Performance Analysis of MIMO-OFDM and MISO-OFDM System based on STBC Code

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ABSTRACT
MIMO (Multiple Input Multiple Output)-OFDM (Orthogonal Frequency Division Multiplexing) technique is most attractive techniques in wireless communication system and it is very popular for high data rate capacity and against multipath fading. This paper presents performance analysis and a comparative study of OSTBC (Orthogonal Space Time Block Code) over Rayleigh fading channel for MISO (Multiple Input Single Output) defined that the transmitter has multiple antennas at the same time the receiver has one antenna and MIMO (Multiple Input Multiple Output) shows that the both the transmitter and receiver have multiple antennas. In this paper we propose QPSK (Quadrature Phase Shift Key), 16-QAM (Quadrature Amplitude Modulator) schemes and also observe that the performance of PAPR (peak power-to-average ratio), BER (bit error rate) in MIMO and MISO.

Keywords
OFDM, MIMO, MISO, STBC, PAPR, BER.

1. INTRODUCTION
MIMO-OFDM system is a powerful tool for improving wireless performance. To better performance can be achieve by increasing number of transmit antennas and receive antennas. This paper presents the STBC with MISO and MIMO for wireless networks .The STBC which include an orthogonal STBC for two transmit and one receive antenna(MISO) and two transmit and two receive antenna (MIMO) have been simulated in MATLAB. MIMO shows better PAPR reduction compared to the MISO. The Performance of QPSK, 16-QAM modulation techniques are investigated in terms of PAPR and BER under different SNR scenarios. All simulations are run under referenced AWGN and Rayleigh channel model. The performance results are introduced in terms probability (symbol PAPR> value) versus PAPR and bit-error rate (BER) versus (signal to noise ratio) SNR.

In [1] authors (Yun Li, Mingyu Gao and Zhiqiang Yi),shows the performance of the cooperative and alternate PTS (C-A-PTS) algorithm is used for the STBC MIMO-OFDM system and compare the performance of PAPR. In this literature author (Helka Maattanem) introduced the basic principles of MIMO system and described the MIMO wireless channel modeling as well as the MIMO channel capacity [2]. OFDM (Orthogonal frequency division multiplexing) is a digital multicarrier communication scheme which is transmitting digital data for limited spectral bandwidth. The main key of this technique is that the entire bandwidth is divided into small sub-bands with orthogonality. It has many advantages such as low multipath distortion, high spectral efficiency but it has several drawbacks like high sensitivity to Doppler shift, the loss of bandwidth due to guard period, more complex than single carrier modulation inter carrier interference between the subcarriers the main drawback of OFDM is high PAPR (peak power to average ratio) which we have study here [3] [4].To deal with this issue different techniques for PAPR reduction have been presented in [6],[7], [8], [9]. Diversity was obtained by the use of OSTBC at transmitter, the received signal were combining by maximum ratio combiner (MRC) and detect by (maximum likelihood) ML detector. MIMO-OFDM system has been done with STBC coding which play a vital role in wireless communication and also improve the spectrum efficiency, channel capacity, coverage area [5]. The BER performance of STBC coding is better for low order modulation than high order modulation [10] [11]. In this paper author focused on OFDM and STBC techniques and also analyzed that if increasing the number of transmits antennas no benefit is obtained by using STBC [12]. In this work author discusses about the basic model of MIMO-system and investigate the channel characteristic (multipath propagation, speed of mobile, speed of surrounding object) and Doppler Effect in MIMO-OFDM System [13]. This paper observe the performance of the Least Squares channel estimation technique and also consider that MIMO-OFDM system is better than MISO-OFDM systems with BPSK modulation technique [14]. In this paper littérateur proposed STTC (space time trellis code) code for MIMO-OFDM System and shows the performance analysis from the past review papers and obtain the difficulty for the further improvement [15].

The remainder of this paper is orderly as follows. In Section II, the MIMO (multiple input multiple output) and MISO (multiple input single output) system is introduces with the power spectrum. In section III, OSTBC (orthogonal space time block code) coding is described encoding algorithm and decoding algorithm in detail with transmits and receives diversity. A basic system model is presented in section IV and simulation parameter and results are determined in section V. finally the conclusion can be obtained in section VI.

