# Improvement of Ber for Mimo-Ofdm System Using Wavelet Transform

**A.Vani ,Pranali Shanker Bargade**

***Abstract: OFDM is a multicarrier modulation technique and this technique is used with MIMO. In MIMO, multiple antennas are used at transmitter and at receiver. For achieving high spectral efficiency, OFDM uses MIMO. Because of failure of orthogonally between the sub carriers, OFDM has inter carrier interference (ICI) and inter symbol interference (ISI.) In OFDM, cyclic prefixing (CP) is used to overcome the problem. In this, BER is calculated using DWT based OFDM with QAM modulation technique over AWGN.BER is calculated for different wavelets using different levels of QAM.The performance metrics are analyzed through MATLAB simulations***

***Index Terms: BER SNR, QAM,, MIMO, DWT ,Wavelet.***

## I. INTRODUCTION

In order to reduce the errors over multipath channels MIMO-OFDM is used. It is a multi input multi output –Orthogonal frequency division multiplexing that allows great information capacity over the multipath channel. This technique is used to mitigate the fading that exists over multipath channel and provides a good quality signal [1]. In MIMO-OFDM system, the size of guard intervals is small [2] and it provides good channel fading characteristics, jamming to impulse response, constant average spectral density, spectrally high power efficient,witstand to very strong echoes,neglible nonlinear distortion.

Diversity techniques used to mitigate the fading in multipath environment over wireless channels. Space diversity is used for wireless channels and for this, many transmitter and receiver antennas used [1]. MIMO increases the fundamental gain that enhance spatial multiplexing, which causes more spectral efficienciant.

OFDM expanded as Orthogonal Frequency Division Multiplexing and uses mutually perpendicular sub carries of frequencies for signal transmission. Since subcarriers are mutually orthogonal to each other the OFDM facilitate very high bit rates in the presence of multipath radio propagation. To eliminates ISI OFDM uses spatial-multiplexing receivers which is called as MIMO-OFDM and it is provided at the cost of computational complexity. It ensures the bandwidth of subcarriers to overlap without Inter Carrier Interference (ICI) providing that modulated carriers are orthogonal.

OFDM system uses IFFT (Inverse Fast Fourier Transform) for multiplex the signals and FFT (Fast Fourier Transform) to decode the signal at the receiver. In this system, the Cyclic Prefix appended before transmitting the signal to channel. However, wavelet based transmission technique has stronger capability of suppressing ISI and ICI than the OFDM scheme. In conventional OFDM system, FFT changed with Discrete Wavelet Transform (DWT) to enhance bit error rate, interference minimization, and improvement in bandwidth efficiency.

## II. RELATED WORK

Literature survey on MIMO-OFDM system using different modulation techniques, Wavelet Transforms and DWT MIMO-OFDM system presented.

In a research paper of Weijun Hong, Shufang Li [3] In this work, wavelet transform technology used for improvement of the effectiveness of image compression Whole image transformed with wavelet transform which provides very high compression ratio. No blocking effects at the stage of image recomposing as that exist in DCT In this, the draw back is, geometric distortion not filtered in extreme high compression ratio environment.

Similarly, a recent paper of Kamrul Hasan Talukder and Koichi Harada [4] presented a image transmission scheme using wavelet transform. In this, digital image transformed from spatial domain into frequency domain using discrete wavelet transform. Accuracy of the reconstructed image obtained using Haar wavelet transformation with increased transmission time.

A.Vamsidhar [5] worked on the performance of Discrete Wavelet Transform (DWT) based Multi-user MIMO-OFDM. In this, MIMO-OFDM system used for performance comparison with FFT. From the simulation, the results evaluated for bit error rate to the transmission ability.The results shows that the DWT constructed multicarrier scheme was superior to the predictable OFDM scheme. In proposed work, Daubecheis and Biorthogonal wavelets used to give more accuracy.

Pitcheri Praveen Kumar, at.el. [6] implements MIMO-OFDM system with the Wavelets have effective MRA (Multi Resolution Analysis) capabilities to extract the optimum response of the signal using DWT based OFDM. Efficiency of performance compared with the FFT based OFDM by establishing the bit error rate (BER) appearance with BPSK and QPSK as a modulation technique in the presence of AWGN channel. The proposed system uses QAM modulation technique that is immune to noise.

