Performance Analysis of MIMO-OFDM System for Fading Channels

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Abstract: The combination of Orthogonal Frequency-Division Multiplexing (OFDM) and multiple input multiple output (MIMO) is maintain the Air Interface for broadband wireless systems. MIMO-OFDM increase the capity and the performance of the system. frequency-division multiplexing (FDM) scheme, which is used as a digital multicarrier modulation method. The paper is designed at estimation the BER performance of the MIMO -OFDM system for AWGN (Additive White Gaussian Noise) Channel, Rayleigh Fading Channel along with a simulation channel. MIMO-OFDM communication systems using Space-Time Block Coding . MIMO-OFDM with STBC (space time bock coding)has excellent performance against multipath and frequency selective fading .The process is repetitive until all MIMO-OFDM symbols are recovered. MIMO-OFDM is a key technology for future generation cellular communication ,wireless LAN, wireless PAN and broadcasting.BPSK modulation is used and it is detect the behaviour of rayleigh fading channel .The adiction of equalizer reduces the BER(bit error rate).The performance of the system is calculated in terms of BER Versus SNR.

Keywords: BER, AWGN, STBC,MIMO,Reyleigh fading.

Introduction

Using MIMO occures main disadvantage is that multiple antennas and RF transceiver are implemented within the same radio device ,so equipment more complex.Therfore MIMO combined with OFDM .MIMO-OFDM playing important role in wireless communication. OFDM is mainly proficient technologies for high data rate wireless communications appropriate to its robustness, frequency selective fading, and low computational complication. OFDM can be used in arrangement with a Multiple-Input Multiple-Output (MIMO) transceiver to increase the diversity gain and the system capacity by exploit.Because the OFDM system efficiently provides numerous parallel narrowband channels, MIMO-OFDM is considered a key technology in promising high-data rate systems such as 4G, IEEE 802.16, and IEEE Orthogonal Frequency Division Multiplexing (OFDM) is one of the most promising technologies for high data rate wireless communications appropriate to its robustness, high spectral efficiency, frequency selective fading, and low computational difficulty. OFDM can be used in combination with a Multiple-Input Multiple-Output (MIMO) transceiver to increase the diversity gain and the system capacity by exploit spatial domain. Because the OFDM system effectively provides numerous parallel narrowband channels, MIMO-OFDM is measured a key technology in emerging high-data rate systems such as 4G, IEEE 802.16, and IEEEv.

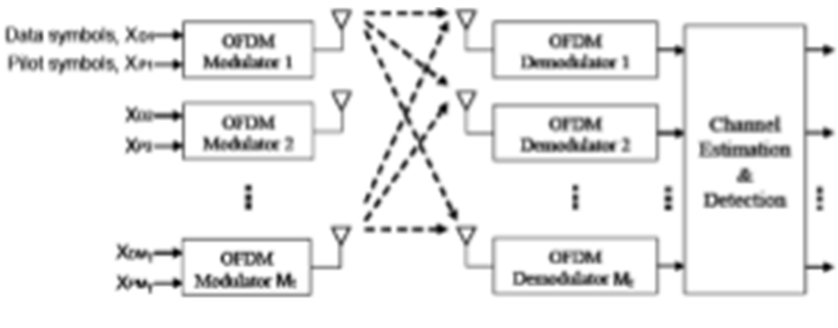


Fig 1. Combating ISI using a guard period

Figure 1 illustrate the basic model of MIMO OFDM system. MIMO communication using individual antennas at commonly the transmitter and receiver to evolve the spatial domain for spatial multiplexing and spatial diversity. MIMO OFDM is estimate for AWGN & Rayleigh fading Channel and each sub-carrier being modulated with special predictable modulation scheme at a low symbol rate, maintain total data rates similar to predictable single-carrier modulation schemes in the same bandwidth .Main improvement of OFDM over single carrier schemes is its ability to deal with with severe channel situation. The low symbol rate accomplish the use of a guard period connecting symbols acceptable, making it possible to eliminate inter-symbol interference and operate echo and time-spreading to achieve a diversity gain, i.e. improved BER (Bit Error Rate) & SNR (Signal to Noise Ratio). We have been explained, the different way of adding guard period to OFDM system, while second part show BER investigation of OFDM-MIMO for different modulation technique, which has been summarized in the form of MATLAB simulation results.

