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BER Performance Improvement of MIMO System

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Abstract: ***Wireless Communication System has gained a lot of importance in the present times due to its high accuracy, greater extent of secure transfer and effectiveness. The major challenges faced by the modern digital wireless communication is to satisfy the ever growing demand of high speed reliable communication in multimedia and internet services with extremely limited frequency spectrum and limited power. Also wireless channel suffers from CCI and fading. MIMO is one of the technology is used to achieve the above requirements. The system efficiency reduces due to limited resources and the impairments of the wireless channels like noise and ISI these can be compensated by using equalization techniques. In this work the performance improvement of the MIMO system can be accomplished by using OSTBC, ML detector and MRC techniques. BER analysis is done under Rayleigh fading channel using BPSK modulation. Simulation results shows that ML equalizer with OSTBC using BPSK gives better performance.***

Index Terms**: *Multiple Input Multiple Output (MIMO), maximum ratio combiner (MRC), Maximum likelihood (ML), Orthogonal Space Time Block Code (OSTBC).***

I. INTRODUCTION

Wireless Communication System has gained a lot of importance in the present times due to its high accuracy, greater extent of secure transfer and effectiveness. One of the most important parts of this system is the Multimedia and internet services. They have become the vital part of the modern era. It has almost become the part of the day to day activity. Generally speaking we can take a person's starts and ends with a wireless communication system , starting from the morning alarm , the fitness tracker, the GPS system, connecting people across the world both for the cause of personal and professionalism, important dates reminder, remote controls almost all activities are associated with a wireless system. The effectiveness of this communication system depends on the efficiency with which the input message reaches the output receiver end with zero or very minimal distortion. The distortion in the message signal may be added due to inefficiency of the encoder, attenuation in the channel or interferences in the channel, inefficiency of the decoder and so on, and efficiency of this channel lies in overcoming these errors. The introduction of the wireless technology has made it possible to transfer the data at very high speed with high quality. The very big challenge for communication system is to achieve high quality data at very high data rate. This problem can be minimized by applying MIMO technology. Unlike wired communication, in wireless communication, the signal reach the receiver end from multiple path and hence leads to the inter symbol interference. This inter symbol interference increases the bit error rate.

The wireless communication systems offer high Data rate, Wide coverage and improved reliability. To achieve these in wireless communication the MIMO systems are used that can efficiently increases the data transmission rate and the system coverage by considering multiple numbers of transmitter antennas and receiver antennas and spatial dimensions are used. When the data is transmitted at high rates, due to this Inter-symbol interference (ISI) occurs. To eliminate this effect different equalization techniques are used. Equalization techniques such as Zero forcing equalizer (ZFE), minimum mean square error (MMSE) and maximum likelihood (ML) detection algorithms can be employed to reduce the ISI.

One way of effective utilization of the communication system is by making use of the frequency reuse technique, but the major drawback in this type of sharing is it does not take into account of the serviceability of the channel i.e. it leads to co-channel interference. This may occur because of two or more base stations sharing the same frequency which has a relative proximity with each other .though the designer carefully takes care to reduce the channel interferences but they fail to completely eliminate this problem of interference which in some cases becomes a dominant factor to determine the efficiency of the wireless communication system .Usually the channel can be used to provide service if its signal to noise ratio is above the threshold value on the other way we say a signal is interference limited if its co-channel interference dominates the channel noise.

Other most common type of error in a communication system is the inter symbol interferences where two or more samples or pulses overlap with each other causing a noise in the channel this is mainly caused by overlapping time periods or multipath propagation and the frequency varying non uniformly in the channel. For a wireless communication system to be efficient the noise across the channel has to be completely eliminated which in turn implies the

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inter symbol interferences has to be completely eliminated or minimized to the order of almost zero.The efficiency of a wireless communication system lies in use of multiple antennas to provide a wide variety of gain increase the dependability.

One of the way to achieve this is by using multiple antennas both the transmitter end as well as the receiving end which is also called a MIMO system (Multiple Input Multiple Output) .The effectiveness of this method of communication lies in usage of multiple antennas at both the sender and the receiver side which allows multiple users to communicate simultaneously with lesser ISI and CCI. The power gain is very significant in low SNR regime where systems are power limited.

II. MIMO SYSTEM

In wireless communication system, to reduce the effect of multipath fading diversity techniques are widely used and also it improves the transmission reliability without increasing the bandwidth or transmitted power. The diversity scheme is the technique for increase the quality of the message signal in which more than one communication channels are used and each are having different characteristics. This is one of the most important technique used to reduce the co channel interference and multipath fading of the signal because each individual channels having different amount of interference.

The various transmission techniques are used to classify the communication link depending on the number of transmit and to receive signal. These different schemes are shown in Fig.1.

Single input single output technique uses one transmit and one receive antenna and achieves no diversity. Single input multiple output technique uses one transmit and multiple receive antenna and achieves receive diversity. Multiple input single output technique uses multiple transmit and single receive antenna and achieve transmit diversity. Multiple input multiple output technique uses multiple transmit and multiple receive antenna and achieve both transmit and receive diversity.

