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Performance Analysis of MIMO-OFDM System Using Different Antenna Configurations

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Abstract:- *MIMO-OFDM technology a simple wireless communication system is simulated based on the principles of technical analysis. It is a high data rate and low power consumption. It transmitted data through spatial multiplexing and spatial diversity to improve the data rate and reliability. MIMO-OFDM system performs better when the diversity of antenna is increased specially at receiver side. MIMO-OFDM system performed by using different antenna configuration in AWGN channel and Rayleigh fading channel. BER is determined by using two different detector such as ZF and MMSE with the help of MATLAB.*

Keywords:-*MIMO,OFDM,BER,AWGN,ZF,MMSE,BPSK*

I. INTRODUCTION

Wireless communication system is to provide high data rate wireless access at high quality of service(QOS). MIMO is the antenna technology for wireless communication in which multiple antenna are used at both the transmitter and receiver. The antenna at each end of the communication circuit are combined to minimize error and optimize data speed. The spatial multiplexing and spatial diversity used to improve the data rate and reliability.

OFDM is a method of encoding digital data on multiple carrier frequencies. It is a frequency-division multiplexing (FDM) scheme used as a digital multi-carrier modulation method. OFDM is digital modulation in which the data stream is split into n parallel stream of reduced data rate with each of them transmitted on separate subcarriers. It has been proposed as a transmission method to support high-speed data transmission over wireless link in multipath environments.

MIMO-OFDM is the interface for 4G and 5G broadband wireless communications. It combines multiple-input, multiple-output technology, which multiplies capacity by transmitting different signals over multiple antenna, and OFDM which divides a radio channel into a large number of closely spaced sub channels to provide more reliable communications at high speeds. MIMO-OFDM system gives good coverage in non-line-of-sight environment. Reliable transmission, high peak data rates as well as high spectral efficiency.

II. MULTIPLE INPUT-MULTIPLE OUTPUT SYSTEM

Most wireless communication systems use Single Input Single Output (SISO) systems where a single transmit (Tx) antenna is used for transmission to single receiver(Rx) antenna. Additional transmitting and receiving antennas can be used to provide better result at the receiver. Now a days Multiple input multiple output communication system used. MIMO technique have three categories. First category uses the increasing of spatial diversity o enhance the power efficiency. While the other category uses to increasing the capacity by using layered method. The third category analyzing the coefficient matrix of the channel and uses these analyzing unitary matrices of the filter in transmitter and receiver to improve the capacity.

MIMO increase system capacity by means of spatial multiplexing. Making use of same frequency resources that would be utilized by a SISO system, MIMO systems benefit from multipath propagation and multiply transfer rates by taking advantages of random fading multipath delay spread. In additional MIMO uses spatial diversity and spatial multiplexing to transmission of data. Spatial diversity use at both at the transmitter and the receiver, it improve the transmission quality in terms of bit-error rate(BER).

Spatial multiplexing used to increase the capacity of a MIMO links by transmitting independent data stream in the same time slot and frequency band simultaneously from each transmit antenna.

Figure 1 shows the general structure of an M x N MIMO wireless system. It can be seen that the MIMO channel is an N x M matrix channel consisting of M·N sub channels. The MIMO system can also be viewed as a combination of multiple transmit beam formers, each transmitting to one of the m Rx antenna. The MIMO technology is a very effective method of increasing the capacity of the channel and system. We suppose,

M_T= the number of transmitting antennas·
$x_j(t)$= the transmitted signal, where j=1,...,M_T.
M_R= the number of receiving antennas.
$y_i(t)$= the received signal, where, i=1,..., M_R.
then the relation between the transmitted signal and received signal is written as:

$$y_{i(t)}=\sum_{j=1}^{M_T} h_{i,j}(t)*x_j(t)+n_i(t),\ \ i=0,1,.....M_R \qquad .....(1)$$

Where, $h_{i,j}(t)$ denotes the channel impulse response between the transmitting antenna of number *j* and the receiving antenna of number *i*. The channel of the MIMO system can be expressed by a matrix

$$H(t) = \begin{vmatrix} h_{1,1}(t)h_{1,2}(t) & \dots & h_{1,M_T}(t) \\ h_{2,1}(t)h_{2,2}(t) & \dots & h_{2,M_T}(t) \\ \vdots & \vdots & \vdots \\ h_{M_R,1}(t)h_{M_R,2}(t) & \dots & h_{M_R,M_T}(t) \end{vmatrix}$$