MIMO (Multiple-Input and Multiple-Output)
is a method for multiplying the capacity of a radio link using multiple transmit and receive antennas to performance multipath propagation. MIMO has become an important element of wireless communication standards including IEEE 802.11n (Wi-Fi), IEEE 802.11ac (Wi-Fi), HSPA+ (3G), Wi MAX (4G), and Long Term Evolution (4G). More recently, MIMO is applied to power-line communication for the 3-wire installations as part of ITU standard and Home Plug AV2 specification. At one time in wireless the term “MIMO” referred to the mainly theoretical use of multiple antennas at both sides, transmitter and the receiver. In modern usage, “MIMO” specially refers to a practical technique for sending and receiving more than one data signal on the same radio channel at the same time. MIMO is fundamentally different from smart antenna techniques developed to enhance the performance of a single data signal, such as beam forming and diversity.
MIMO is further sub-divided into three main categories tese are **precoding, spatial multiplexing or SM, and diversity coding.**

Precoding
is multi-stream beam forming, in the narrowest description. In more terms, it is considered to be all spatial processing that occurs at the transmitter. In beamforming, the same signal is emitted from each of the transmit antennas with suitable phase and gain weighting such that the signal power is maximized at the input of receiver. The main benefits of beamforming are to increase the gain of received signal - by making signals emitted from different antennas - and to reduce the multipath fading effect. In line-of-sight propagation, beamforming outcome in a well-defined directional form. However, conventional beams are not a good analogy in cellular networks, which are mainly characterized by multi lane propagation. When the receiver has multiple antennas, the transmit beamforming cannot concurrently maximize the signal level at all of the receive antennas, and precoding with multiple streams is often beneficial. Here we need to note that precoding requires information of channel state information (CSI) at the transmitter and at the receiver.

Spatial multiplexing
requires MIMO antenna pattern. In spatial multiplexing, a high-rate signal is split into multiple lower-rate streams and each stream is transmitted from a different transmit antenna at the same frequency channel. If these signals arrive at the receiver antenna array with correctly different spatial signatures and the receiver has perfect CSI, it can separate these streams into (almost) parallel channels. Spatial multiplexing is a powerful technique for increasing channel ability at higher signal-to-noise ratios. The maximum number of spatial streams is restricted by the lesser of the number of antennas at the transmitter/receiver. Spatial multiplexing can be used without CSI at the transmitter, but can be collective with precoding if CSI is available. Spatial multiplexing can also be used for simultaneous transmission to multiple receivers, known as space-division multiple access or multi-user MIMO, in which case CSI is essential at the transmitter. The scheduling of receivers with different spatial signatures allows brilliant separability.

Diversity
coding techniques: In diversity methods, a single stream is transmitted, but the signal is coded with the help of techniques called space-time coding. The signal is emitted from each of the transmit antennas with full or near orthogonal coding. Diversity coding exploits the self-regulating fading in the multiple antenna links to improve signal diversity. Because there is no channel knowledge, there is no beamforming or array gain from diversity coding. Diversity coding can be joint with spatial multiplexing when some channel knowledge is available at the transmitter side.

Orthogonal frequency division multiplexing (OFDM)
is a popular method for high data rate wireless transmission. OFDM may be combine with antenna arrays at the transmitter and receiver to amplify the diversity gain and/or to enhance the system capacity on time-variant and frequency-selective channels, resulting in a multiple-input multiple-output (MIMO) arrangement. This paper explores different physical layer research challenges in MIMO-OFDM system design, including physical channel capacity and modeling, analog beam

forming techniques using adaptive antenna arrays, error control techniques, OFDM opening and packet design, and signal processing algorithms are used for performing time and frequency synchronization, channel estimation, and channel tracking in MIMO-OFDM systems.

