Comparison of BER Performance with DFT and DWT for MIMO-OFDM System

A.VANI,
Assistant professor
ECE Dept
CBIT
Hyderabad

Pranali Shankar Bargade
PG Student
ECE Dept
CBIT
Hyderabad

Abstract : OFDM is a multicarrier modulation technique which provides high spectral efficiency. There is inter carrier interference (ICI) and inter symbol interference (ISI) in OFDM because of loss of orthogonality between the subcarrier. This problem is overcome by using cyclic prefixing (CP), which uses 20% of available bandwidth. Comparison between the FFT based OFDM systems with DWT based OFDM system have been made according to QAM modulation technique over AWGN. The wavelet families are compared with FFT based OFDM system. The results confirm that the DWT based OFDM system is better in terms of bit error rate (BER) performance.

***IndexTerms* - OFDM; FFT; DWT Families [Haar; DB; Biorthogonal]; BER; SNR; LTE**

I. INTRODUCTION

OFDM is a wideband wireless digital communication technique. For high data rate wireless transmission, OFDM is a popular method. OFDM is a multicarrier modulation technique which improves the spectral efficiency. Multicarrier Modulation schemes divide the original input data signal into many independent signals, which is modulated and multiplexed into the channel at different carrier frequencies such that information is transmitted on each of the sub carriers and the sub channels are nearly distortion less. In usual OFDM system, IFFT (Inverse Fast Fourier Transform) and FFT [5] (Fast Fourier Transform) are used to multiplex and decode the signal. The Cyclic Prefix is added before transmitting the signal to channel, in this system. But in wavelet based transmission technique has stronger ability of suppressing ISI and ICI than the conventional OFDM scheme. The modulation scheme used in this paper is different level of QAM modulation.

QAM is the method which combines two amplitude modulated signals into one channel. It may be an analogy QAM or a digital QAM. Two amplitude modulated signals are merged using the same carrier frequency with a 90 degree phase difference in QAM.

II.MIMO System

MIMO communication uses multiple antennas at both the transmitter and receiver to make full use of the spatial domain for spatial multiplexing and/or spatial diversity. The capacity of a MIMO link is increased by spatial multiplexing. In this, independent data streams are transmitted in the same time slot and frequency band simultaneously from each transmit antenna. And multiple data streams at the receiver differentiated using channel information about each propagation path.

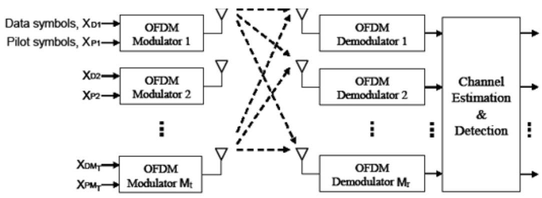


Fig 1: MIMO System Process

Channel state information (CSI) is crucial at the receiver in order to coherently detect the received signal and to perform diversity combining, in MIMO-OFDM systems. The more variable channels give more diversity. In order to obtain accurate CSI at the receiver, pilot-symbol-aided estimation must be used to track the variations of the frequency selective fading channel. Among the various resources in MIMO multicarrier systems the power assignment is related to the accuracy of the channel estimation.

Fourier Transform Based Channel Estimation:-DFT can be used simultaneously as an accurate interpolation method in the frequency domain when the orthogonality between training sequences is based on the transmission of scattered pilots.

