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Performance of Discrete Wavelet Transform based on OFDM with BER Analysis

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ABSTRACT

Orthogonal Frequency Division Multiplexing(OFDM) and Multiple Input and Multiple Output (MIMO) aretwo main communication systems in 4th generation. OFDM is one type of modulation technique with multi carrier and used to transfer the information efficiently in required bandwidth. Frequency Division Multiplexing (FDM) has low spectral efficiency as comparing with the OFDM. In OFDM two types of interferences will be there are, Inter Carrier Interference (ICI) and Inter Symbol Interference (ISI) due to the orthogonality loss of subcarriers, to achieve this problem cyclic prefix (CP) is used. CP is a guard band in OFDM system that uses 20% of required subcarrier. OFDM system based on wavelet provides better orthogonality between subcarriers. Signal to Noise Ratio (SNR) of the message signal improved by the wavelet transform techniques. Wavelet based system doesn't require cyclic prefix, so bandwidth can't be wasted. Compare these results with 16QAM, 8QAM with conventional DFT method. This is the one advantage to improve the utilization of the spectrum. OFDM system based on wavelet is proposed at the place of Discrete Fourier Transform(DFT) based OFDM in LTE. Comparing performance of Bit Error Rate(BER) in wavelet based techniques with DFT based OFDM.

Keywords

OFDM, FFT, DWT Families [Haar,DB, Biorthogonal], BER, SNR, LTE.

INTRODUCTION

In rapidly growing technologies plays main role in the transfer of data almost everywhere in the planet. But the limited bandwidth assigned to a more number of users controls the spectrum availability to the users.Multicarrier modulation is usually utilized to controls impairments in the channel and improves the spectral potency. MCM is classified the spectrum into sub bands based upon the modulation is accomplishing and multiplexing into channel has various number of carrier frequencies, So, data is transmitted through orthonormal sub-carriers, particularly the area unit of sub channels is nearly distortion less. In typical OFDM system, Conventional OFDM uses of IFFT & FFT for multiplexing the signals and reduces the difficulty at both transmitter and receiver. The CP is added before transmitted the message signal to channel and remove the after the channel. To decrease the ISI and ICI CP must be used. BPSK, QPSK and QAM are typical modulation schemes. BPSK is the one among the best sorts of digital modulation. The part of the constant amplitude of carrier signal moves between 0 to 180 degrees. The non coherent receiver's area unit straightforward and cost effective to create, and thus area unit wide employed in wireless communications [10]. The QPSK is a construction modulation technique; it uses a couple of bits per image to represent every part. QAM is the technique of mixing 2 amplitude modulated signals into one channel.

FOURIER TRANSFORM

Mainly, DFT is placed at receiver section for converting the signal from time domain to frequency domain, once the orthogonality between coaching sequences is predicated on transmission of scattered pilots.

