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Performance Analysis of BER in OFDM System Using Comparison of FFT and DWT Transforms

[1] K. Boopathi Raja, [2] V. Mohanapriya, [3] C. Nishara, [4] M. Kamala Sundhari
[1] Assistant Professor, Department of ECE, SNS College of Technology, Coimbatore, India
[2][3][4] UG Student, Department of ECE, SNS College of Technology, Coimbatore, India

Abstract: **- In wireless communication system, there exists a main demand for enhancing the data rates and to improve the system reliability. OFDM systems are widely used as modem of multicarrier transmission systems where the system has higher reliability and better bandwidth efficiency. In OFDM system, it is necessary to assess the performance of the system and Bit Error Rate provides the idle way in which the entire performance of a system including the transmitter, receiver and the medium between the two are assessed. In this way, BER enables the actual performance of the system operation to be tested instead of testing the component parts. In this paper, comparison of BER performance is carried out with two different transforms such ac FFT and DWT in which the DWT transform is performed with two different filters such as deubechies filter and Haar filter. Simulation are carried out to ensure the performance of the system and to obtain the optimum values of BER.**

I. INTRODUCTION

OFDM has become the modem of choice in many Wireless applications which merely satisfies main demands such as high spectral efficiency, robustness against frequency selective fading Ability to cope with severe channel without complex equalization filters. More over OFDM is widely implemented in applications such as LTE 4G Mobile Broadband, IEEE 802.11 Wi-Max, IEEE 802.20 MBWA Mobile Broadband Wireless Access, Digital Audio Broadcast (DAB), Digital Video Broadcasting Terrestrial TV (DVB-T) systems, Wireless Local Area Networks (WLAN), ultra-wideband systems, Cognitive Radios (CR) and so on. In the OFDM system, to ensure the BER performance, two different types of Transform are considered. The transforms such as DWT and FFT are selected here to ensure the BER performance. This paper focuses upon the comparison of BER performance with DWT and FFT and ensuring the better performance of the OFDM system. The remaining part of the paper is organised as follows. SECTION II presents a brief introduction of the OFDM system. SECTION III gives the knowledge about the Transforms such as DWT and FFT. SECTION IV provides the Simulation Output of the comparison results and SECTION V provides the conclusion of the paper.

SECTION II
II. ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING

Orthogonal Frequency Division Multiplexing is a multichannel transmission system that employs multiple subcarriers by which it combines a large number of low data rate carriers to construct a composite high data rate communication system. The OFDM system is mostly attracted because the system has the capability of handling the Multipath Interference at the receiver side. The main two effects that are generated by Multipath are frequency selective fading and Inter Symbol Interference (ISI). The narrowband channel perceived with flatness along with the use of powerful error correction codes together with time and frequency interleaving overcome the frequency selective fading. The insertion of an extra guard interval between consecutive OFDM symbols can reduces the ISI. The signal representation of the system is given as follows Consider an OFDM consisting of N subcarriers.

$$X = \{X_{k,\ k=0,1,..,N-1}\}$$

Let N symbol block is formed with each symbol modulating one set of subcarriers that is chosen to be orthogonal.
The complex baseband OFDM signal x(t) can be written as

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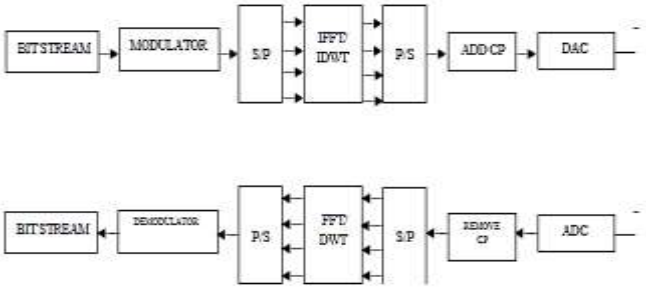
$$x(t) = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} X_k e^{j2\pi f_k t}, 0 \le t \le NT$$

The orthogonality requires that the sub-carrier spacing which is given by Δf

$$\Delta f = \frac{k}{T_U} \quad \text{Hertz}$$

Where, TU seconds is the useful symbol duration
k is a positive integer, typically equal to 1



BLOCK DIAGRAM OF CONVENTIONAL OFDM SYSTEM

SECTION III

FFT BASED OFDM

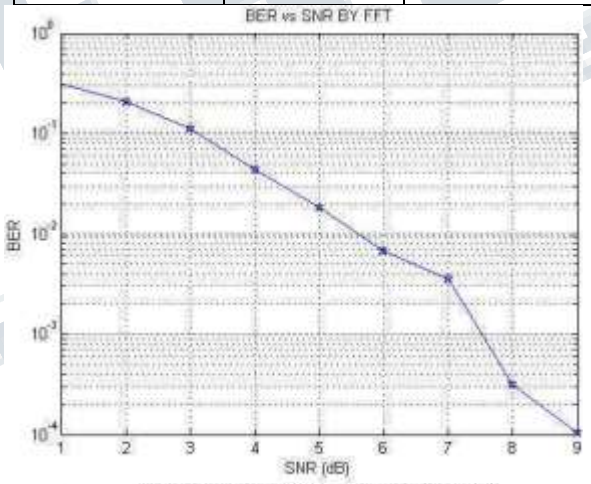
The Fast Fourier Transform (FFT) is a Discrete Fourier Transform (DFT) algorithm that speed up the calculation by reducing the number of computation needed for N point subcarriers from 2N to 2NlogN. The input bit streams are modulated with modulation techniques such as BPSK, QPSK, QAM etc. The use of IFFT transform in OFDM system requires the addition of cyclic prefix at the transmitter side in order to diminish the effect of Inter Symbol Interference (ISI). At the receiver reverse process is done where the cyclic prefix is removed, FFT is applied and the data are demodulated to obtain the original bit stream