2. MIMO-MISO SYSTEM
Diversity is most powerful method that is widely used in space time coding with various antenna configuration. Here we compare two different types of antenna configuration, MISO (multiple input single output) using two transmit and one receive antenna that present transmit diversity and MIMO (multiple input multiple output) using two transmit and two receive antenna that show full diversity technique. Here we use one channel and two propagation path for MISO system and for MIMO system one channel and four propagation links. the basic block diagram of MIMO-OFDM

system is show below with multiple input antennas and multiple output antennas.

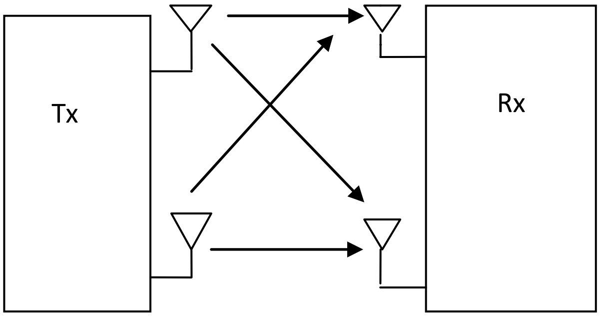

Figure 1: Block Diagram of (MIMO)

$$Y = Hx + n \qquad (1)$$

Where Y is receiving signal, X is transmitted signal and H is the channel matrix and n is the Additive White Gaussion Noise (AWGN) vector at a given instant in time channel noise and the matrix form can be

$$\begin{bmatrix} Y_1 \\ \vdots \\ Y_n \end{bmatrix} = \begin{bmatrix} h_{11} & \cdots & h_{1t} \\ \vdots & \ddots & \vdots \\ h_{n1} & \cdots & h_{nt} \end{bmatrix} \begin{bmatrix} x_1 \\ \vdots \\ x_n \end{bmatrix} + \begin{bmatrix} n_1 \\ \vdots \\ n_n \end{bmatrix} \qquad (2)$$

The above matrix represent n number of transmit and receive antennas which have n possible path for data transmission. Here each receiver Antenna receives the direct path as well as a fraction of signal from the other propagation links. Thus the channel response h_{11} expressed the direct path between transmitter antenna one and receiver antenna one and h_{12} channel response represent the path formed between transmit antenna two to receiver antenna one and so on. Thus the channel matrix has N X T dimension.

In this process MIMO-MISO system using inverse fast Fourier transform (IFFT) and fast Fourier transform (IFFT), respectively. Power spectral density (PSD) is useful tool which directly calculated by FFT method and it is define at which frequencies energy of signal are strong and weak .Figure 2 and 3 shows the power spectrum of the MISO-OFDM signal and the MIMO-OFDM signal. Here horizontal axis is representing frequencies in MHz and vertical axis represent amplitude in dB of the signal with two modulation techniques (QPSK, 16-QAM).

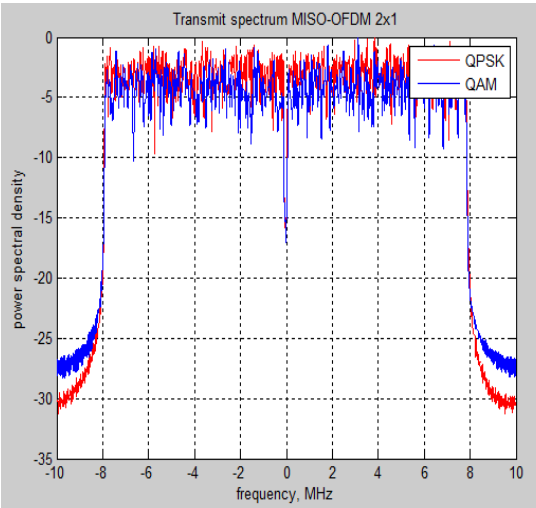

Figure 2 the spectrum of the MIMO-OFDM signal.