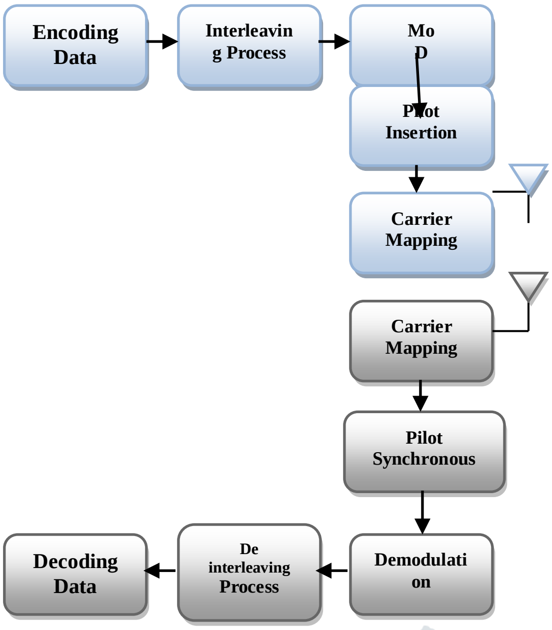


Fig 2: Block Diagram: FFT Based OFDM

The effect of channel estimation and compensation are illustrated in the received signal constellation before and after channel compensation for the OFDM system with 16-QAM. Channel estimation obtained by using LS- linear, LS-spine and MMSE channel estimation methods with and without DFT technique and the DFT-based channel estimation method improves the performance of channel estimation.

III,Wavelet Based Channel Estimation

A wavelet defined as rapidly decaying wavelike oscillation that has zero mean. A wavelet exists for a finite duration.

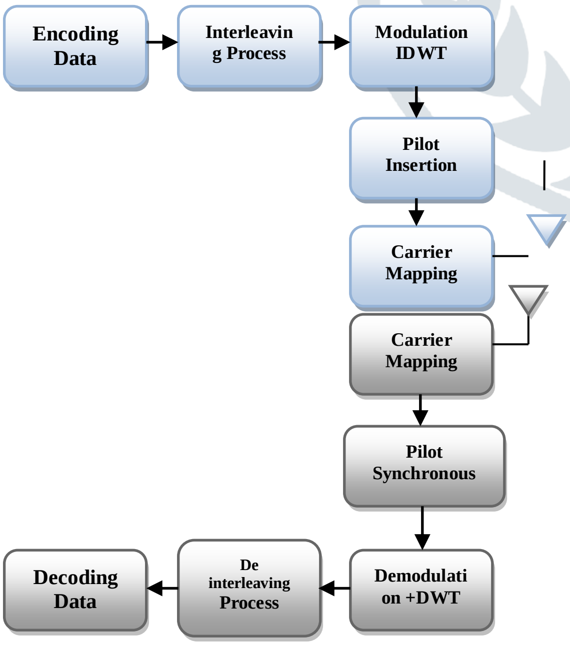


Fig 3: Block Diagram: DWT Based OFDM

A wavelet transform is used for convolving the signal against particular instances of the wavelet at various time scales and positions.[6] Hence, wavelet transform provides a time-frequency representation.

.

HAAR Transform

The HAAR wavelet transform considered as to pair up input values, stores the difference and pass the sum. This process is done recursively, pairing up the sums to provide the next scale, finally resulting in differences and one final sum. The HAAR Wavelet Transformation is a form of compression. It involves averaging and differencing terms, storing detail coefficients, eliminating data, and reconstructing the matrix such that the resulting matrix is similar to the initial matrix.

Daubechies:-

The compactly supported orthonormal wavelets are invented by Ingrid Daubechies. The names of the wavelets such as Daubechies family wavelets are written db N, where N is the order, and db the "surname" of the wavelet. The db1 wavelet is the same as HAAR wavelet. The wavelet functions of the next nine members of the family: **DB2 ;DB3 ;DB4; DB5 ; DB6 ;DB7 ;DB8 ;DB9 ;DB10**

Biorthogonal:-

This family shows the property of linear phase, which is required for signal and image reconstruction. In this, two wavelets are used, for decomposition (on the left side) and for reconstruction (on the right side). The family of this wavelet: Bior1.3; Bior1.5; Bior2.2; Bior2.4; Bior2.6; Bior2.8; Bior3.1; Bior3.3; Bior3.5; Bior3.7; Bior3.9; Bior4.4; Bior5.5; Bior6.8

Step1: Processing in column wise to get H and L

H = (Co-Ce) L = (Ce + H/2) Where Co and Ce is the odd column and even column wise pixel values