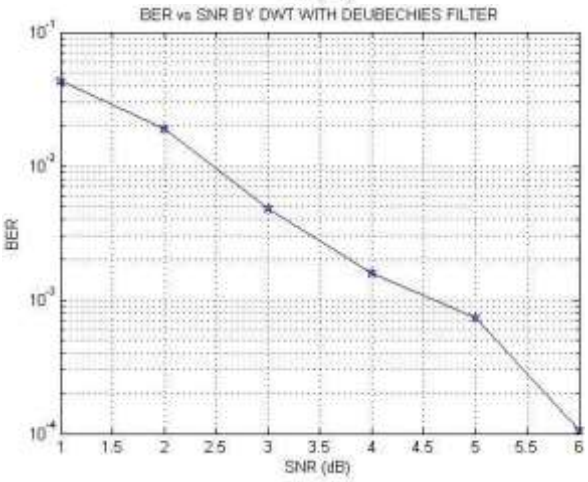
DWT BASED OFDM:

Discrete Wavelet Transforms (DWT) are most popularly used in OFDM systems that produces discrete outputs by mapping the time domain data into wavelet domain data. The wavelet scheme satisfies the condition of orthogonality and has high power spectral density as compared to FFT- OFDM. More over the use of DWT doesn't require any cyclic prefix addition so that the BER performance of the system is improved. The wavelet-based signals are well localised both in time and frequency domain. In DWT there are some different types of filtering schemes such as Deubechies, Symlets, Coiflets and Haar filter. Here in the BER performance analysis, Deubechies and Haar filter are used in which Haar is one of the simplest wavelet filter where the deubechies filter are most properly used in DWT

SECTION IV
SIMULATION AND RESULTS

PARAMETER	FFT BASED OFDM	DWT BASED OFDM
No of subcarriers	64	64
Cyclic Prefix	¼ of data subcarriers	Not required
FFT size	64	-
Wavelet filter	-	Haar, db2
Modulation method	QAM	QAM
Channel	AWGN	AWGN
Pilot Insertion	4	-





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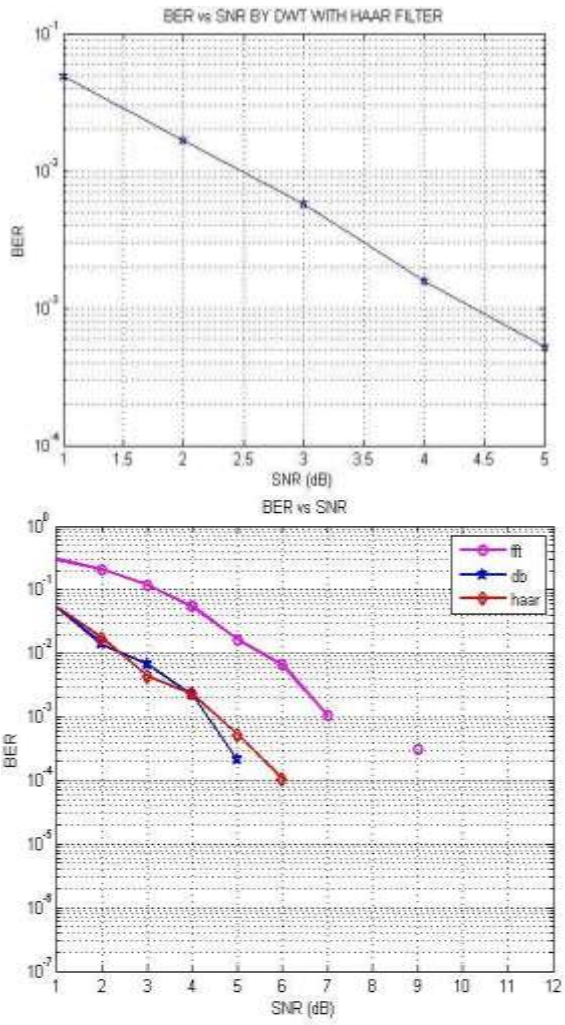

The graphical results from MATLAB simulations shows the performance analysis of BER by the variation of the BER with SNR for both FFT based OFDM system and DWT based OFDM system with deubechies an Haar filter while considering the AWGN channel. From these results, it is clear that the DWT transform provides better BER performance with various filters than FFT transform while ensuring the higher data rates of the OFDM system.

SECTION V

V. CONCLUSION

In this paper, it can be concluded that DWT based OFDM provides better spectrum efficiency than the FFT based OFDM based system and also DWT doesn't require the cyclic prefix addition for diminishing the ISI and ICI effects. More over the BER performance is less effected by SNR in DWT based OFDM whereas it is highly affected by SNR in FFT based OFDM system. Thus it is obvious that DWT based OFDM system provides better performance of BER by increasing the overall data rates and DWT outperforms FFT based OFDM system.

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