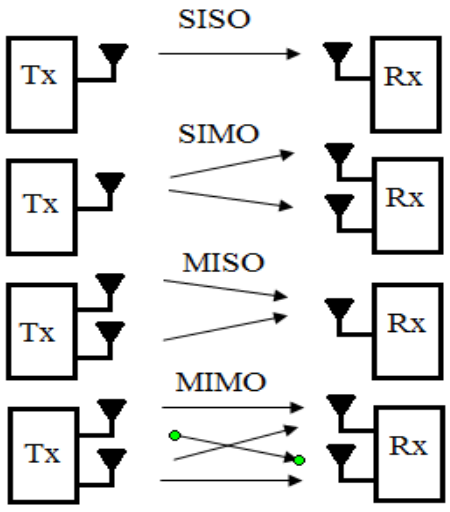

Fig.1. Transmission Techniques

III. MIMO SYSTEM MODEL

A MIMO system model is shown in Fig.2. The input bit stream is first fed into modulation technique, here BPSK modulation is used. The modulated digital signals are fed into MIMO Encoder. OSTBC is the MIMO technique used over here. The channel assumes here is Rayleigh fading. Receiving section performs reverse operation i.e. all transmitted signals are detected and sent to OSTBC Decoder. After that decoded signal is fed into equalizer here ML and MRC equalization technique is used. After that demodulation using BPSK demodulator and approximated signal is recovered.

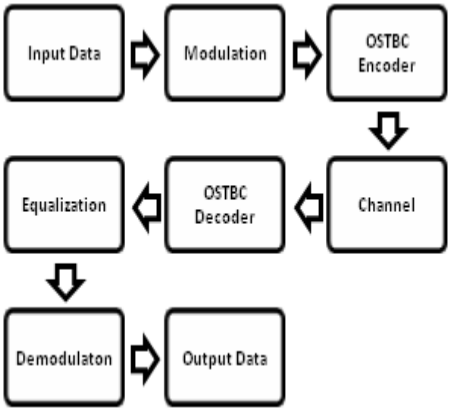

Fig.2. MIMO system model

IV. CHANNEL DESCRIPTION

The effect of phase shifting of the signal and multipath constructive and destructive interference causes Rayleigh fading. There is no direct path between transmitter and receiver in Rayleigh fading channel. The received signal can be written as:

$$R(n) = \Sigma\, h(n, \tau)\, S(n - m) + w(n) \qquad (1)$$

Where w (n) is the AWGN noise with unit variance and zero mean, $h(n)$ is the channel impulse response.

V. EQUALIZATION

Equalization technique is used to overcome the ISI interference where two or more samples or pulses overlap with each other causing a noise in the channel this is mainly caused by overlapping time periods or multipath propagation and the frequency varying non uniformly in the channel. Equalization techniques can be divided into two categories namely linear and nonlinear equalization. These categories are determined from the use of output of an adaptive equalizer that is used for subsequent control of the equalizer. Here MRC and ML equalizer is used.

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VI. SIMULATION PARAMETERS AND RESULT

A. *Simulation parameters*

The Standard Parameters used for simulation of MIMO system model is listed in Table 1.

B. *Simulation result*

The BER analysis of MIMO system for different transmission technique using ML and MRC equalizer simulation results are performed by MATLAB software are shown as follow:

Fig.3. shows the BER analysis graph of SISO system. Simulation results represents that the BER values varies from 10^0 to 10^{-4} and Eb/No values varies from 0 to 34.For BPSK modulation under Rayleigh channel.

I. SIMULATION PARAMETERS FOR MIMO SYSTEM

Parameters	Value
Number of transmit antenna	2
Number of receive antenna	2
Modulation	BPSK
Channel model	Rayleigh
Noise Model	AWGN

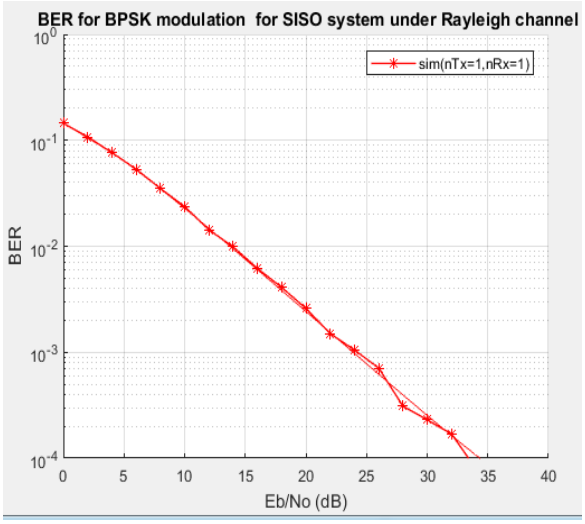

Fig.3. BER analysis of SISO system.