.....(2)

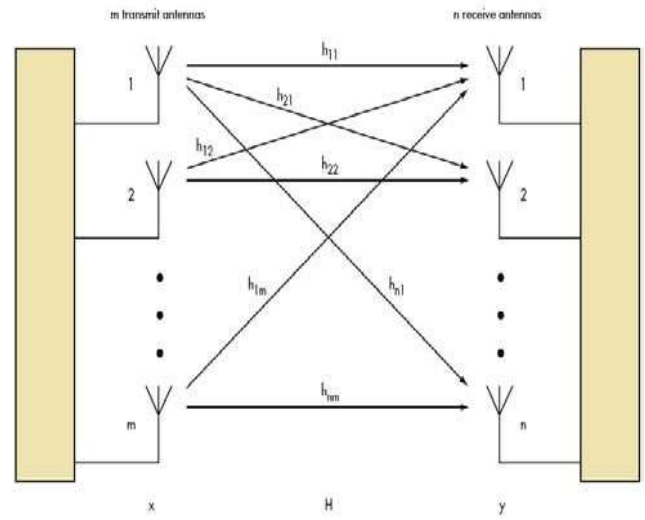

Fig 1. M×N MIMO System

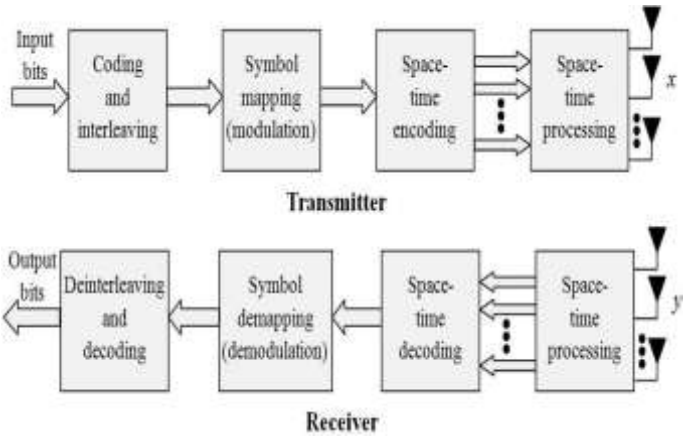

Fig 2.Block Diagram of MIMO System

The receiver with multi-antenna can separate and decode the data stream by using advanced space-time coding. the N sub-streams are sent to the channel at the same time and each transmitted signal occupies the same frequency band. The bandwidth is not increase. If the channel are independent, the MIMO system can create a number of parallel space channels. It increase the data rate by using these channels to transmit information independently.

A. MIMO Channel Capacity

The channel capacity is given by

$$C = \log_2[\det(I_N + phh^H)]$$

.....(3)

Where I_N is the identity matrix, the vector h represents the channel gain or transfer function between the single Tx antenna and the Rx antenna array, and h^K is the Hermitian transpose of h, where H is the *N* x *M* MIMO channel matrix.

III. ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING SYSTEM

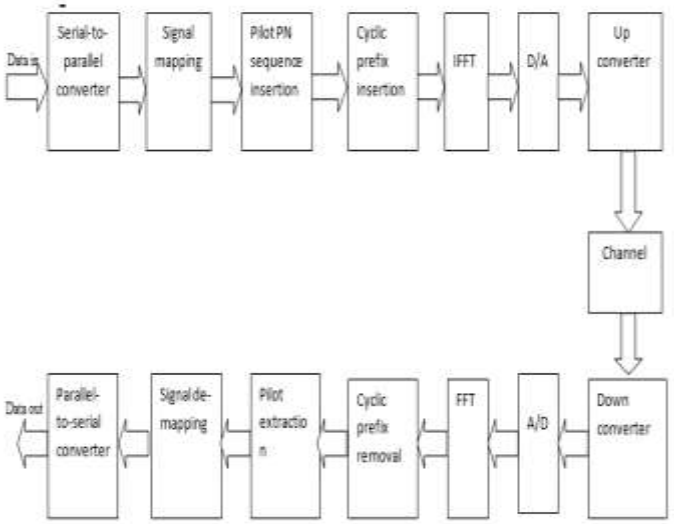

Fig 3. Block Diagram of OFDM System

Fig shows the block diagram of OFDM system. OFDM is the combination of modulation and multiplexing. Multiplexing is applied to independent signals but these independent signals are a sub-set of the one main signal. In OFDM the signal itself is first split into independent channels. Modulated by data and then re-multiplexed to create the OFDM carrier.