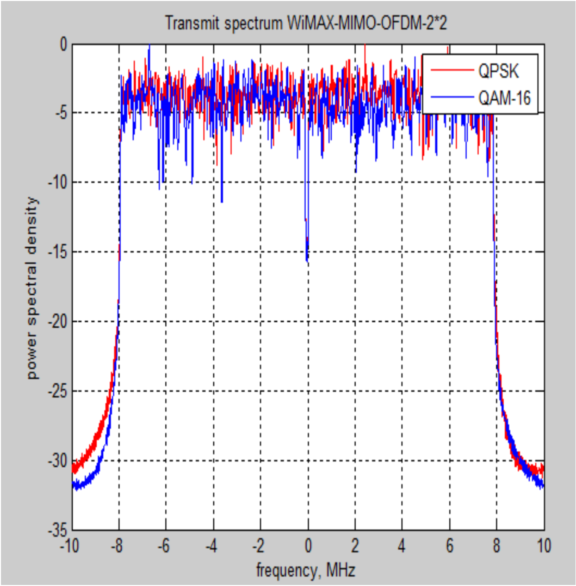

Figure 3 the spectrum of the MIMO-OFDM signal.

3. OSTBC (ORTHOGONAL SPACE DIVISION MULTIPLEXING)

Orthogonal space-time block code is the combination of spatial and temporal diversity. There are two main types of space-time codes, namely space-time block codes (STBC) and space-time trellis codes (STTC). STBC operates on a block of input symbols, columns of the coding matrix represent time and rows represent antennas. Main feature of STBC is very simple decoding scheme. STTC operates on one input symbol at a time, the result of STTC is vector whose length represents transmit antennas. Disadvantage of STTCs is that they are difficult to design and require high complexity encoders and decoders. STBC is simpler technique compare to STTC. Space-time block coding utilizes multiple transmit antennas to create spatial diversity. This allows a system to have better performance in a fading environment. Good performance with minimal decoding complexity. Encoding matrix is described as

$$s = \begin{bmatrix} S_1 & S_2 \\ -S_2^* & S_1^* \end{bmatrix} \qquad (3)$$

The space-time coding scheme is based on pairs of symbols that are transmitted in two consecutive symbol intervals. Encoding is done in space and time (space-time coding), s_1 and s_2 are transmitted symbols. In transmission we will send s_1 from first transmit antenna and s_2 from second transmit antenna in the first time slot t. In second time slot $-s_2$* from first transmit antenna and s_1* from second transmit antenna was sending where * is the complex conjugate operation. this sequence is shown in table-I.

Table-I Transmit diversity scheme for different time

Time	Antenna(Tx1)	Antenna(Tx2)
t	S_1	S_2
t+T	$-S_2$*	S_1*

The channel may be modulated by a complex multiplicative distortion assuming that the fading co-efficient h_1, h_2, h_3, h_4

are constant from the transmit antenna to receive antenna. We can write

$$h_1(t) = h_1(t+T) = h_1 = \alpha_1 e^{j\theta 1} \quad (4)$$

$$h_2(t) = h_2(t+T) = h_2 = \alpha_2 e^{j\theta 2} \quad (5)$$

$$h_3(t) = h_3(t+T) = h_3 = \alpha_3 e^{j\theta 3} \quad (6)$$

$$h_4(t) = h_4(t+T) = h_4 = \alpha_4 e^{j\theta 4} \quad (7)$$

Where α is amplitude gain, θ is phase shift, T is symbol duration.

Table-II Receive diversity scheme for different time

Time	Antenna(Rx_1)	Antenna(Rx_2)
t	Y_1	Y_3
t+T	Y_2	Y_4

The received signals for MISO system at different time interval can be expressed as