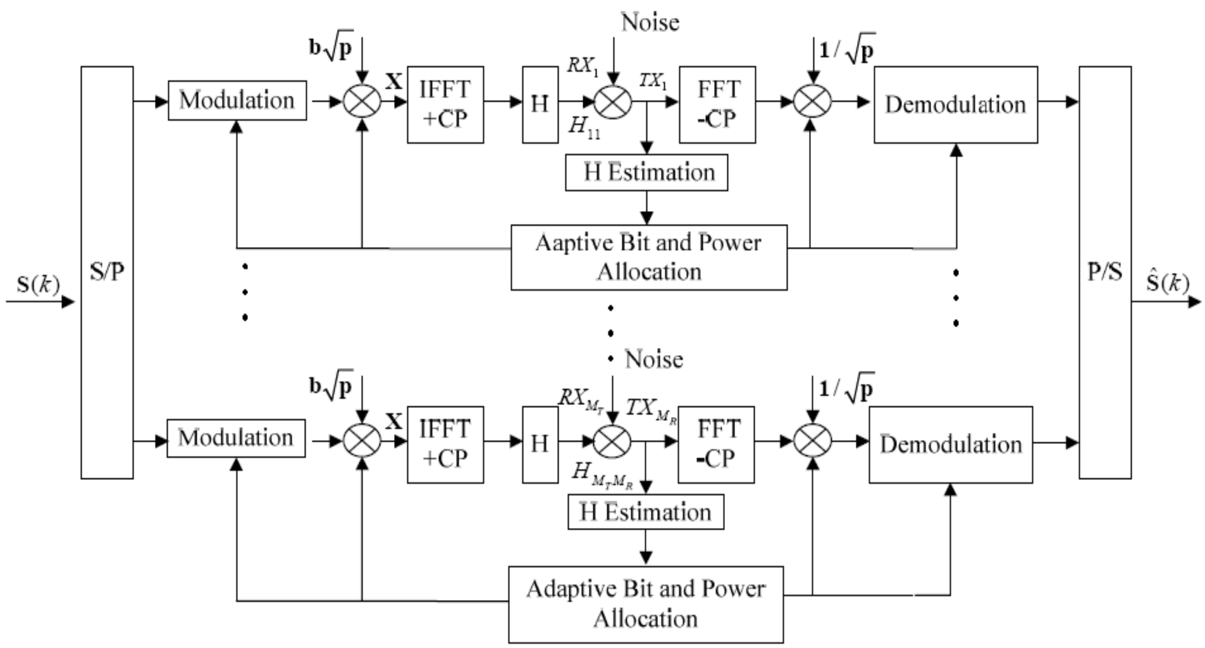
MIMO-OFDM

is the basis for most superior wireless local area network (Wireless LAN) and mobile broadband network standards because it achieves the greatest spectral effectiveness and, therefore, delivers the highest capacity and data output. At the very starting the different information streams could be transmitted at the same time on the same frequency by taking benefit of the fact that signals transmitted through space bounce off objects and take multiple paths to the receiver. That is, by using number of antennas and precoding the data, different data streams could be sent over many different paths. Raleigh recommended and later proved that the processing required by MIMO at higher speeds would be most convenient using OFDM modulation, because OFDM converts a high-speed data channel into a number of parallel, lower-speed channels.

Traditionally, radio engineers treat natural multipath propagation as an destruction to be mitigate. MIMO is the first radio technology that treat multipath circulation as a phenomenon to be exploited. MIMO multiply the capacity of a radio link by transmit various signals over multiple, co-located antennas **MIMO-OFDM** is the basis for most advanced wireless local area network (Wireless LAN) and mobile broadband arrangement standards because it achieves the greatest spectral efficiency and, therefore, delivers the highest capacity and data throughput. Greg Raleigh made-up MIMO in 1996 when he showed that different data streams could be transmitted at the same time on the same frequency by taking advantage of the fact that signals transmitted through space bound off objects and take multiple paths to the receiver. so as to is, by using multiple antennas and precoding the data, different data streams could be sent over different paths. Raleigh recommended and later proved that the processing required by MIMO at superior speed would be most manageable using OFDM modulation, because OFDM convert a high-speed data channel into a number of parallel, lower-speed channels.

