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Review on Existing Methods of Adaptive Modulation and Power Allocation using MIMO OFDM

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Abstract

The increasing demand for transmitting information over a wireless channel has led to the emergence of Multiple Input Multiple Output (MIMO) technology. Adaptive modulation selection plays a major role due to the progressing variation of wireless channel condition. The performance of Multiple Input Multiple Output (MIMO) Orthogonal frequency division multiplexing (OFDM) system is improved through detecting low complexity signal and with minimum power allocation. In this paper the existing methods of Adaptive Modulation and Power Allocation using MIMO OFDM is reviewed and the performance is compared in terms of BER(Bit Error Rate) and Spectral Efficiency and throughput.

Keywords*:* Adaptive modulation, MIMO-OFDM, signal detection, power allocation, optimal power.

1. Introduction

Orthogonal frequency division multiplexing (OFDM) has become a widespread technique for transmission of signals over wireless channels. OFDM has been implemented in several wireless standards such as digital audio and video broadcasting, short range communications etc. The increasing demand for higher data transmission rate over fading channels needs multicarrier transmission, commonly identified as orthogonal frequency division multiplexing (OFDM). Inter symbol interference (ISI) has been avoided by OFDM because of the simple transceiver structure of frequency selective fading [1]. With usage of MIMO, wideband communication system obtained a great role for academic and industrials due to spatial diversity, spectral efficiency and the gain of multiplexing [2]. Recently, the concept of multipath fading and time varying channels of OFDM transmission are taken into consideration [3]. Researchers are investigated Low complexity channel estimation and equalization. Many researchers have studied using multiple transmit antennas for multiplicity in wireless systems. Transmit diversity may be based on linear transforms or space–time coding, In specific, space–time coding is categorized by high code efficiency and good performance; hence, Efficiency and performance of orthogonal frequency division multiplexing (OFDM) systems can be improved [4]. The system performance can be increased if MIMO channels can be made using if multiple transmit and receive antennas. In comparison with single-input-single-output (SISO) system with flat Rayleigh fading or narrowband channels, a capacity of a MIMO can be increased by a by a factor of the minimum number of transmitting and receive antennas. To moderate the inter-symbol interference (ISI), space–time processing can be used for wideband transmission .However, the complication of the space–time processing increases the bandwidth, and the performance considerably degrades when estimated channel parameters have been used. In OFDM, the entire channel is divided into many narrow parallel sub-channels by increasing the symbol duration and reducing or eliminating the ISI caused by the multipath. Due to this, OFDM has been choice in digital audio and video broadcasting. Multiple transmit and receive antennas can be used with OFDM to further improve system performance [4]. The multiple input multiple outputs (MIMO) with OFDM system is a favourable solution to gain high data rate and multiplicity in a fading environment.

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MIMO systems may achieve spatial multi-user access using singular value decomposition (SVD) MIMO techniques. The MIMO OFDM systems multiplex the users both in the frequency and the spatial domains. Hence, the co-channel interference caused by the sub-carrier reuse may lower the system's performance. For MIMO OFDM systems with co-channel interference, the combination of power control with adaptive modulation is desirable to reduce the effect. . In MIMO communication system, 30%–50% of the power is utilized from the total power consumption. The energy efficiency maximization will increases the time required for processing the system. Hence, it is considered as a challenging issue for improving the energy efficiency. Several categories of power consumption model is investigated to measure the spectral and energy efficiency trade-off with the presence of Rayleigh fading channel [8].

2. MIMO OFDM

In Modern communication systems MIMO channels are a Combined with OFDM to provide robustness [5] and high spectral efficiency [6]. It combines MIMO which multiplies capacity by transmitting different signals over multiple antennas and OFDM which divides the radio channel into a large number of closely spaced sub channels to provide more reliable communication at high speed. Highest capacity and data throughput using MIMO technology is improved, which is hired to improve the signal to noise ratio for wireless technologies. In MIMO- OFDM system, the signals are transmitted orthogonally with each other. OFDM needs time and frequency synchronization to sustain its orthogonality between subcarriers and also resistive to frequency offset which can be caused either by Doppler shift due to relative motion between the transmitter and receiver or by the difference between the frequencies of the local oscillator at the transmitter and receiver[6].

The figure shows the block diagram of MIMO OFDM system.