$$Y_1 = Y(t) = h_1 S_1 + h_2 S_2 + n_1 \quad (8)$$

$$Y_2 = Y(t+T) = -h_1 S_2^* + h_2 s_1^* + n_2 \quad (9)$$

The received signals for MIMO system at first time slot t can be expressed as

$$Y_1 = h_1 S_0 + h_2 S_1 + n_1 \quad (10)$$

$$Y_3 = h_3 S_0 + h_4 S_1 + n_3 \quad (11)$$

The received signal for MIMO system at next time slot (t+T) can be expressed as

$$Y_2 = -h_1 s_1^* + h_2 s_0^* + n_2 \quad (12)$$

$$Y_4 = -h_3 s_1^* + h_4 s_0^* + n_4 \quad (13)$$

Where Y_1, Y_2, Y_3, Y_4 are received signals and h_1, h_2, h_3, h_4 are fading coefficient between transmit antenna to receiver antenna, * is complex conjugate operation. n_1, n_2, n_3, n_4 are independent complex noise.

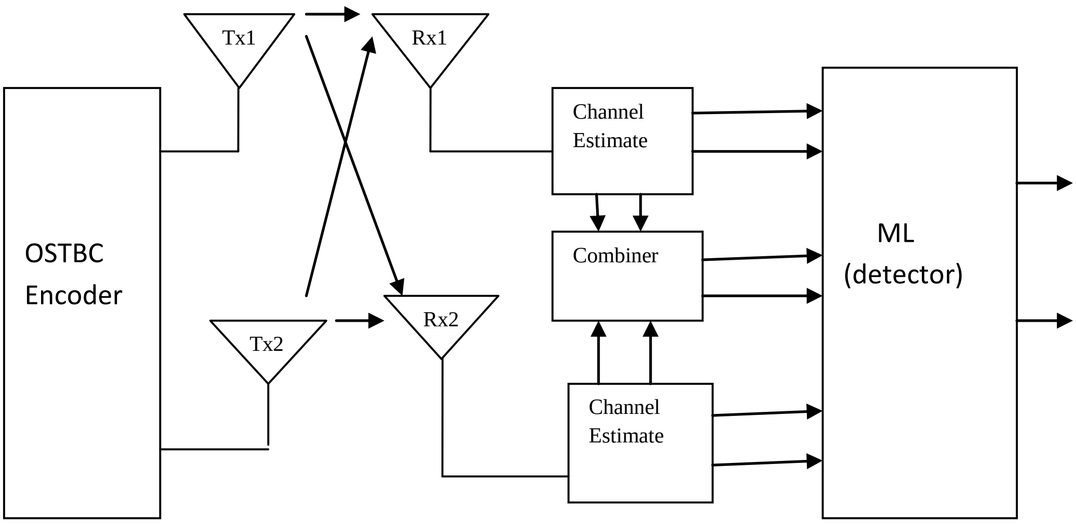

Figure 4: MIMO OFDM system with OSTBC

4. SYSTEM MODEL

4.1 Data Generation

The function of data generator is basically generating the random data to the transmission section. These random data is generated by number of OFDM symbols, word size (2=QPSK, 4=16-QAM), and modulation techniques (QPSK, 16-QAM). Rand is a MATLAB function which generates uniformly distributed pseudorandom numbers for data generator.

4.2 Modulation

The incoming data streams are modulated by modulation techniques (QPSK and 16-QAM). The data is transmitted on each carrier then mapped into a Phase Shift Keying (PSK).

Since differential encoding requires an initial phase reference an extra symbol is added at the start for this purpose. The data on each symbol is then modulated to a phase angle based on the modulation method. Group them into pair of two symbols

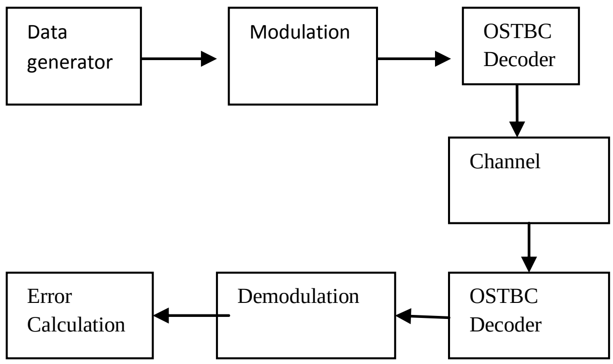

Figure 5 Basic Block diagram of MIMO-OFDM System

4.3 OSTBC Encoder

Space Time Block Coding (STBC) is coded the modulated signal and transmit them into different IFFT section after this process guard insert in each symbol then transmit them through different antennas.