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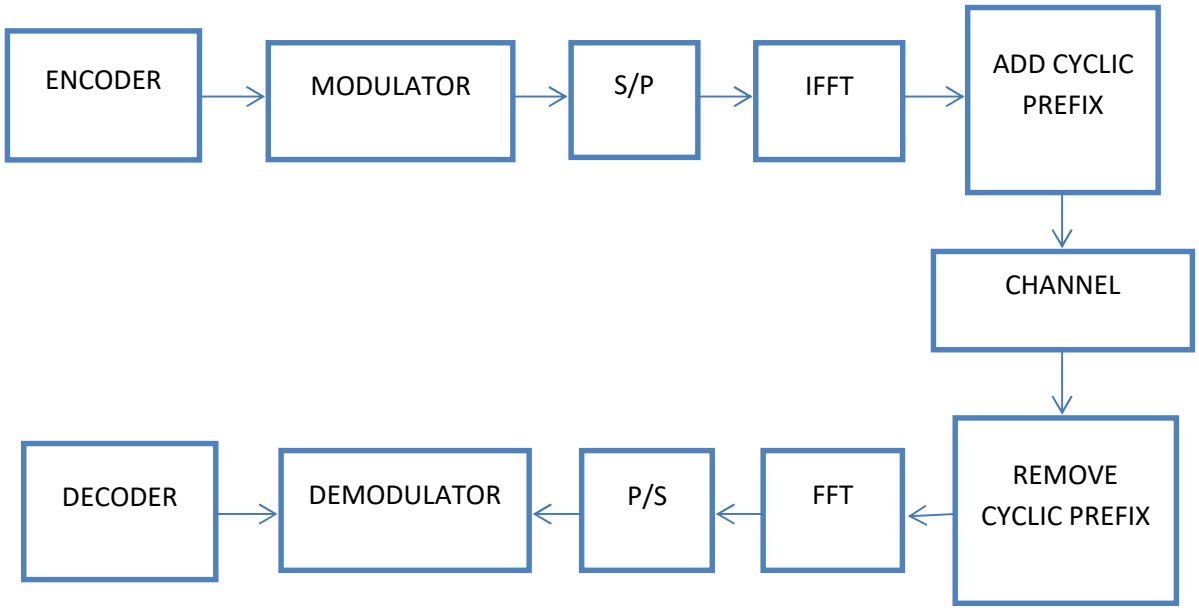
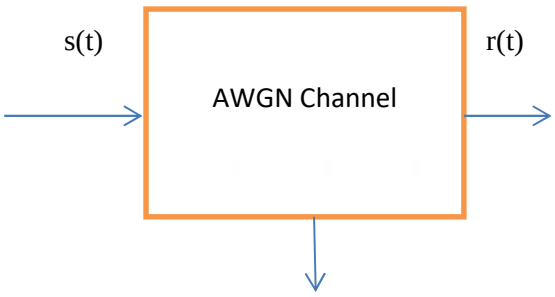
Discrete time domain equation of DFT is given by,

$$X_k(n) = \frac{1}{\sqrt{N}} \sum_{i=0}^{n} X_m(i) e^{\frac{j2\pi}{N}}$$

BLOCK DIAGRAM
OFDM WITH FFT



The modulator at the transmitter performs the mapping function of digital serial data sequence into parallel bit of stream. When the channel corrupts the transmitted signal by addition of Gaussian noise, first insert the memory less modulation signal followed by modulation signals with memory. The obtained signal at the receiver side can be expressed as,



Where, r(t) is received signal, s(t) is transmitted signal and n(t) is noise. Based on the received signal r(t) observation over the signal interval to design a receiver that it minimizes the probability of occurring of an error.

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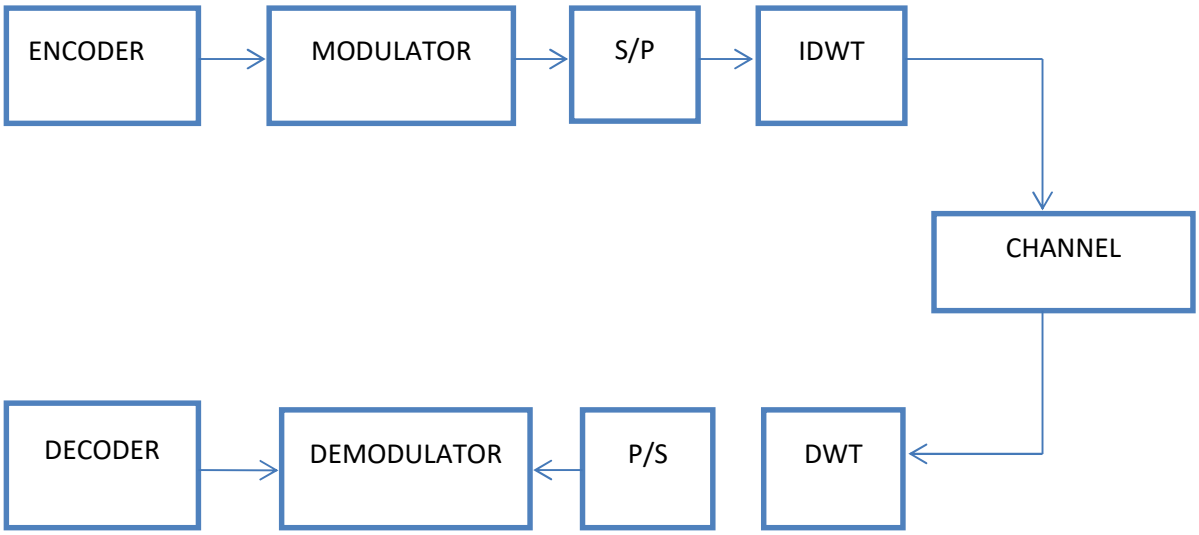
BLOCK DIAGRAM

