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BER Computation of MIMO OFDM System Using BPSK Modulation

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ABSTRACT: Orthogonal Frequency Division Multiplexing System is an important topic in the advanced wireless communication area. In few years, wireless communication has been focused from both industry and educational fields. Multiple transmit and receive can be used to form multiple-input multiple-output (MIMO) channels to increase the capacity and data rate. The given paper introduces the Bit Error Rate analysis of MIMO OFDM. The given paper explains one of the multiplexing techniques that helps in efficient use of transmission bandwidth and that speeds up the data transfer known as Orthogonal Frequency Division Multiplexing. This multiplexing technique overcomes the disadvantages of the traditional Frequency Division Multiplexing of using guard bands between two signals being transmitted to avoid mixing of signals. Firstly we designed the OFDM transmitter and receiver over Gaussian channel. We implemented using parameters like IFFT/FFT size, cyclic prefix, subcarrier spacing, carriers, word size, modulation type etc. Firstly we designed the OFDM transmitter and receiver over Gaussian channel. In the given paper, Bit Error Rate has been analyzed of MIMO OFDM system using Binary Phase Shift Keying modulation scheme. The results of given paper have been provided by plotting graph of bit error rate versus $\mathbf{E_b/N_o}$ are simulated using MATLAB®. The statistical analysis has been implemented to using Binary Phase Shift Keying modulation scheme.

KEYWORDS: MIMO, BPSK, FFT.

I. INTRODUCTION

In communication field, requirement of high data rate has been increased day by day. So Orthogonal Frequency Division Multiplexing (OFDM) system has been designed for efficient wireless system. The basic theory of OFDM is to divide high streams of information into a number of data streams parallel usages of many orthogonal subcarriers. This system is used to remove inter symbol interference and bandwidth problems. Multiple Input Multiple Output scheme plays important role in the implementation of OFDM technology in wireless communication system. MIMO OFDM system offers high data rate and better performance by reducing inter symbol interference. MIMO OFDM with space time block coding system is mainly employed in 4G wireless technologies because of its decoding simplicity and overcoming multipath fading process. In digital communication BER reveals the system behavior and evaluates the system performance. In this paper, we analyze both transmission and reception process of OFDM by using BPSK modulation. We also analyze modulation by using bit error rate calculations. The modulation takes place over Gaussian channel.

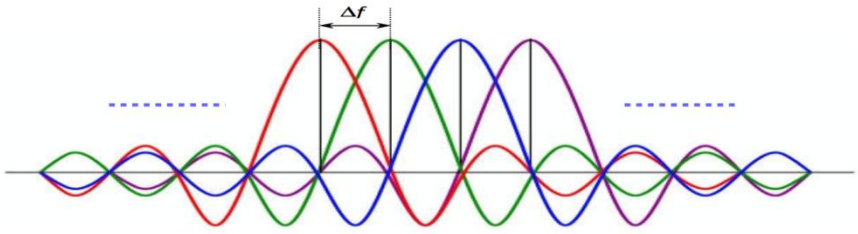

Fig1: Orthogonality principle

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II.MIMO AND OFDM CONCEPT

Orthogonal Frequency Division Multiplexing (OFDM) is one of the most EFFICIENT physical layer technologies for high data rate wireless communications due to its robustness to frequency selective fading, high spectral efficiency, and low computational complexity. OFDM can be used in conjunction with a Multiple-Input Multiple-Output (MIMO) transceiver to increase the diversity gain and/or the system capacity by exploiting spatial domain. Because the OFDM system effectively provides numerous parallel narrowband channels, MIMO-OFDM is considered a key technology in emerging high-data rate systems such as 4G, IEEE 802.16, and IEEE 802.11n.

MIMO communication uses multiple antennas at both the transmitter and receiver to exploit the spatial domain for spatial multiplexing and/or spatial diversity. Spatial multiplexing has been generally used to increase the capacity of a MIMO link by transmitting independent data streams in the same time slot and frequency band simultaneously from each transmit antenna, and differentiating multiple data streams at the receiver using channel information about each propagation path, future standards need to specify both bandwidth requirements and type of signaling that achieves the data rate required for minimal predefined qualities of services for future applications.

Frequency bands used by mobile devices are strictly specified by responsible regulatory bodies, which set limits on the bandwidth available for communication. Therefore, a very natural and important question is what the maximum data rate is (equivalently, information rate) at which reliable communication over a mobile channel of a given bandwidth is attainable. This quantity is known as the channel capacity .for the well-known expression for the maximum data rate that can be achieved, for reliable communication. That is the average bit error rate (BER) can be made arbitrarily close to zero.