IV. Rayleigh Fading

Rayleigh fading is a statistical model for the effect of a propagation environment on radio signal, it is used by wireless devices. Rayleigh fading models assume that the magnitude of a signal that has passed through such a transmission medium will vary randomly. Rayleigh fading is most applicable when there is no dominant propagation along a line of sight between the transmitter and receiver.

V. MIMO-OFDM

MIMO-OFDM is the most competitive technology for 4G and 5G broadband wireless communication. The combination of MIMO-OFDM is useful for transmission of higher data rate. MIMO signal can improve wireless communication system through spatial diversity and special multiplexing method. We have OFDM system by using OFDM system we can transmit data or signal. For that purpose, we have to use either TDMA or FDMA in a serial port or in parallel port in different frequency format or single frequency format. By using our system we can eliminate problem which is found in data transmission over antennas and system quality of service.

VI. SIMULATION RESULTS

In MIMO-OFDM there is a one or more transmit antenna and one or more receive antenna. This technique is simulated by using MMSE (Minimum Mean Square Error Equalization) and ZF (Zero Forcing Equalization) detection for BPSK modulation with AWGN channel with the help of MATLAB version 9.4a. The simulation result plotted between bit error rate (BER) and signal to noise ratio (SNR). The bit error rate is detected for various SNR values.

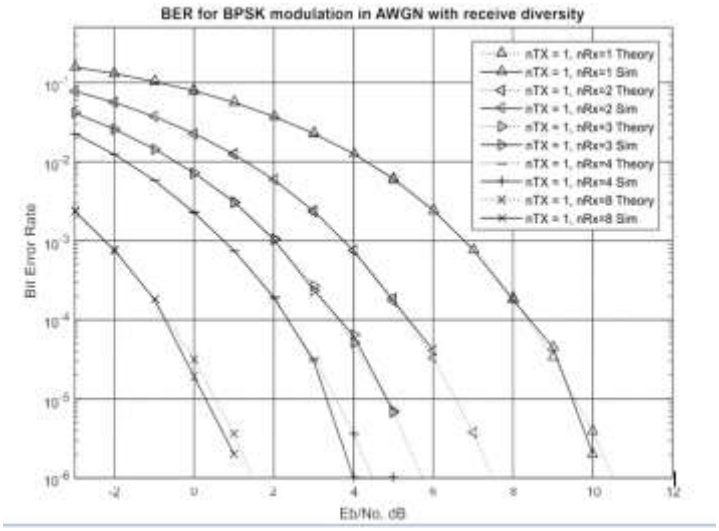

Fig 4.BER for BPSK modulation in AWGN with receiver diversity

Fig shows the BER performance for MIMO-OFDM System using BPSK modulation Technique. Here we can use the one transmitting antenna and multiple receiving antenna just like 1*1,1*2,1*4,1*8. We perform the graph between the bit error rate and Eb/No, here bit error rate decreases and signal to noise ratio is increases. The bit error rate is calculated for simulation and theoretically and the bit rate is 10^6. The number of transmitting antenna as well as number of receiving antennas we will get better BER and the SNR value is also decreasing.

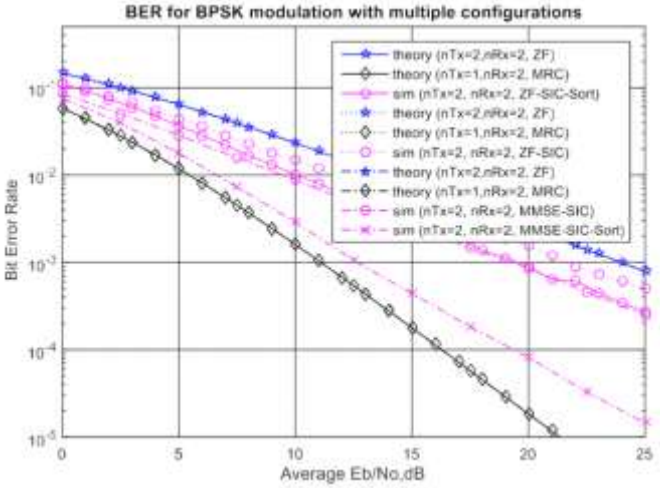

Fig 5.shows the BER performance a MIMO-OFDM

Fig shows the BER performance for MIMO-OFDM System using BPSK modulation technique for multiple configuration here zero forcing equalization (ZF),zero forcing equalization for successive interference cancellation and minimum mean square error detector are used.