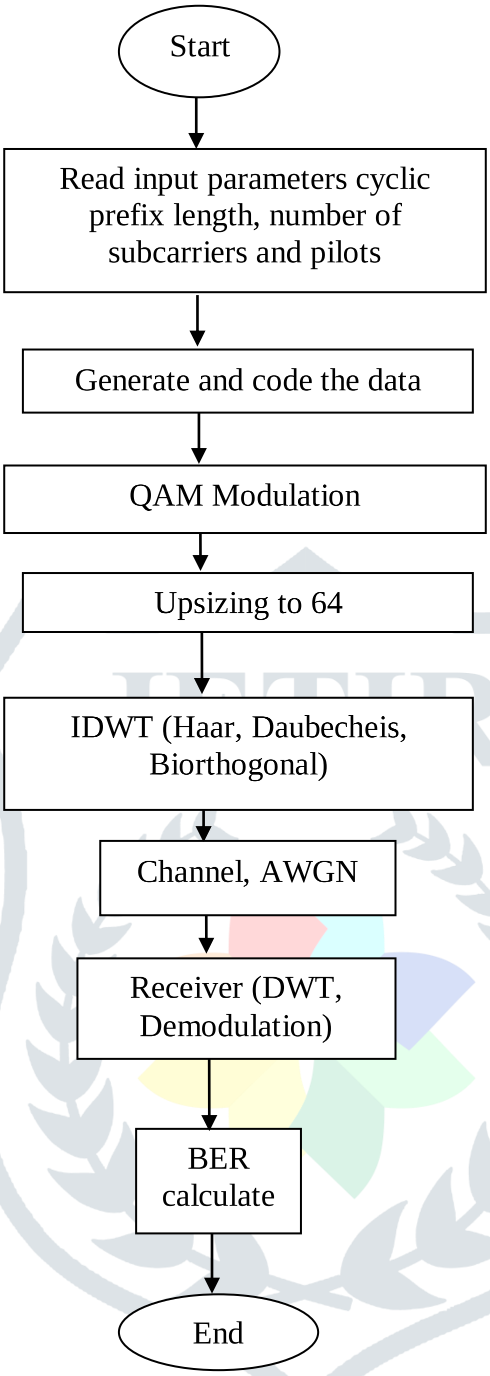
Step 2: Processing row wise to get LL,LH,HL and HH

Separate odd and even rows of H and L, Namely, Hodd – odd row of H, Lodd- odd row of L, Heven- even row of H Leven – even row of L

LH = Lodd-Leven LL = Leven + (LH / 2)

HL = Hodd – Heven HH = Heven + (HL /2)

Flowchart



IV. RESULTS AND DISCUSSION

The number of bit errors is the number of received bits of a data stream over a communication channel in a digital transmission. Bit errors are altered due to noise, interference, distortion or bit synchronization errors. The bit error rate or bit error ratio (BER) is the unit less performance measure often measured as a percentage. The bit error rate probability is the expectation value of the BER. In a noisy channel, the BER is often expressed as a function of the normalized carrier to noise ratio measured denoted Eb/N0 that is energy permit to noise power spectral density ratio, or Es/N0 that is energy per modulation symbol to noise spectral density

Different Modulation schemes with symbol rate

In modulation process analogue signal denoted is by *m*(*t*) digital signal is denoted by *d*(*t*) – *i.e.* sequences of 1's and 0's The message signal could also be a multilevel signal, rather than binary; this is not considered further at this stage.

MODULATION	Bits/Symbol	Symbol Rate
BPSK	2	1/2(0.5)
QPSK	4	1/4(0.25)
QAM-8	8	1/8(0.125)
QAM-16	16	1/16(0.0625)
QAM-64	64	1/64(0.015625)
QAM-256	256	1/256(0.00390625)

RESULT Analysis:-

BER PERFORMANCE EVALUATION

By using MATLAB performance characteristic of DFT based OFDM and wavelet based OFDM are obtained for different level of modulation that are used for the LTE, as shown in figures. Modulations that could be used for LTE are QPSK, 16 QAM and 64 QAM (Uplink and downlink). QPSK does not carry data at very high speed. When signal to noise ratio is of good quality then only higher modulation techniques can be used. High signal to noise ratio does not required for lower forms of modulation (QPSK)[11] .Signal to noise ratio (SNR) of different values are introduced through AWGN channel for the purpose of simulation.