A MIMO system takes advantage of the spatial multiplicity that is obtained by spatially estranged antennas in a dense multipath scattering environment. MIMO systems may be implement in a number of unusual ways to obtain either a diversity gain to combat signal fading or to obtain a capacity gain. commonly, there are three category of MIMO technique. The first aims to recover the power efficiency by exploit spatial diversity. Such techniques include delay diversity, space–time block codes (STBC) and space–time trellis codes (STTC). The second class use a layered approach to raise capacity. One trendy illustration of such a system is V-BLAST suggested by Foschini et al. where full spatial diversity is usually not achieved. as a final point, the third type exploits the knowledge of channel at the transmitter. It decay the channel coefficient template with singular value decomposition (SVD) and uses these decomposed unitary matrices as pre- and post-filters at the transmitter and the receiver to achieve near capability.

Methodology



Adaptive Modulation For Mimo-Ofdm System

We consider a MIMO-OFDM system with T M transmit antennas, R M receive antennas and N sub-channels, which is shown in Fig. 1. At transmit antenna RXi(1<i<MT) of transmitter, N signals X（Xn ∈X, 1<n< N) in a symbol period T. Let X={X0, X1,…, Xn-1} denote the length –N data symbol block. The IDFT of the data block X yields the time domain sequence x={x0,x1,…,xN-1}, xN=IFFTn{Xk}(n) to mitigate the effects of channel delay spread, a guard interval comprised of either a CP or suffix is appended to the sequence X . To avoid ISI, the CP length G must equal or exceed the length of the discrete-time channel impulse response M. The OFDM signal is transmitted over the pass band RF channel, received, and down-converted to base band. At the receiver, the time domain symbol x′ of the receive antenna TXj(1<j<Mr), from which the initial G samples are removed, followed by a N point FFT on the resulting sequence.

In addition, under root p is proportion factor for adaptive bit and power allocation. Character of channels is assumed to be known at the transmitter and receiver. If the time delay of symbols transmitted over wireless channels is near or over the period of transmitted symbols, frequency selective fading incurs when the symbols are transformed into frequency domain. Based on the character of OFDM, it can be regarded as flat fading in narrow band period of each sub-channel for OFDM system. In slow fading scenario, the pulse response of channel in a symbol period T is constant. We assume that the channel gain of each sub-channel is n H, and then the demodulated symbol X′ satisfies with the following expression:

X′=XHn+n…… (1)

Nn is AWGN mapped to each sub-channel, which power is 2n. If the power spectrum density of AWGN is n0, noise power of each sub-channel for OFDM system is /Nn/square=n0/T. If we consider the case of perfect channel state information at the transmitter and receiver, we can decompose the MIMO channel on each tone into parallel non-interfering SISO channels using the singular value decomposition (SVD). Let the instantaneous channel matrix on the ith tone have a SVD, Hi=UiSiVi*,

Where Ui and Vi are unitary matrices and Si is the diagonal matrix of singular values of Hi. Now, if we use a transmit precoding filter of i V and a receiver shaping filter of i U , the equivalent MIMO channel between the IFFT and FFT blocks decomposes into parallel sub channels.

Dynamics Bit and Power Allocation

In general, we can evaluate a system from two sides, which are Quality of Service (QoS) and Cost of Service (CoS). QoS can be represented by BER and rate of system, and CoS can be represented by total transmission power. Based on adaptive modulation margin adaptive (MA) principals, that is, under the constrain of given bit rate and the target BER requirement, this method can adaptively adjust the transmit power of each sub-carrier to minimize the transmit power of the system. In single user case, different bits and modulations are allocated for each sub-carrier according to the channel state of each sub-carrier. Since the power needed for transmitting definite bits is independent each other, it is approved that the optimal bit allocation is greedy allocation.

A. Dynamics Bit and Power Allocation Strategy Based on Greedy Algorithm Based on MA principle, dynamics bit and power allocation strategy based on greedy algorithm is put forward in this paper, that is, In this algorithm, m bit are allocated to sub-carrier, each time it selects the sub-carrier for which transmission of m additional bit can be done with the smallest additional transmit power for a request BER. It can be formulated as follows

1) Algorithm Initialization

(1) Let cn = 0, n= 1, 2,…, N;

(2) decide step m;

(3) Compute ΔPn = [f (m) −f (0)];

2) Bit Allocation

(1) Find the bit that will cost the least to increment ΔP= [f (m) – f (0)];

(2) Choose the sub-carrier which index is nˆ = arg min ΔPnˆ n;

(3) Allocate the sub-carrier m bit, Cnˆ=Cnˆ +m;

(4) Compute the incremental power of that sub-carrier ΔPn = [f (cnˆ+m) −f (cnˆ)]/αsquare n again, repeat the above steps R/m time.