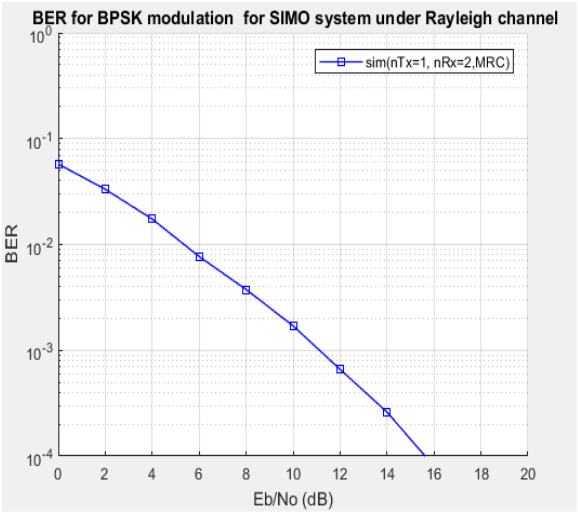

Fig.4. BER analysis of SIMO system.

Fig.3 shows the BER analysis graph of SISO system. Simulation results represents that the BER values varies from 10^0 to 10^{-4} and Eb/No values varies from 0 to 34.For BPSK modulation under Rayleigh channel.

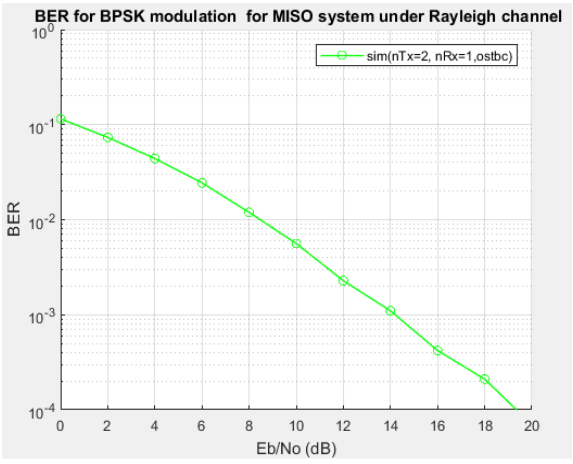

Fig.5. BER analysis of MISO system.

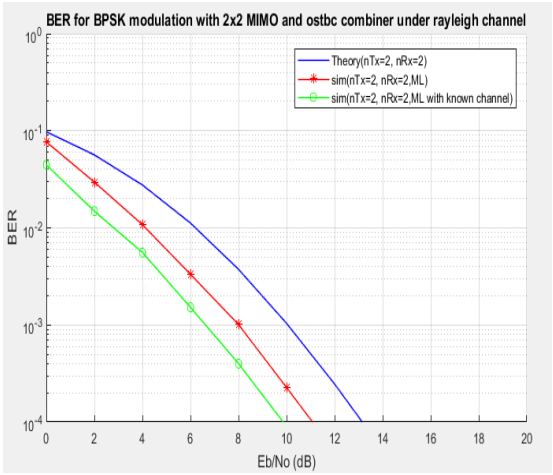

Fig.6. BER analysis of 2X2 MIMO system.

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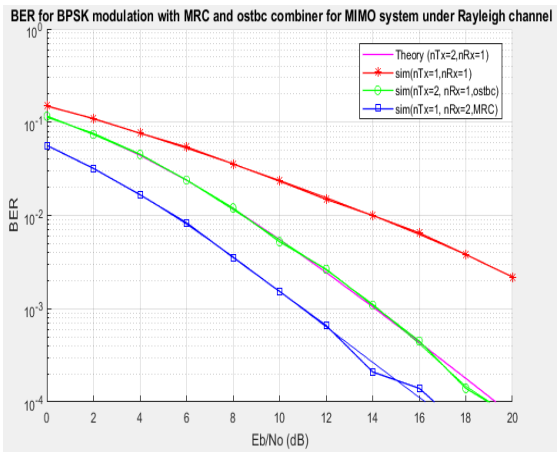

Fig.7. BER comparison analysis of MIMO system.

Fig.4 shows the BER analysis graph of SIMO system. Simulation results represents that the BER values varies from 10^{-1} to 10^{-4} and Eb/No values varies from 0 to 14.5. For BPSK modulation using MRC under Rayleigh channel.

Fig.5 shows the BER analysis graph of MISO system. Simulation results represents that the BER values varies from 10^{-1} to 10^{-4} and Eb/No values varies from 0 to 19.5. For BPSK modulation using OSTBC under Rayleigh channel.

Fig.6 shows the BER analysis graph of 2x2 MIMO system. Simulation results represents that the BER values varies from 10^{-1} to 10^{-4} and Eb/No values varies from 0 to 9.8. For BPSK modulation using OSTBC for ML equalizer under Rayleigh channel.

Fig.7. shows the BER comparison analysis graph of different transmission techniques of MIMO system. Simulation results represents that the BER values varies from 10^{-1} to 10^{-4} and Eb/No values varies from 0 to 16 for BPSK modulation using MRC under Rayleigh channel.

VII. CONCLUSION

In this paper, the comparative study of optimal BER in MIMO system for BPSK modulation with MRC, OSTBC and ML Equalizer is represented. The BER analysis is carried out for MIMO configurations under Rayleigh fading channel. The BER performance of the system using ML equalizer is better and it improves the Performance of the 2x2 MIMO system with the SNR 9.8 for the BER value 10^{-4}.

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