Comparison of FFT-OFDM and DWT-OFDM System in Digital Communication

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***Abstract*:- Favorable outcome of the OFDM has been achieved that multi-carrier modulation is an well-organized offer for wireless communications. Wavelet based modulation is a recent type of modulation for transmission of signals which is multicarrier in nature on the channel which is wireless that uses the property of wavelet called orthogonality but other than the sine functions..The modulation of the discrete wavelet transform varies with respect to some aspect to traditional method to provide better performance outcome. In this paper brief study is given on the wavelets and the BER performance comparison between the two systems of FFT based OFDM and the DWT based OFDM the analysis done for the Haar wavelet family with the modulations of PSK and QAM and simulated in the AGWN channel based on the survey of the OFDM in communication system.**

Keywords:- Orthogonal frequency division(OFDM).

1 INTRODUCTION

The desired for increasing wireless communication technologies and the progressive growth in multimedia applications is the major driving force behind OFDM's stable popularity. OFDM is a best possible approach used for speed data rate communication system. It is a unique method of multicarrier modulation where commonly FFT is used in OFDM to produces orthogonal subcarriers. The orthogonality is eliminated when signal is passed in multipath condition to maintain the orthogonality cyclic prefix is included to every symbol before transmission. But this additionally decreases the spectral efficiency when compare to wavelet based OFDM and analysis of BER profile can be obtained by using energy per bit to noise. Wavelet has been developed as replacement of Fourier Transform. The wavelet transform has many advantages than Fourier Transform because it can provide time and frequency resolution at a time. Different modulation schemes are compare with both the systems based on their performance it can be concluded that wavelet transform is best choice for OFDM systems different types of the wavelet can be used such Haar, Daubechies, Symlet, Coiflet ,Discrete Mayer, Bio-orthogonal in which Haar gives the best result among wavelet family. More proposed research conclude that the wavelet based OFDM is best applicable for the real time. wavelet based schemes have more applicable for the wireless systems and many authors have suggested that the wavelet theory is more efficient method to built the OFDM. In this work the appearance of specific most regular Wavelet bases OFDM schemes over wireless channels is designed and wavelet basis Intended suitable for OFDM, for its optimal appearance gains will be investigated.

2 . LITERATURE SURVEY

A comparative study is done about replacing the fourier transform by wavelet packet transform in communication of multicarrier systems in wide range implementation of data transfer systems when SNR is zero there is no major difference as the SNR increases the gap between wavelet and FFT based OFDM will increasing [1] Discussed about DWT-OFDM and FFT-OFDM systems comparison study and wavelet based system is design such that should obey the orthonormal condition and reconstruction of signals with different wavelet family Simulation model indicates that BPSK modulation is used with a compactable cyclic prefix. They have proved that biorthogonal mother wavelet gives satisfactory performance parameters for implementing DWT-OFDM [2] OFDM is the type of modulation scheme called as multi-carrier method used for higher rate of transmission with efficient bandwidth and stronger to the multipath fading ,different type of the wavelet and Haar compared with the DFT based OFDM systems also analyze the channel estimation. Harr gives the less bit rate error at the SNR of 11db [3]

3 PROPOSED METHOD

Comparative study on the OFDM by using the both the DFT and wavelet based method is performed. The traditional Fourier Transform is to provide a spectral information about the signal, only applicable for stationary signals but many real world signals are non-stationary and needs to be processed in real time. Wavelet transform will have multi resolution analysis with the reduce BER

2.1 FOURIER BASED OFDM (FFT-OFDM)

The signal is produce by initial choosing the spectrum needed based on the data which is given as input and scheme of modulation used each carrier which is produced will assigned to some data to be transmit. The essential amplitude and phase of the carrier wave is been calculated based on modulation scheme an effective implementation of transmitter and receiver can be done with IFFT and FFT equation (1) gives the transmitter side mathematical calculation, where random bits given as input. The data $\{dk\}$ should be processed by modulation to map the available data before IFFT operation with N sub carriers its

output is the sum of the information signals in the discrete time.

$$X(k) = \frac{1}{N}\sum_{m=0}^{N-1} x(n) e^{\frac{j2\pi kn}{N}} \quad (2.1)$$

Where $Xk/0\leq k\leq N-1\}$indicates the sequence in discrete time domain $\{Xm/0\leq m\leq N-1\}$ represent the complex numbers in discrete frequency domain to minimize the inter symbol interference in the receiver side cyclic prefix (CP)is added before transmission and the entire process is reversed to obtained the decoded data CP is removed to obtain the data in discrete time domain. The output of FFT can be obtained as the sum of the received signal in discrete frequency domain which can be mathematically defined in the equation form

$$x(n) = \sum_{k=0}^{N-1} X(k) e^{-j2\pi kn/N} \quad (2.2)$$

By using modulation technique should be generate symbols to get number of subcarriers we have to provide appropriate IFFT order. Cyclic prefix is included at every symbol length to avoid ICI and ISI to retained the orthogonality in channel transmission cyclic prefix is adjusted to OFDM frame which must be longer than channel impulse response. Channel performance can be find and hence equalized by inserted pilot subcarriers at the initial defined subcarrier intervals. The sub-channels are identified by computing DFT of the scaled samples of an OFDM symbols at the receiver. Where due cyclic prefix added the which increases the bandwidth and decreases the BER