OFDM WITH DWT



WAVELET BASED CHANNEL ESTIMATION

OFDM system with wavelets is an effective method to replace FFT in conventional OFDM system. DWT is a technique to remove cyclic prefix, which plays the main role in wastage of bandwidth and also reduces the transmission power. It is utilized to minimize the result of transmission power. The bandwidth controlling of all channels in DWT-OFDM is better than FFT-OFDM. In Wavelet transform techniques, the message signal is decomposed into orthogonal set of wavelets that provide the method for examining the obtained signals by considering coefficients of the wavelets.The data output equation in IDWT is given as,

$$d(k) = \sum_{m=0}^{\infty}\sum_{n=0}^{\infty} D_n^m 2^{\frac{m}{2}} \psi(2_k^m - k)$$

Where, k is the no. of subcarriers ($0 \le k \le N-1$), D_n^m are coefficients of the wavelets which denote the signal position and scale on time-axis and (t) is the mother wavelet with minimized factor m times and then shifted n times for each subcarrier.

$$D\ {}_n^m = \sum_{k=0}^{N-1} d(k) 2^{\frac{m}{2}} \psi(2_k^m - k)$$

HAAR

For An input delineate by an inventory of numbers, the HAAR riffle rework is also thought of to easily try up input values, storing the distinction and spending the total. This method is continual recursively, pairing to the sums for produce following scale, finally leading to variations and final total. The HAAR riffle Transformation may be a straightforward variety of compression that involves average and difference terms, storing detail coefficients, eliminating information, and reconstructing the matrix specified the ensuing matrix is equivalent to the initial matrix.

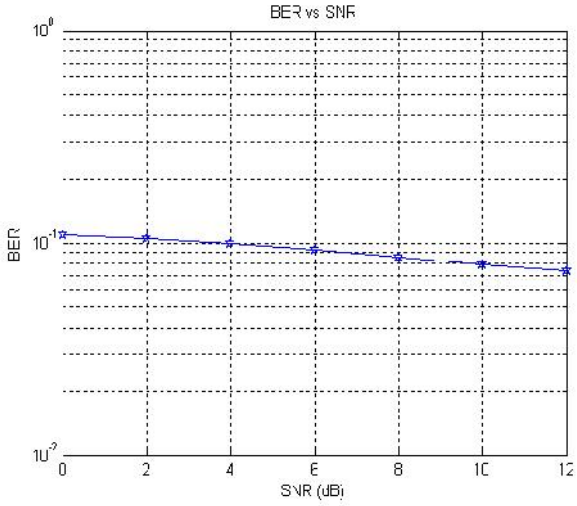


Fig.16QAM

DAUBECHIES

Ingrid Daubechies, one in all the brightest stars within the world of riffle analysis, fictitious what area unit known as succinctly supported orthonormal riffles -- therefore creating separate wavelet analysis practicable. The names of the Daubechies family wavelets area unit written sound unit N, wherever N is that the order, and sound unit the surname of the riffle. The db1 riffle, as mentioned higher than, is that the similar as HAAR riffle. Here is that the riffle functions psi of following 9 members of the family: DB2 ;DB3 ;DB4; DB5 ; DB6 ;DB7 ;DB8 ;DB9 ;DB10.

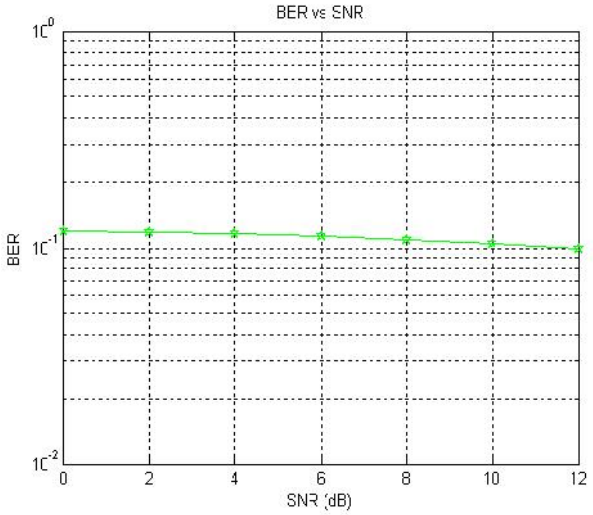


Fig.16QAM

BIORTHOGONAL

The family of wavelets shows property of linear part that is required for signal and reconstruction of an image. By victimization 2 wavelets, one for decay (on the left side) and therefore the different for reconstruction (on

the proper side) rather than a similar single one, fascinating properties area unit derived. 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.