4.4 Channel

The signals are propagate through Flat fading Rayleigh channel. Then AWGN is added to the signal.

4.5 OSTBC Decoder

In the STBC decoder received signals are combined by maximal ratio combining (MRC) and detected by maximum likelihood detection.

4.6 Demodulation

Demodulator converts the modulated waveform created at the receiver to their original bits.

4.7 Error Calculation

finally errors were calculated and PAPR, BER are plot for different Probability {PAPR>$PAPR_0$} and SNR values respectively.

5. SIMULATION

Simulation parameter is show below in TABLE-III, here we use IFFTSIZE=256 which has 192 carrier signal use for data symbol ,8 pilot signal ,55 carriers used for guard period present in OFDM system and Different modulation techniques are using such as QPSK,16-QAM.in this system multiple input single output and multiple input multiple output technique has been described.

Table-III Simulation Parameter

PARAMETER	VALUES
Sampling Frequency(Fs)	20MHz
FFT Size	256
Modulation Techniques	QPSK, 16-QAM
Parallel Channel	200
Input Sampling Period	1.0000e-06
Transmit Antennas	2
Receive Antennas	1 and 2
Max Doppler Shift Frequency	50Hz
Software	MATLAB 12.0

As a result shows in table-IV probability {PAPR>$PAPR_0$} =10^3, when peak to average ratio is 6dB, 12.9dB for QPSK, 16-QAM in MISO system and probability {PAPR>$PAPR_0$} =10^{-3}, when peak to average ratio is 9.2dB, 16dB for QPSK, 16-QAM in MIMO system.

Table-IV Compute PAPR for MIMO-OFDM and MISO-OFDM

Digital Modulation	Peak to Average Ratio for Probability {PAPR>$PAPR_0$}10^{-3} With MIMO-OFDM	Peak to Average Ratio for Probability {PAPR>PAPR} 10^{-3} with MISO-OFDM
QPSK	6.0 dB	9.2dB
16-QAM	12.9dB	16dB

Table-V Comparison of BER for MIMO-OFDM and MISO-OFDM

Digital Modulation	SNR for BER 10^{-2} with MIMO-OFDM	SNR for BER 10^{-2} with MISO-OFDM
QPSK	11.3 dB	10.5dB
16-QAM	11.0dB	10.6dB

Above table-V presents the BER performance of the MIM0-OFDM signals,which shows that BER=10^{-2} when SNR=11.3dB and 11dB for QPSK,16-QAM respectively and the BER performance of the MIS0-OFDM signals,which shows that BER=10^{-2} when SNR=10.5dB and 10.6dB for QPSK,16-QAM respectively