2.2 WAVELETS:

wavelet is a small-scale waveform that is effectively restricted by duration having an average value of zero and tend to be asymmetric in nature and not having regular pattern analysis consists of splitting up a signal in scaled and shifted forms of the initial original signal a class of functions will localize a function in both scaling and space a family of wavelets can be built from a function $\psi(x)$, sometimes referred to as mother wavelet which is restricted in a finite time interval translation and contraction wavelet is named as daughter wavelet which are especially useful for compressing image data in communication system hence a wavelet transform properties are in some kind greater than existing Fourier transform but in DWT signals are analyzed at various frequency bands with different resolutions by decomposing the signal into approximate and detailed co-efficient which are associated with the two types of filter namely high and low pass filters we can obtain the different bands of frequency by filtering in the high pass and low pass filters successively with respect to time domain signal .The original signal x(n) is initially passed through half-band high pass filter g(n) and half-band low pass filter h(n) all the frequency which is above the half of highest frequency are eliminated by the half-band low pass filters, while a half-band high pass filter removes all frequencies which below the half of highest frequency of the signals the resolution can be halved by low pass filter but the scales will not changed further the signal is sub-sampled by two because half the number of sample is redundant with reference to nyquist's rate. Decomposition technique mathematically defined as

$$y_{high}(k) = \sum_n x(2k-n) \quad (2.3)$$
$$y_{low}(k) = \sum_n x(n)\, h(2k-n) \quad (2.4)$$

Where $y_{high}(k)$ and $y_{low}(k)$are high pass and low pass filters output after sub-sampling by a factor of two.This decomposition halves time resolution since only half of the numbers of samples where turns up to characterize the overall signal. On the other hand, it doubles the resolution of frequency since the frequency band of the signal will spans only half the past frequency band effectively decreasing the uncertainty by half, mentioned method is called as the subband coding which can further decomposed at each and every level, both filtering and sub-sampling result in half of the sample. In DWT-OFDM the time-windowed complex exponentials are changed by wavelet "carriers" at various scales (j) and positions on the time axis (k). translation and diluation function were used to generate these unique function Called as "wavelets mother" and denoted by ψ(t)

$$\psi_{i,t} = 2^{-\frac{j}{2}} \psi(2^{-j}t - k) \quad (2.5)$$

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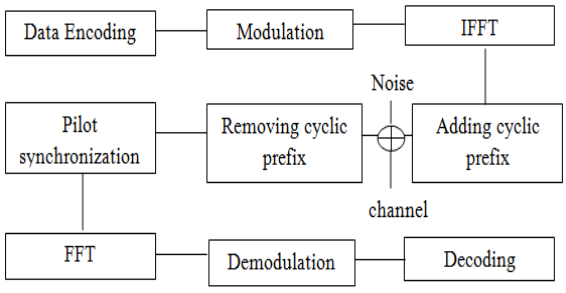

Fig 2.1 : DFT based transrecevier in OFDM

The random data is generated by the data generator then which is been passed through the constellation mapping. BPSK modulator is used to gain the QAM symbol by mapping raw binary data then which is been obtain symbol is processed by IFFT block which includes N parallel streams of symbol and performing IFFT operation on this parallel stream in the receiver side the process is reversed to obtain the decoded data the purpose of cyclic prefix is

been used to removed the inter symbol and carrier interference obtained at the received data in the discrete time domain format further processed to the FFT for recovery of the data With the pair of the both FFT and IFFT needs to produced the OFDM using subcarrier in the digital domain which obeys orthogonality Figure 3.1 shows the block diagram of the OFDM in the discrete time domain ,where N-complex value of the data symbol will modulates the N carriers in the orthogonal condition using IFFT forming the transmitted data in the OFDM will multiplexes N number of the low-rate in the data streams and each will experiencing an white noise in the AGWN channel during transmitted.

Wavelet transform have the capability to replace the DFT in OFDM .wavelet transform is one of the tool used for the signal analysis in both time and frequency domain It is a mechanism which includes the multi-resolution concept where signal which is given as the input is decomposed into different level of frequency components for the analysis of the individual resolution matching scale. In this Proposed model we are utilizing the IDWT and DWT in the place of the IDFT and DFT in the traditional model as shown in Figure 3.2 due to the basic property which is orthogonality obey by the wavelet families helps to not to use the cyclic prefix initially after encoding is finished which is followed by interleaving after that data is been converted to decimal form and modulation is been proceeded after that is the pilot insertation and mapping of the subcarrier is done then IDWT of the data, which strengthens the orthogonality to the subcarrier .IDWT will convert the time domain to the frequency domain then the data is been passed through the AGWN channel to the DWT will occur finally pilot synchronization where the added pilots at the transmitter is discarded then the demodulation is done. after that the Demodulated data is converted to the binary form followed by the de-interleaving and the decoding is done to again the initial or original data .