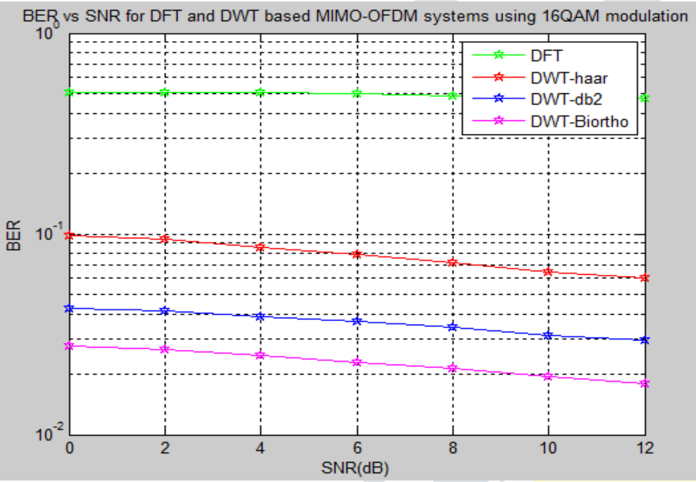


Fig.4.1 Comparison Analysis of DFT vs. Wavelet for HAAR; DB; Biorthogonal Process Using 16QAM

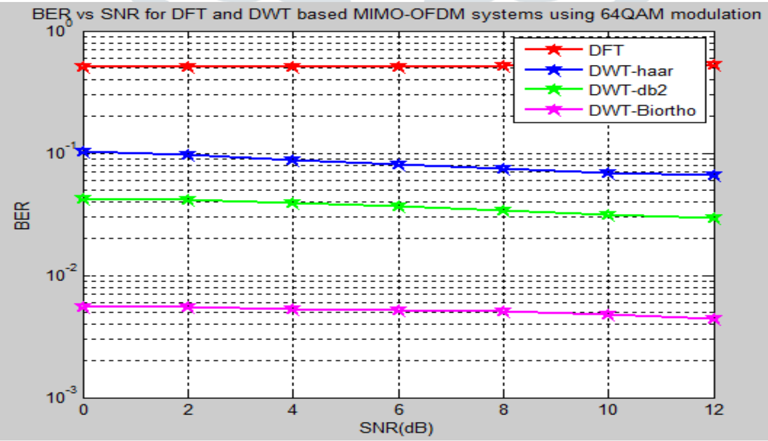


Fig.4.2 Comparison Analysis of DFT vs. Wavelet for HAAR; DB; Biorthogonal Process Using 64QAM

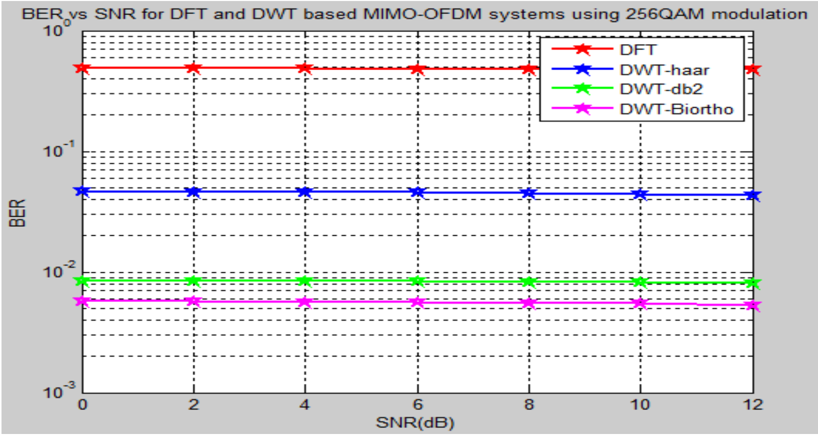


Fig. Fig.4.3 Comparison Analysis of DFT vs. Wavelet for HAAR; DB; Biorthogonal Process Using 256QAM

MIMO-OFDM System with	16QAM	64QAM	256QAM
FFT	0.1023	0.1995	0.2511
Haar	0.0630	0.0630	0.0398
Daubechies	0.0398	0.0398	0.0079
Biorthogonal	0.0158	0.0050	0.0025

Table 4.1 BER Values at SNR = 12dB

The performance of 256 QAM Bi-orthogonal wavelet transforms is better as compared to the other level of modulation of QAM and other wavelet transform i.e. Haar wavelet and Daubechies wavelet transforms. From the figure it can be seen that the BER was highly influenced by SNR value at the receiver.