3) Results

(1) {c1, c2,…., cN}. Computed from the above steps is the last bit allocation scheme.

(2) Power allocation can be denoted as e = 2cn-1/SNRn/GAP, where GAP is a variable parameter.

Spectral Efficiency and Perfoamance Analyse

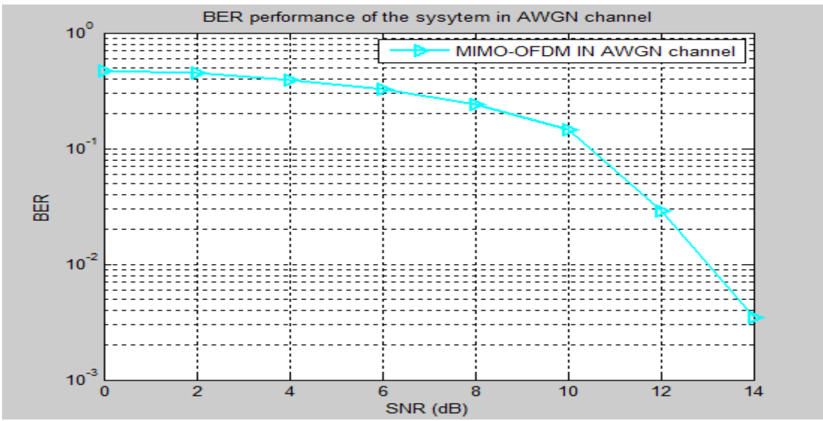
Adaptive bit and power allocation is an adaptive modulation scheme used in multi-carrier communication systems, which can improve spectral efficiency of system.

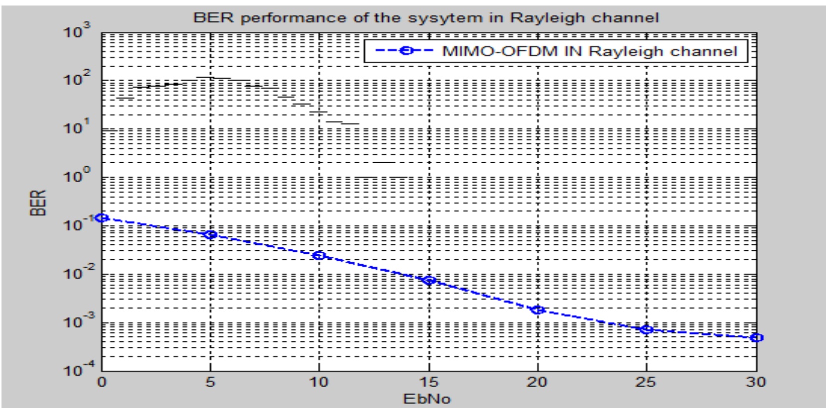
The main sides which can effectively affect the performance of adaptive modulation MIMO-OFDM system are frequency intervals, channel estimation error, and so on. For we have supposed that the transmitter and receiver of system have known the channel state information (CSI) in this paper, thus we just discuss the performance of MIMO-OFDM system under different frequency intervals. Increasing frequency intervals of system which can decrease the complexity of allocation algorithm can result in the decrease of performance of system. The performance of adaptive OFDM system can be improved with the increasing of adaptive degrees, that is to say, the performance of fully adaptive system is superior to that of non-adaptive system.