D.Meenakshi, S.Prabha, N.R.Raajan [7] analyses the performance of ripple based Multi-user MIMO OFDM systems and compared with a FFT based MIMO-OFDM. In this, Simulation created with DWT, Haar model and multiple antennas scheme and dual modulation schemes using BPSK and QPSK as in AWGN. For establishing presentation to the transmission ability, DWT constructed

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multicarrier scheme establish higher transmission ability against bit error rate than predictable OFDM scheme. In the proposed work, Daubecheis and Biorthogonal wavelets used to give more accuracy.

## I. MIMO-OFDM USING WAVELET TRANSFORMS

In wireless communication, popular OFDM technique is used for high data transmission. OFDM with multiple-input multiple-output (MIMO) configuration used to increase the diversity gain or system capacity both on time-varying and frequency-selective channels. In OFDM, processing speed is increased with use of IFFT and FFT which also reduces the complexity at transmitter and receiver.

Wavelets (little waves) transform are most appropriate for non stationary signals and are the functions that are concentrated around a central point in time and frequency. The image information divides into approximation and detail sub signal by this Wavelet analysis. The wavelet representation shows a multi resolution expression of a signal with localization in both time and frequency. The signal decomposed into a set of basis functions using wavelet transforms. DWT is a discrete wavelet transform and it uses any wavelet transform for discrediting into samples. Wavelet transform offers high side lobes suppression ratio hence DFT/IDFT replaced with DWT and for implementation; DWT MIMO-OFDM is used. Wavelet transform has several advantages such as flexibility, lesser sensitivity against channel distortion and least significant interference with better consumption of spectrum. Hence, Wavelet transform used with MIMO-OFDM and proposed to design the sophisticated wireless communication systems.

## II. METHODOLOGY TO IMPLEMENT THE PROPOSED SYSTEM

Wavelet Transform analyzes the changes of time and corresponding change in frequency. The basis functions from Wavelet transforms vary both in frequency range and in spatial range. The frequency of the signal and time related with the frequency can be provided using wavelet; this makes it very convenient in faulty detection.
DWT operates on pixel basis and it transforms the information from spatial domain into frequency domain. DWT divides the high frequency and low frequency on pixel basis

The implementation is performed as a multistage transformation. In DWT domain an image is decomposed as four sub-bands at level 1 like LL, LH, HL and HH.Among four sub-bands LH, HL and HH denote the finest scale wavelet coefficients and LL sets for the coarse-level coefficients. Another level of decomposition is obtained with LL sub-band.

DWT operates on pixel basis and it transforms the information from spatial domain into frequency domain. DWT divides the high frequency and low frequency on pixel basis

## III. ALGORITHM

**Step 1:** Initially the values are been assigned i.e. number of subcarrier = 96, number of pilots = 8, cyclic prefix length = 14 and number of transmitting frames = 100.

**Step 2:** To generate and code the data as per the values assigned in step 1.

**Step 3:** The signal is modulated according to the level of QAM modulation selected i.e. 16QAM, 64QAM, 256QAM. The signal constellation is rectangular or cross shaped and the nearest pair of points in the constellation is separated by 2.

**Step 4:** The IDWT operation is performed. The signal or image extension mode is set for discrete wavelet and wavelet packet transforms.

**Step 5:** measuring of power using DWT OFDM with and without AWGN noise.. The dB SNR specifies the scalar Signal to Noise Ratio per sample.

**Step 6:** dimensional wavelet decomposition is performed with respect to a particular wavelet that are Haar wavelet, Daubecheis wavelet and Biorthogonal wavelet. The approximation coefficients vector cA and detail coefficients vector cD are calculated by a wavelet decomposition of the OFDM signal. The received DWT signal is demodulated. The value of M is 16, 64 and 256 which must be an integer or power of 2.

**Step 7:** Based on the received signal, the BER is calculated for different wavelet transforms.

## V.RESULTS

In this implementation, the simulation results are obtained with different level of QAM modulation techniques. 16QAM, 64QAM, and 256QAM are used as different levels of QAM modulation. The image is transmitted with the help of Wavelet transform like HAAR, Daubechies and Biorthogonal. The simulation parameters used for proposed system is as follows:

| Simulation Parameters | Values |
|---|---|
| Number of subcarriers (N) | 96 |
| Number of pilots (p) | 8 |
| Cyclic prefix length (c) | 14 |
| Number of transmitting frames (Ns) | 100 |
| DWT Family | Haar<br>Daubechies (dB2)<br>Biorthogonal (bior 5.5) |
| Modulation method | 16-QAM,64-QAM,<br>256-QAM |
| Channel | AWGN |