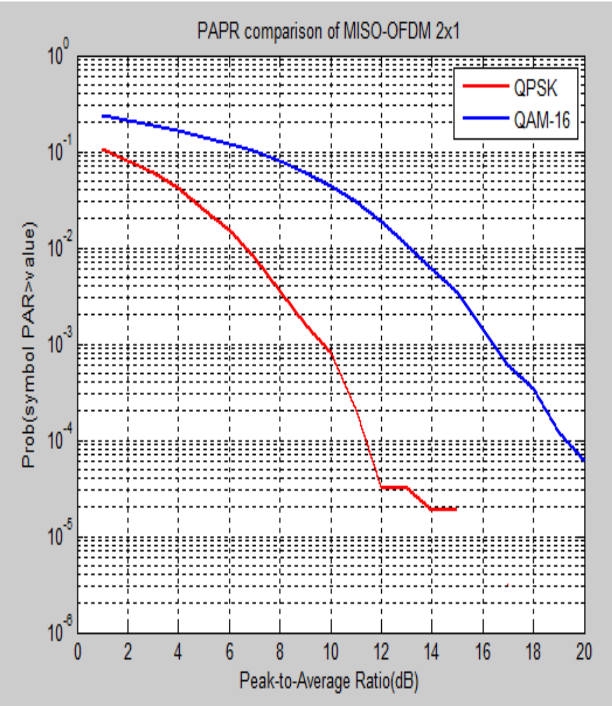

Figure 6 PAPR Plot for MISO using QPSK, 16-QAM

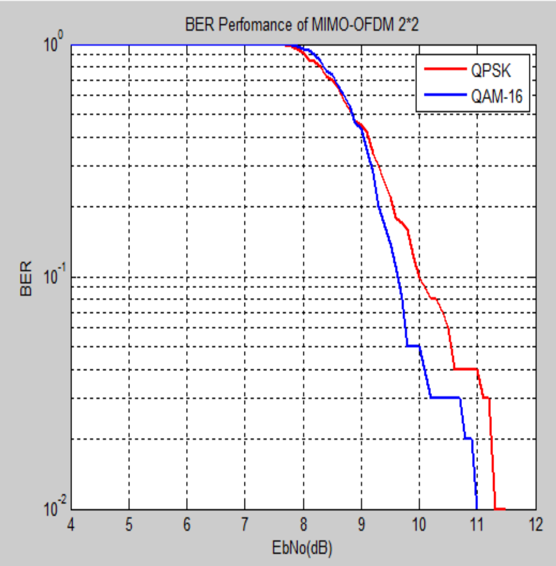

Figure 7 BER Plot for MISO using QPSK, 16-QAM

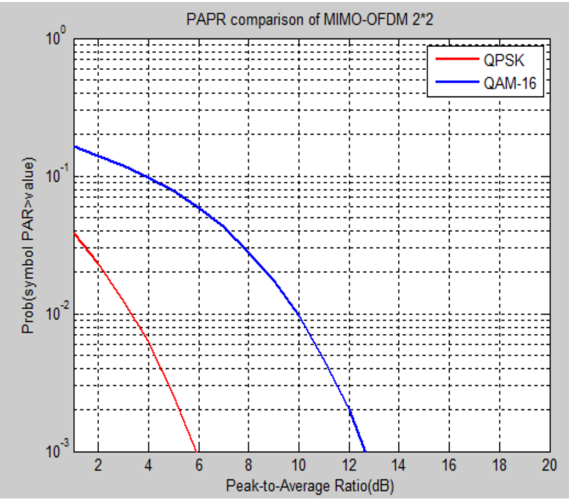

Figure 8 PAPR Plot for MIMO using QPSK, 16-QAM

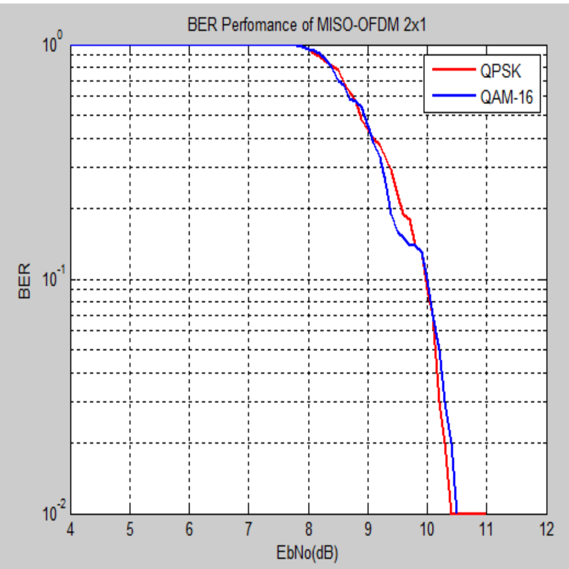

Figure 9 BER Plot for MIMO using QPSK, 16-QAM

6. CONCLUSION

A new PAPR reduction method was proposed for MISO/MIMO OFDM systems with an orthogonal space time block code based. Simulation results showed that the proposed method MIMO has better PAPR performance than the MISO method in QPSK, 16-QAM modulation techniques but for BER analysis MISO-OFDM gives the better result than MIMO-OFDM system. It is observe that QPSK modulation method gives good performance for PAPR reduction and 16-QAM modulation technique has better for BER reduction.

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