In contrast to spatial multiplexing the AIM of spatial diversity is increase the diversity order of a MIMO link to mitigate fading by coding a signal across space and time , so that a receiver could receive the replicas of the signal and combine those received signals constructively to achieve a diversity gain.In recent years we have witnessed an increasing popularity of multimedia applications that run on personal mobile devices. Services such as high quality video calls ,mobile TV, audio and video contents on demand and various interactive map/locator services (such as GPS)are becoming widely supported in new generations of personal mobile devices. A majority of these services need a minimal guaranteed data rate between users (or between a user and a base station) in order to provide a minimal predefined quality of service, which puts a demand on transmission band width and need for spectral efficiency on wireless channels. To provide support for bandwidth demanding applications on the physical layer.

Fig2. MIMO system

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III. IMPLEMENTATION OF MIMO OFDM SYSTEM

A] A 2 x 2 MIMO OFDM model:

In this model, there are two transmitters and two receivers to increase the data rate of the wireless communication system. MIMO system is used to transmit two or more data streams over the single channel. Hence the system can transmit the two or more data per channel without the need of Extra bandwidth. A MIMO system with Nt transmit antennas and Nr receive antennas has a maximum diversity gain. Space time block coding is used to transmit more than one copy of data stream across number of antennas. The given system is designed by 2*2 antennas and it can support 64 point FFT, modulation may be BPSK or QPSK, channel type is AWGN.

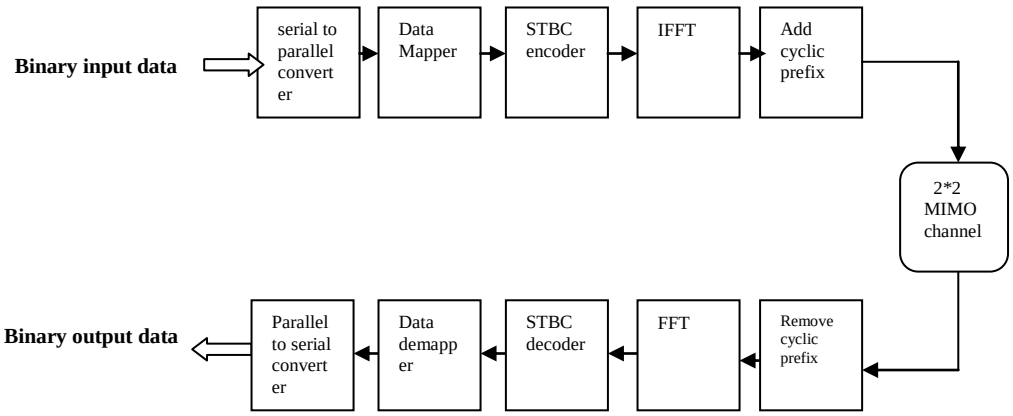

Figure 3: Block diagram of MIMO OFDM system

B] Algorithm for implementation of MIMO OFDM

Step 1: The initialization parameters are set as shown in table 1.

Table 1: Parameters and its values

Parameter	Value
Antenna configuration	2x2 antennas
Noise	AWGN
SNR range	0 to 30
Cyclic prefix factor	1/4, 1/16
Modulation type	BPSK

Step 2: The serial data are transformed into parallel information for OFDM. Then the mapped data are transmitted via the Space Time Block Coding.
Step 3: Pass the encoded sequences through IFFT and then add the Cyclic Prefix to the data in the frequency domain.
Step 4: The resultant data are transmitted using two transmitting antennas through an Additive White Gaussian Noise (AWGN) channel.
Step5: The information gain by means of the two receiving antennas is applied to the FFT after removing the cyclic prefix and then passed to the STBC Decoder.
Step6: This parallel information is later transformed into serial form. The BER vs. E_b / N_0 plotted for modulation like BPSK.

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IV.BER FOR BPSK SCHEME

In digital communication, BER reveals the system behavior and evaluates the system performance. Bit error is the number of bits that are altered by factors such as unwanted signal, interference and bit synchronization errors. BER is the ratio of bit errors to the total number of bits of an information signal i.e.