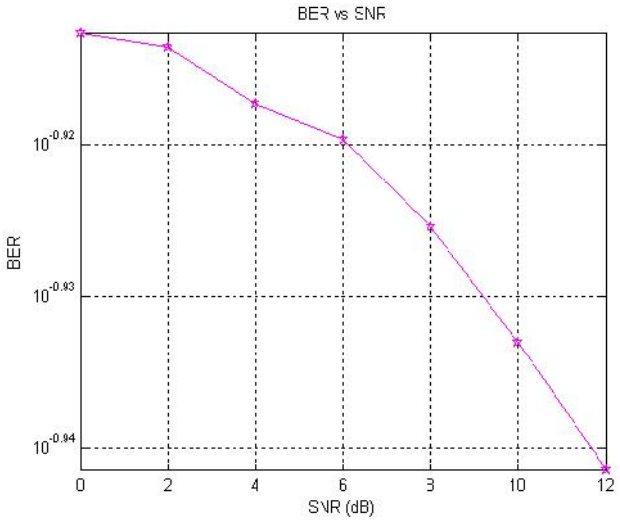


Fig.16QAM

MODULATION

In modulation, message signal contains the knowledge, is employed to regulate parameters of the carrier signal, thus on impress the knowledge onto carrier signal. Analog is denoted by m(t) digital is denoted by d(t) sequence of ones and zeros. Message signal m(t) might even be a structure signal, instead of binary; this can be not thought of this stage.

TABLE.1

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)

RESULTS

BER PERFORMANCE EVALUATION

By victimization MATLAB simulation characteristic of OFDM by DFT and OFDM by DWT area unit These results attained for different types of modulations that area unit used for the LTE, as shown in figures. Modulations that might be used for LTE area unit QPSK, sixteen QAM and (Uplink and downlink). QPSK doesn't carry information at terribly high speed. Once SNR is of fine quality then solely higher modulation techniques are often used. A lower variety of QPSK modulation does not need high SNR. For the aim of simulation, the SNR of various values modulation techniques through AWGN channel. Totally different riffle varieties biorthogonal, daubechies2 and haar is employed in riffle based mostly OFDM for 16-QAM.

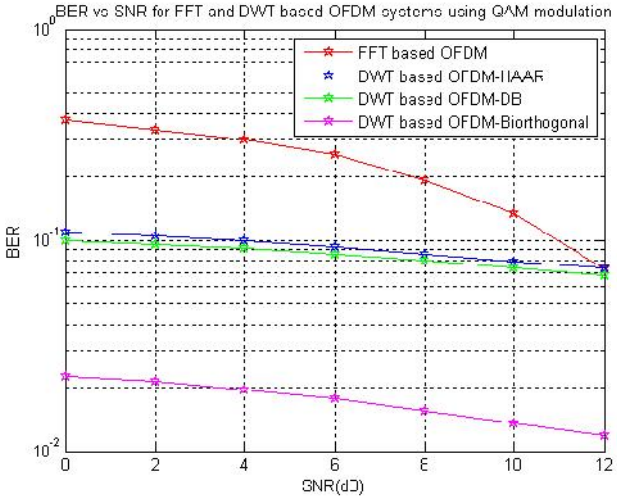


Fig: 16QAM

CONCLUSION

SNR has been improved by the Wavelet Transform based Techniques compared with conventional FFT based OFDM. In this, it has been two modulation techniques for implementation that are QPSK, sixteen QAM and, that are employed to LTE. At low SNR, the system achieves 1 bit per symbol, as BPSK is primarily used. However, as the SNR increases, the system attains more bits with QPSK, 8QAM, according to switching level and estimated SNR, efficiency improves steadily. Three different techniques used they are daubechies2, haar and biorthogonal wavelets, each one show best results at totally various intervals of SNR.

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