Simulation Parameters for proposed method

**HAAR Wavelet Transform**


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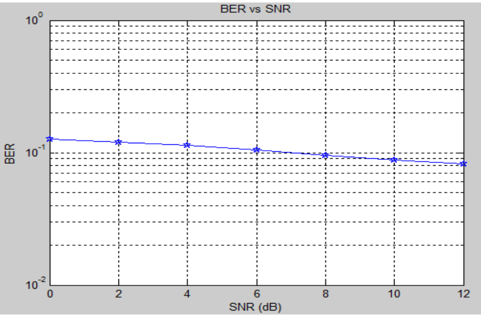


Fig. 5.1 BER vs SNR of MIMO-OFDM using HAAR Transform with 16QAM Modulation

Figure 5.1 shows the performance of MIMO-OFDM system under AWGN channel using Haar wavelet with 16QAM modulation techniques. The BER is $10^{-3}$ at SNR = 12dB for 16 QAM.

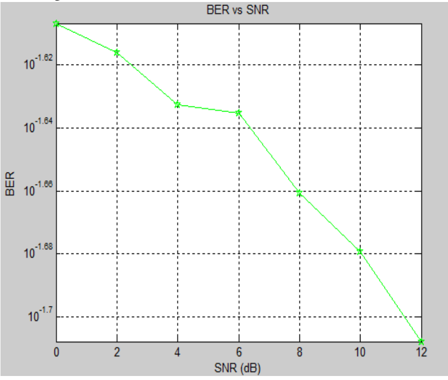


Fig. 5.2 BER vs SNR of MIMO-OFDM using HAAR Transform with 64QAM Modulation

Figure 5.2 shows the performance of MIMO-OFDM system under AWGN channel using Haar wavelet with 64QAM modulation techniques. For 64 QAM, the BER is $10^{-1.73}$ at SNR = 12dB.

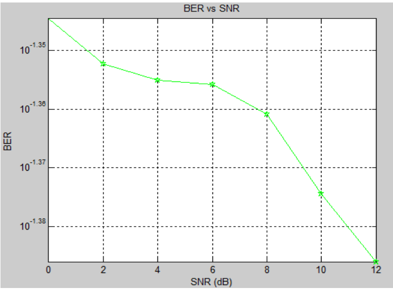


Fig. 5.3 BER vs SNR of MIMO-OFDM using HAAR Transform with 256QAM Modulation

Figure 5.3 shows the performance of MIMO-OFDM system under AWGN channel using Haar wavelet with 256 QAM modulation techniques. For 256 QAM, the BER is $10^{-1.385}$ at SNR = 12dB. From figures, it is observed that as the level of QAM modulation increases, the Bit error Rate (BER) value is decreasing. Therefore, SNR performance is improved.

**Daubechies wavelet transform**

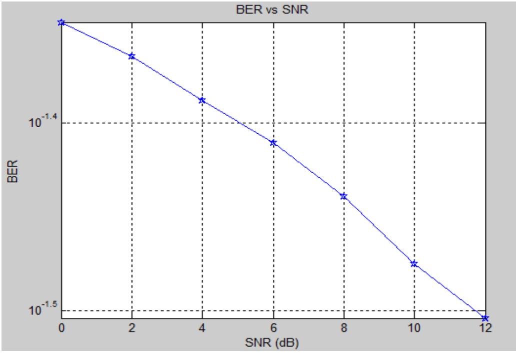


Fig. 5.4 BER vs SNR of MIMO-OFDM using Daubechies Transform with 16QAM Modulation

Figure 5.4 shows the performance of MIMO-OFDM system under AWGN channel using Daubechies wavelet with 16QAM modulation techniques. For 256 QAM the BER is $10^{-1.5}$ at SNR =12dB.

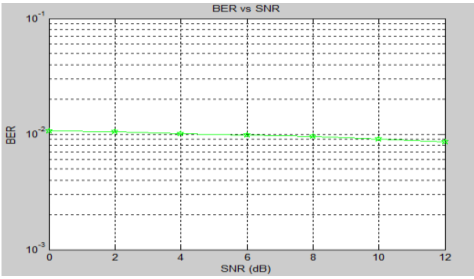


Fig. 5.5 BER vs SNR of MIMO-OFDM using Daubechies Transform with 64QAM Modulation

Figure 5.5 shows the performance of MIMO-OFDM system under AWGN channel using Daubechies wavelet with 64-QAM modulation techniques. For 64-QAM, the BER is $10^{-2.3}$ at SNR = 12dB.