BER = No of bit in errors/ Total no of bits transmitted

It is unit less performance measure, often express as a percentage. BER can be improved by using appropriate modulation scheme and coding technique. The BER can be considered as an approximate estimate of the bit error probability. Bit error rate BER is a parameter which gives an excellent indication of the performance of a data link such as radio or fibre optic system. As one of the important parameters of interest in any data link is the number of errors that occur, the bit error rate is a key parameter. Knowledge of the BER also enables other features of the link such as the power and bandwidth, etc to be tailored to enable the required performance to be obtained. $\mathbf{Pb=1/2(\frac{\frac{Eb}{N0}}{\frac{Eb}{N0}+1})}$

For OFDM using BPSK Modulation having parameter like,

No. of bits transmitted = 12000
No. of carriers used = 6
Bits per each carrier = 2000

Table II. SNR vs BER calculations

SNR	BER
0	0.0757
1	0.0564
2	0.0388
3	0.0215
4	0.0118

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V. SIMULATION RESULTS

Table 3:
MIMO-OFDM System implementation simulation parameters

Sr. No.	Parameter	Rating
1	IFFT/FFT size	64 point
2	Modulation	BPSK
3	Sampling frequency	312.5KHz
4	Carriers	4
5	Channel type	AWGN (Rayleigh fading)
6	Cyclic prefix	1 symbol
7	Cyclic prefix duration	0.8µS

For wireless application, we used forward error correcting code i.e. convolutional coding is used in the result. There are 2 transmitters and 2 receivers configuration so in comparison with simple OFDM it gives high throughput. So it is mainly used for wireless i.e. WLAN application. Figure shows 2*2 channel design OFDM simulation on the basis of FFT type having code length 1000.

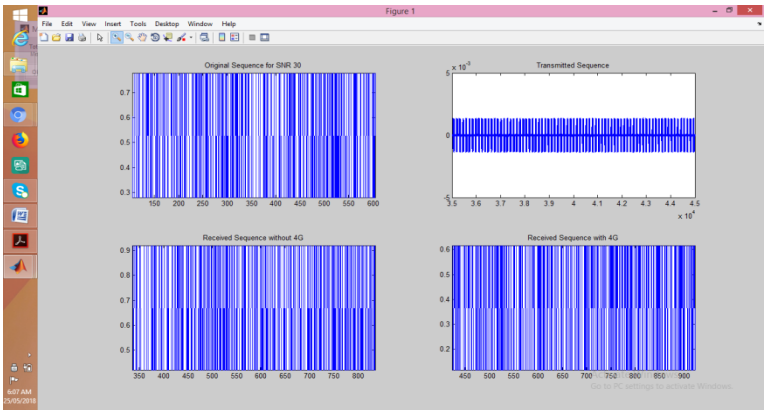

Figure 4(a) simulation of MIMO OFDM system for simple radix FFT algorithm

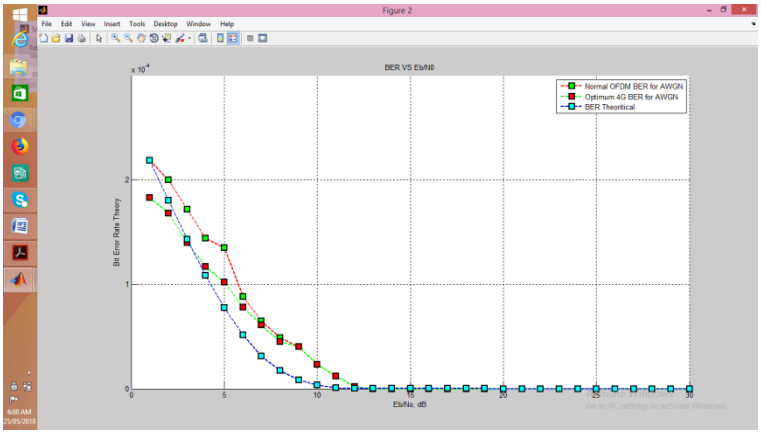

Figure 4(b) Plot of bit error rate versus E_b/N_o of MIMO OFDM system

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VI. CONCLUSION

In the given paper, 2*2 MIMO OFDM system has been implemented. The main focus of the system is to analysis of MIMO OFDM using BPSK modulation scheme. Multi input Multi output is a very attractive technique for multicarrier transmission and become one of the standard choices for high speed data transmission over a communication channel. The performance analysis was carried out by using plot of $\mathbf{E_b/N_o}$ **versus** Bit error rate.

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