adaptive (RA) optimization [19][20]. It is difficult to solve these problems unless the integer variables are relaxed to allow real numbers.

These classical algorithms are computationally intensive due to the nature of non-linear optimization.

However, OFDM systems have the undesirable feature of a large Peak to Average Power Ratio (PAPR) of the transmitted signals. Consequently to prevent the spectral growth of the OFDM signal, the transmit amplifier must operate in its linear regions. Therefore, power amplifiers with a large linear region are required for OFDM systems, but such amplifiers will continue to be a major cost component of OFDM systems. Consequently, reducing the PAPR is pivotal to reducing the expense of OFDM systems. However, the increase in bandwidth is an impractical method, and an alternate solution is to adopt some spectral efficient techniques like MIMO systems [21]. The key advantage of employing multiple antennas is to get reliable performance through diversity and the achievable higher data rate through spatial multiplexing.

3. Related Work

In 2007, Yaning Zou et al. [22] studies the performance of space-time coded (STC)-OFDM systems under I/Q imbalance. As a practical example, they consider a 2 x 1 STC-OFDM system is examined in detail and a closed-form solution for the resulting signal to interference ratio (SIR) due to I/Q imbalance at the output of the receiver combining stage is derived. The analytical outcomes are verified using extensive computer simulations, and can easily be extended to multi-antenna receiver cases as well. In general, the obtained results indicate that I/Q imbalance can easily become a limiting factor in practical STC-OFDM systems and should be carefully mitigated using proper digital and/or analog signal processing.

In 2008, Ahmed K. Sadek et al. [23] addresses the problem of joint optimization of transmit beamforming and space-frequency (SF) coding for MIMO-OFDM systems with spatial correlation feedback in broadband communications. This problem is challenging in the sense that the transmitter should be designed to beamform across multiple eigenspaces associated with the multipath environment simultaneously. The Eigenvalue selection scheme provides the best performance among the proposed algorithms.

In 2010, Mohammad Torabi et al. [24] investigate the combination of different techniques, resulting in user scheduling schemes for multiuser MIMO-OFDM systems employing orthogonal space–frequency block coding (OSFBC) over multipath frequency selective fading channels. Our contribution is a performance analysis framework that evaluates the advantages of employing user scheduling in MIMO-OFDM systems employing OSFBC in conjunction with adaptive modulation schemes. They derive analytical expressions for the average spectral efficiency (ASE), the average bit error rate (BER), the outage probability, and the average channel capacity for different scheduling and adaptive modulation schemes. Discrete-rate and continuous rate adaptive modulation schemes are employed to increase the spectral efficiency of the system. They assume a signal to-noise-ratio (SNR)-based user-selection scheme and the well known proportional fair scheduling (PFS) scheme.

In 2011,Ashutosh Dubey et al. [25] proposed a Modernize SLM (MSLM) scheme to reduce the PAPR by using the complex signal separate into real & imaginary parts and individually phase sequence multiple real as well as imaginary part of complex signal then select minimum PAPR signal of real & imaginary and these are combine. The simulation show achieves good PAPR, which is a strong candidate for Future wireless communication.

In 2011, Zhang jie et al. [26] presents a simulation model of MIMO-OFDM system based on STBC which built and transmission performances under different channels are analyzed. The simulation results show that the MIMO-OFDM system based on STBC outperforms other MIMO-OFDM system without STBC in BER performance.

In 2011, Aaditya Khare et al. [27] propose a novel approach which is reduce PAPR and Computational complexity without any distortion based on clipped OFDM. In these technique the phase sequence multiplication before perform FFT operation by using PN sequence generator and second phase sequence multiplication is the invert version of PN sequence generator. The performance of Space-Frequency (SF) block coding for MIMO OFDM along with different equalizers is also analysed. Bit Error Rate (BER) analysis is presented using different equalizers and then optimum equalization method is suggested. They show the practical aspect of propose scheme in MATLAB environment.

In 2012, Shruti Trivedi et al. [28] discuss about Multiple transmit and receive which can be used to form multiple input multiple-output (MIMO) channels to increase the capacity and data rate. The key advantage of employing multiple antennas is to get reliable performance through diversity and the achievable higher data rate through spatial multiplexing. In MIMO system some information can transmitted and received from multiple antennas simultaneously since the fading for each link between a pair of transmit and receive antennas can usually be considered to be independent, the probability that the information is detected accurately is higher. Fading of the signal can be mitigated by different diversity techniques, where the signal is transmitted through multiple independent fading paths in terms of the time, frequency or space and combined constructively at the receiver. They analyse Bit Error Rate (BER) using BPSK modulation and then optimum modulation is analysed.

4. Problem formulation

MIMO system has three technical advantages, such as Beam forming technology, Spatial Diversity based on space-time coding and spatial multiplexing. Space-time coding can be used to achieve high diversity gains of MIMO systems. It can reduce the symbol error probability due to channel fading and noise by joint coding of the data stream. It can also increase the redundancy of signal by joint-coding, and gain a spatial diversity of signal in the receiver. We can take advantage of the additional diversity gain to improve the reliability of communication links. And we can improve data transfer rate and spectral efficiency by using higher order modulation under the same reliability of links. There is also a need of BER distribution with different comparison point and perform the comparison with the SNR.

5. Analysis

After studying and analysing several research works in the direction of MIMO-OFDM system, we can suggest some following points which can be improved or there is the need of betterment in the field. The points are following:

1) High rate STBC systems have attracted a lot of interest since they are required to build high throughput wireless communication systems.
2) The techniques studied in this work can be applied to future research in this area. Research on high rate STBCs for MIMO systems with a large number of transmit and receive antennas, such as 4,8 or 16 transmit and receive antennas, is an active topic, since such systems can provide large diversity and multiplexing gain can be a good research area.
3) Hybrid framework is needed.

6. Conclusion

In this paper we have survey several aspects for MIMO-OFDM. However, the performance of multiple antennas can be improved if channel state information obtained at the receiver is fed back to the transmitter. Exploiting partial channel knowledge at the transmitter, two simple channel adaptive transmission schemes, namely, channel adaptive code selection and channel adaptive transmit antenna selection can been used.

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Jitendra Kumar Daksh,
I am Student of Microwave Engineering (EC) In Sriram College of Technology.BE in Electronics and Communication from L.N.C.T Bhopal (MP).