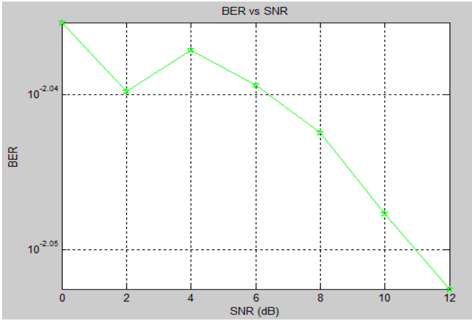


Fig. 5.6 BER vs SNR of MIMO-OFDM using Daubechies Transform with 256QAM Modulation

Figure 5.6 shows the performance of MIMO-OFDM system under AWGN channel using Daubechies wavelet with 256-QAM modulation techniques. For 256-QAM, at SNR = 12dB, the BER is $10^{-2.056}$. As compared to the Haar transform, the BER values are decreasing in Daubechies transform hence the system becomes more efficient.

**Bi-orthogonal wavelets transform**


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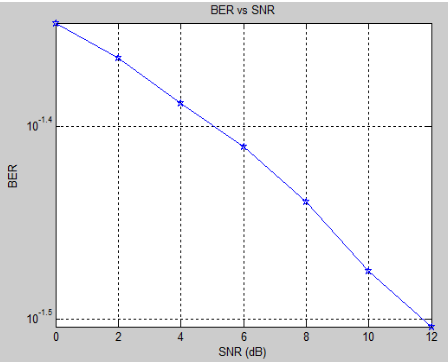


Fig. 5.7 BER vs SNR of MIMO-OFDM using Biorthogonal Transform with 16QAM Modulation

Figure 5.7 shows the performance of MIMO-OFDM system under AWGN channel using Biorthogonal wavelet with 16QAM modulation techniques. For 16-QAM, the BER is $10^{-1.5}$ at SNR = 12dB.

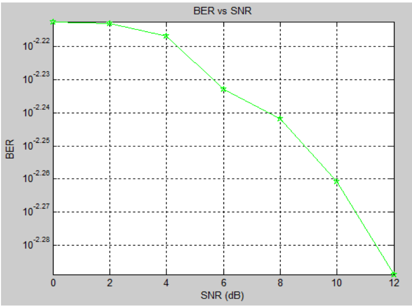


Fig. 5.8 BER vs SNR of MIMO-OFDM using Biorthogonal Transform with 64QAM Modulation

Figure 5.8 shows the performance of MIMO-OFDM system under AWGN channel using Biorthogonal wavelet with 64QAM modulation techniques. For 64-QAM, the BER is $10^{-2.285}$ at SNR = 12dB.

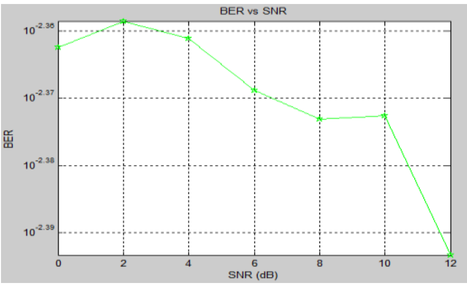


Fig. 5.9 BER vs SNR of MIMO-OFDM using Biorthogonal Transform with 256QAM Modulation

Figure 5.9 shows the performance of MIMO-OFDM system under AWGN channel using Biorthogonal wavelet with 256-QAM modulation techniques. The BER is $10^{-2.394}$ at SNR = 12dB. The table below shows the BER values of different wavelets with different level of QAM modulation. From this, it is observed that for 256-QAM Biorthogonal wavelet has the lowest BER value.

## VI .CONCLUSION

The performance of MIMO-OFDM is measured with BER vs SNR using QAM modulation.BER calculated using different wavelet transformation techniques. The proposed algorithm simulated through MATLAB programming. Simulated results shows that, the performance of BER of MIMO-OFDM is improved using DWT based MIMO-OFDM system than with the existing approach. With this observations it is apparent that proposed system has a many prospective in audio and video broadcasting, with 4G and Long term evaluation, etc.LTE, etc.

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