Using FFT based MIMO-OFDM system for 16-QAM the BER is reduced from 0.1023 to 0.0158 in DWT Biorthogonal based MIMO-OFDM system. Similarly, in 64 QAM BER is decreasing from 0.1995 to 005 and in 256-QAM it is reduced to 0.0025. The simulation results show that the BER has been reduced in a great manner by wavelet and higher level of QAM techniques. The symbols are modulated by 16QAM, 64 QAM and 256 QAM. It clearly shows that DWT is much better than the DFT based MIMO-OFDM system. This reflects the fact that the DWT is more significant than the DFT based MIMO-OFDM system.

CONCLUSIONs

In this paper, the performance of wavelet based OFDM system analyzed and compared it with the performance of DFT based OFDM system. From the simulation results obtained, BER curves of wavelet based OFDM are better than that of DFT based OFDM. The proposed technique tested on 16 QAM, 64 QAM and 256 QAM which are used in LTE. In wavelet based OFDM different types of filters can be used with the help of different wavelets. Daubechies2 and haar and biorthogonal wavelets which provide their best performances at different intervals of SNR.

.

REFERENCES

1. G.L. Tuber, J.R. Barry, S.W. McLaughlin, Ye Li, M.A. Ingram and T.G. Pratt, "Broadband MIMO-OFDM wireless communications," Proceedings of the IEEE, vol. 92, No. 2, pp. 271-294, February. 2004.
2. Jan-Jaap van de Beek, O.Edfors, and M.Sandell, "On channel estimation in OFDM systems," Presented at in proceedings of Vehicular Technology, Chicago, pp. 815-819, 1995.
3. B.Song, L.Gui, and W.Zhang, "Comb type pilot aided channel estimation in OFDM systems with transmit diversity," IEEE Trans. Broadcast., vol. 52, pp. 50-57, March. 2006.
4. Noh. M., Lee. Y. , and Park. H. "A low complexity LMMSE channel estimation for OFDM," IEE Proc. Commum., vol. 153, No. 5, pp. 645- 650, 2006
5. Upena Dalal, "Wireless Communication", Oxford University press, july 2009, pp.365 – 408
6. Manish J. Manglani and Amy E. Bell, "Wavelet Modulation Performance in Gaussian and Rayleigh Fading Channels", Electrical and Computer Engineering Department, Virginia, 2001.
7. B.G.Negash and H.Nikookar, "Wavelet Based OFDM for Wireless Channels", International Research Centre for Telecommunication Transmission and Radar, Faculty of Information Technology and Systems, Delft University of Technology, 2001
8. S. Adhikari, S. L. Jansen, M. Kuschnerov, B. Inan, and W. Rosenkranz, "Analysis of spectrally shaped DFT-OFDM for fiber nonlinearity mitigation," Opt. Express, to be published.
9. S. Nakajima, "Effects of spectral shaping on OFDM transmission performance in nonlinear channels," in Proc. 16th ISTMWC 2007, Budapest, Hungary, Jul., pp. 1–5
10. O. Gaete, L. Coelho, B. Spinnler, and N. Hanik, "Pulse shaping using the discrete Fourier transform for direct detection optical systems," in Proc. ICTON, Stockholm, Sweden, Jun. 2011, pp. 1–4, paper We.A1.2.
11. C. Xia and D. van den Borne, "Impact of the channel count on the nonlinear tolerance in coherently-detected POLMUX-QPSK modulation," in Proc. OFC 2011, Los Angeles, CA, Mar. 2011, pp. 1–3, paper OWO1.1.