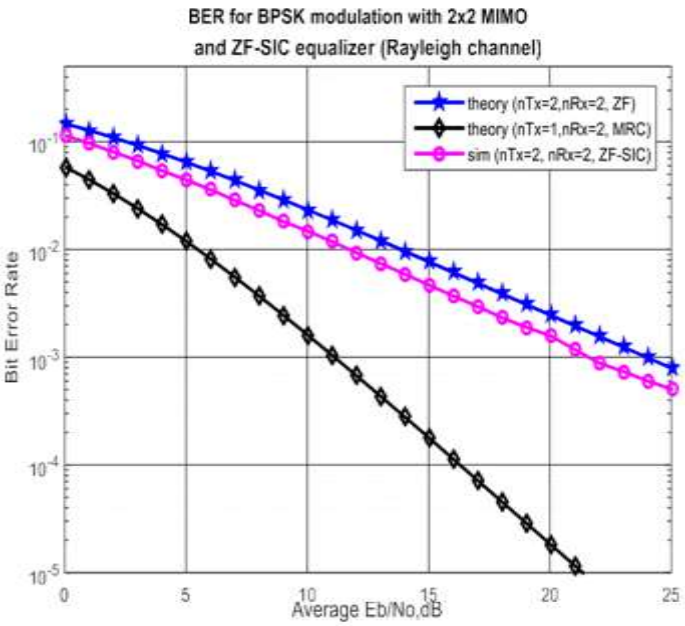

Fig 6.BER for BPSK modulation with 2×2 MIMO and ZF-SIC equalizer

Fig shows the 2×2 MIMO system with zero forcing equalizer with 1*1 system for BPSK modulation in Rayleigh channel. The graph perform between Bit Error Rate and Average Eb/No it will try to improve the bit error rate performance by trying out successive interference cancellation. It consist of Rayleigh fading with multiple channel and BPSK modulation.

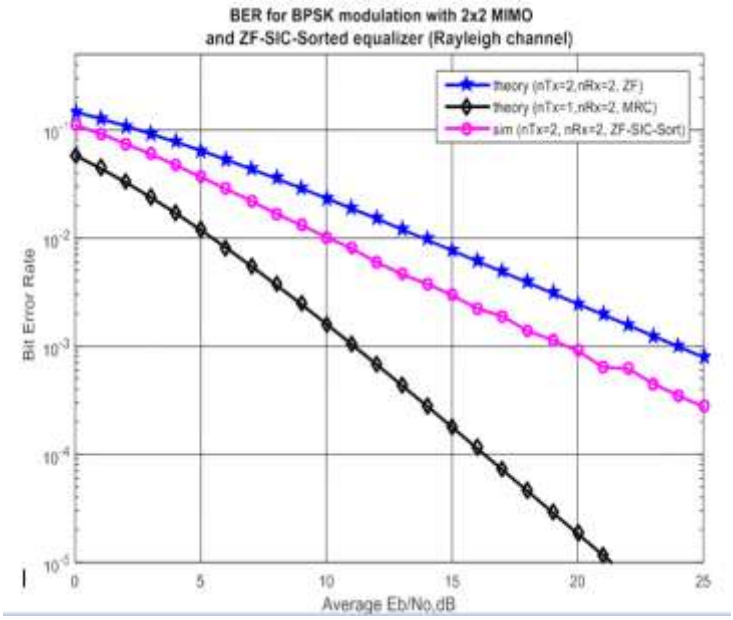

Fig 7.BER for BPSK modulation with 2×2 MIMO and ZF-SIC-sorted equalizer

Fig shows that the BPSK modulation with 2 transmitter and 2 receiver MIMO system with zero forcing equalizer. It consist of Rayleigh fading with BPSK modulation. It improve the bit error rate performance by trying out successive interference cancellation with sorted equalizer.

CONCLUSION

Here we have analysis a simple MIMO-OFDM wireless communication system it is simulated in MATLAB. The simulation result shows that the system has good performance when diversity is increased both at the transmitter and receiver side of MIMO-OFDM system. The BER performance of MIMO-OFDM is analyzed for MMSE and ZF detection using different antenna configuration and BPSK modulation.

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