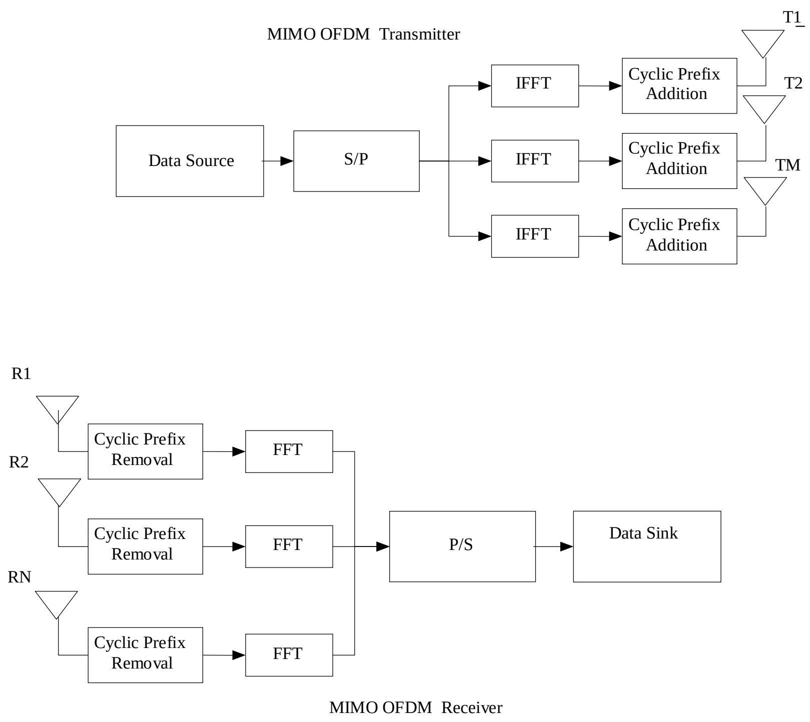

Figure1: MIMO OFDM Transmitter- Receiver System

MIMO(Multiple Input Multiple Output) System can be combined with the OFDM (Orthogonal Frequency Division Modulation) to achieve higher data rate. MIMO system provide higher rate of transmission through special multiplexing. By using MIMO with OFDM can reduce the Inter symbol Interference with low Bandwidth requirement. Separate data block can be transmitted over different carrier to achieve higher data rate. In MIMO-OFDM first data to be transmitted is converted from serial to parallel. This frequency domain symbol are converted in to time domain by using IFFT(Inverse Fast Fourier Transform). Afterward Cyclic prefix is added to remove overlapping of symbols. In cyclic prefix Tail bits are copied and pasted to head of the data block. Using multiple number of antenna NT data can be transmitted using spatial multiplexing technique. At the receiver signal is received by multiple antenna NR. Cyclic prefix should be removed from the data. Then FFT algorithm is to be used to perform DFT (Convert time domain symbol in to frequency symbol). The signal is detected using MIMO Detection Techniques then Data is converted from parallel to serial.

3. Literature Review

Theoretical studies of communication links employing multiple transmit and receive antennas have shown great potential for providing spectrally efficient wireless transmission.

Imad ,Barhumi [9] proposed 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 and derives optimal pilot sequences and optimal placement of the pilot tones with respect to this MSE. To reduce the training overhead, an LS channel estimation scheme over multiple OFDM symbols is used. For improving channel estimation, a recursive LS (RLS) algorithm is proposed, from which they 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. Experimental results shows that the optimal pilot sequences derived in this paper outperform both the orthogonal and random pilot sequences and considerable gain in signal-to-noise ratio (SNR) is obtained with the use of RLS algorithm,

Y. Geoffrey, Jack H. Winters, and Nelson [10], considered orthogonal frequency division multiplexing (OFDM) for MIMO channels (MIMO-OFDM) for wideband transmission to moderate inter-symbol, interference and to increase system capacity. Two independent space-time codes for two sets of two transmit antennas are used here. At the receiver, the independent space–time codes are decoded using whitening, followed by minimum-Euclidean-distance decoding based on successive interference cancellation. Simulation results show 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 code word contains 500 information bits and the channel's Doppler frequency is 40 Hz (corresponding normalized frequency: 0.9%). By Increasing the number of the receive antennas, the system performance is improved. 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. They proved MIMO-OFDM is a favourable technique for highly spectrally efficient wideband transmission

Yilei Yao1,,Shangzhi Xu1[11], proposed the balanced power allocation scheme which can enhance the MIMO-OFDM performance by reducing power consumption under the assumption of perfect channel state information (CSI) .Convex Optimization method is used for to define the coordinate performance of capacity and total power. Experimental result shows the effectiveness of proposed algorithm by reduction of total power consumption than water- filling scheme by using interior-point method. They claimed the proposed scheme also gets similar capacity performance compared to water-filling scheme.