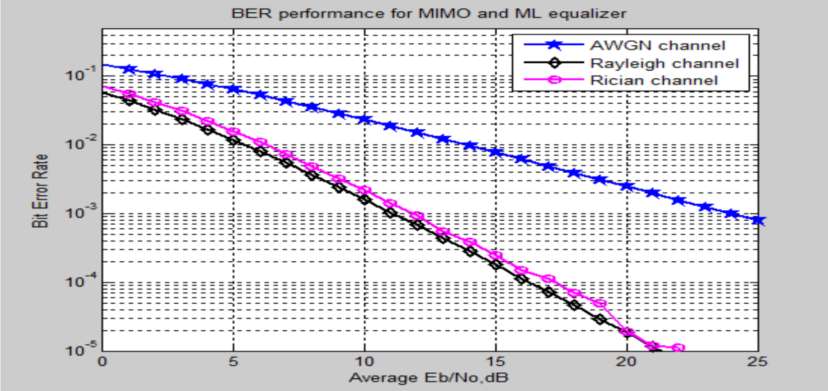
Results

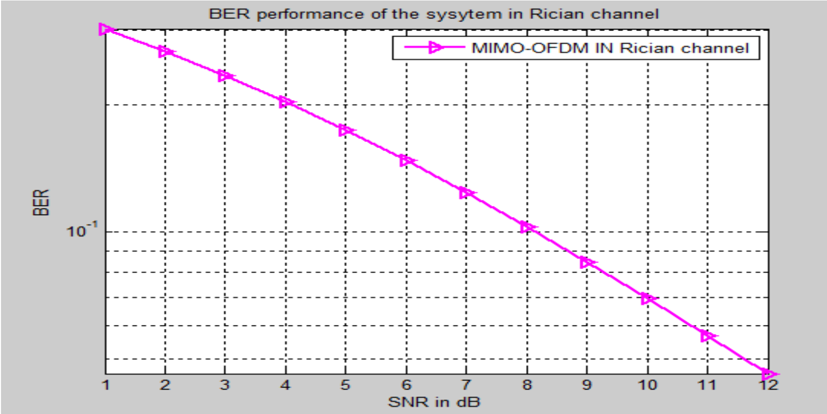
In our simulation schemes, the sub-carriers of OFDM symbol is N = 64; cyclic prefix is CP = 16. The receive antennas and transmit antennas are different combinations of Nt = {1, 2, 4} and Nr = {1, 2, 4}. The bits allocated for each OFDM symbol is B = 128. In this paper, adaptive modulation is used, which order is M = 2c， c = {0, 2, 4, 8}. The channel model is multi-path Rayleigh fading channel; power delay distribution is exponential distribution, which is {1, exp (−1), exp (−2)}. And noise variance is σ =1×10−3. Under the same MIMO-OFDM simulation scheme, when the subcarrier number of OFDM symbol is altered, the performance of system has some improvement with the subcarrier number increasing in MIMO-OFDM system has different performance under different adaptive degrees. The performance of system without bit and power adaptive allocation is worse than that of the system only without bit or power adaptive allocation. And it is clearly worse than that of the system with bit and power adaptive allocation.

Using same OFDM parameters scheme and greedy bit and power allocation algorithm, the performance of SISO-OFDM system is superior to that of MIMO-OFDM system using average bit and power allocation and the performance of system using greedy algorithm is far superior to that of system using average bit and power allocation with the same OFDM and MIMO parameters. As we know, the main adaptive bit and power allocation algorithm used for OFDM system is CHOW algorithm. Compared with CHOW algorithm and average bit and power allocation, greedy algorithm is far superior to average algorithm as well as a little superior to CHOW algorithm, especially with SNR increasing. With the same OFDM parameters, greedy algorithm and different antennas scheme, the performance of OFDM system using MIMO technology is clearly superior to that of OFDM system without MIMO technology and the performance of MIMO-OFDM system increase with antennas increasing. From the spectral efficiency side, the adaptive bit and power allocation using greedy algorithm is superior to CHOW algorithm as well as far superior to average algorithm.









Conclusion

The combination of adaptive modulation, MIMO technology and OFDM technology can effectively resist various fading in wireless channel and at most improve the capacity of system as well as performance. It is proved that whatever in BER or in spectral efficiency, the performance of adaptive bit and power allocation for MIMO-OFDM system using greedy algorithm is clearly superior to that of system using average bit and power allocation algorithm. greedy algorithm is some superior to CHOW algorithm. The maximum achievable diversity advantage of OFDM-MIMO system. In contrast to the conventional OFDM, the factor comes from the band hopping approach, which is regardless of the temporal correlation of the channel. In this paper the impact of a of OFDM and MIMO were assessed in the presence of future work. It was found that the systems are less robust to phase noise compared to their linear systems. we present a comparative study with inphase component to show the better noise reduction

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