Hammerstrom, Ingmar, and Armin Wittneben [12] presented a two-hop MIMO-OFDM communication scheme. They Examine the possibilities of power allocation (PA) over the sub-channels in frequency and space domains for maximizing the prompt rate of this link assuming that channel state information at the transmitter (CSIT) is available. They considered 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. Optimal power allocation has been provided at the source with a node transmit power constraint which maximizes the instantaneous rate for a given relay. They use a high SNR approximation of the SNR at the destination.

A.K Jaiswal, Er.Anil Kumar, Anand Prakash Singh[13], show the performance of MIMOOFDM (Multiple Input Multiple Output-Orthogonal Frequency Division Multiplexing) system in Rayleigh Fading Channel.They compared Ergodic and Outage Capacity with taking various numbers of Transmitting and Receiving antennas and various performance measures such as SNR, BER etc. They Concluded that channel capacity optimization is necessary to improve the performance of MIMO-OFDM System.

Ngoc Phuc Le, and Farzad Safaei[14], presented antenna selection approach for MIMO-OFDM system by considering the spectral and energy efficiency trade-off. An adaptive antenna selection algorithm was used in which the amount of antenna indices and the valid RF chains were selected based on the channel. Minimum numbers of antennas are utilized with exhaustive search method. The optimal performance with less complexity was achieved with greedy algorithm if it contains more number of antennas.

Ali Elghariani, and Michael Zoltowski[15], proposed signal detection approach in large scale MIMO system with less computational complexity. To improve the BER performance, the heuristic algorithms such as Reactive Tabu Search (RTS) and Local Ascent Search (LAS) was developed with high modulation order. It was constructed from existing Quadratic Programming (QP) detector. The first one combines the constellation of shadow area constraints and interference cancellation and the second approach depends upon Bound and Branch search tree algorithm.

Jordi Diaz and Yeheskel Bar-Ness[16], propose a new approach for the design of adaptive modulation and coding (AMC) for MIMOOFDM wireless communications. They validate a possible conflict on the joint extraction of diversity and adaptation benefits of a MIMO-OFDM channel known at the transmitter. This proposed algorithm avoids this conflict by adapting as accurately as possible given the side information while using diversity to combat remaining uncertainty. This is done by channel parallelization, sorting and grouping into modulation modes. They also introduced a new power allocation strategy, which perform better than conventional water-filling in a practical setting.

Alfonso Camargo, Dachuan Yao, and Andreas Czylwik[17], considers the practical multiple-input multiple-output systems with orthogonal frequency division multiplexing (MIMO-OFDM) and bit-interleaved coded modulation (BICM) in spatially correlated broadband channels. They used link adaption techniques to show that the bandwidth efficiency is increased compared to systems with fixed MIMO schemes in all propagation scenarios, while maintaining a predefined link quality. Additionally, the adaptive transmission in channels with low spatial correlation can attain the complete multiplexing gain, whereas the finite set of modulation and coding schemes restricts the multiplexing gain that can be extracted when the spatial correlation is large.

Essi Suikkanen [18] proposed the detector algorithm to tackle the condition of channel for reducing the power consumption at the receiver while maintaining the Quality of Service (QoS). More computation and power equipment were used with low rank channel or less SNR ratio in order to provide reliable communication. Low or simple power detector was used if the communication involves better channel condition. Low power consumption and complexity was achieved with simple detectors, but it was not guaranteed with complex detectors.

4. Conclusion

In MIMO-OFDM different antennas are positioned at different spatial locations, MIMO systems can take advantage of spatial diversity to overcome channel fading provided the constituent paths are uncorrelated.
Multiple copies of a signal are transmitted from the Tx antennas in transmit diversity and received at the Rx antennas in receive diversity. This highlights an important advantage of spatial diversity, i.e.it does not require any additional time or frequency budget to achieve diversity. The above reviewed work are concentrated on improving the throughput without focusing the energy utilization of the system. Since most equipment are operated on battery power which makes it difficult to improve the throughput and energy efficiency. In MIMO communication system, 30%–50% of the power is utilized from the total power consumption. The energy efficiency maximization will increases the time required for processing the system. Hence, it is considered as a challenging issue for improving the energy efficiency. Several categories of power consumption model is

require to investigate to measure the spectral and energy efficiency trade-off with the presence of Rayleigh fading channel

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A Brief Author Biography

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