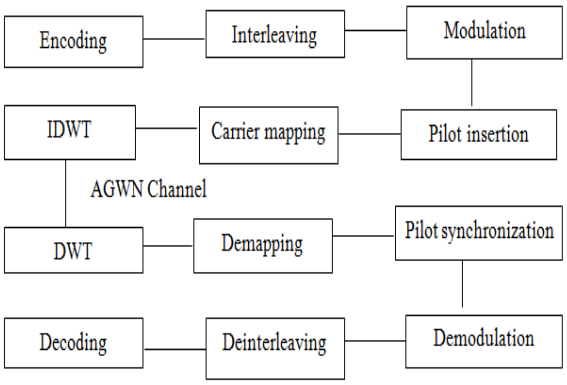

Figure 3.2 :Wavelet based Transrecevier

In transmitter side zero padding is done where as in the receiver side it is removed here particularly for the DWT we are using the Haar wavelet which is simplest but not continuous wavelet which is similar to a step function and also produce the higher resilience to the noise with the reduces bit error rate for the given SNR value another one parameter is it will reduce the amplitude for the digital video broadcasting systems equation 3.6 indicates Zero-mean white Gaussian noise is added to the signal appear in the transmitter side in the AGWN channel therefore receiver signal can be indicated by below equation

$$Y(t)+X(t)= W(t) \qquad 3.6$$

w(t) is the zero-mean white Gaussian noise with variance σ^2

4 SIMULATION PARAMETERS AND

RESULTS

The evaluation of FFT-OFDM and the DWT-OFDM has been investigated by means of MATH LAB computer simulation .generalized DWT and the Particularly Haar wavelet family is used and the result is compare with the each other by plotting the graph of the SNR verses BER of the OFDM systems.

Serial Number	Parameters	Used value for FFT	Used value for DWT
1	Modulation	16,64 PSK 16,64 QAM	16,64 PSK 16,64 QAM
2	Number of subcarrier	52	52
3	Length of the FFT	64	-
4	Number of bit/ second	10^4	10^4
5	channel	AGWN	AGWN
6	SNR	0:2:50	0:2:50

Table.I: Simulation Parameter

The graphical results gives the bit error rate probabilities of both the systems. The results presented reveals the BER performance as a function of the energy per bit to noise ratio. Table I shows the overall parameter of the designed OFDM system.For the simulation purpose SNR of various values are passed through AGWN channel .data of 9600 bits is passed in the form of 10000 symbols ,so one symbol is 96 bits .Averaging for a particular values of SNR for each and everysymbol is done and BER is obtained and similar process is continued for all values of SNR and output of BERs are obtained

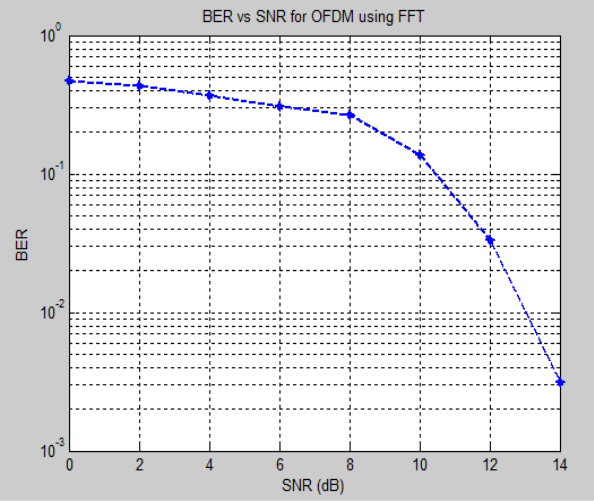

Figure 4.1 Simulation result for FFT based system for AWGN channel

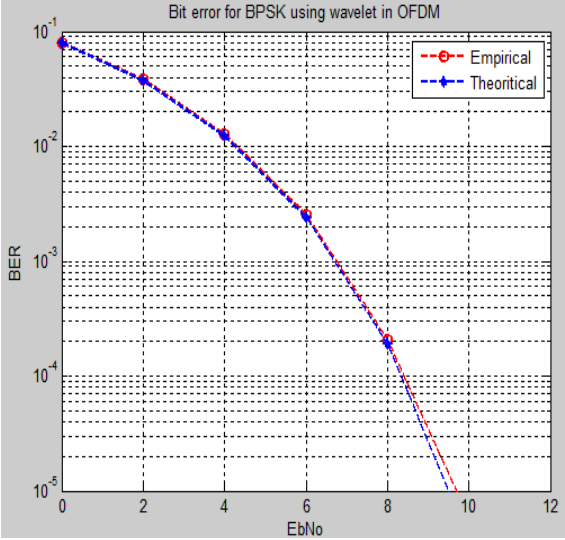

Figure 4.2 Simulation result for DWT based system for AWGN channel

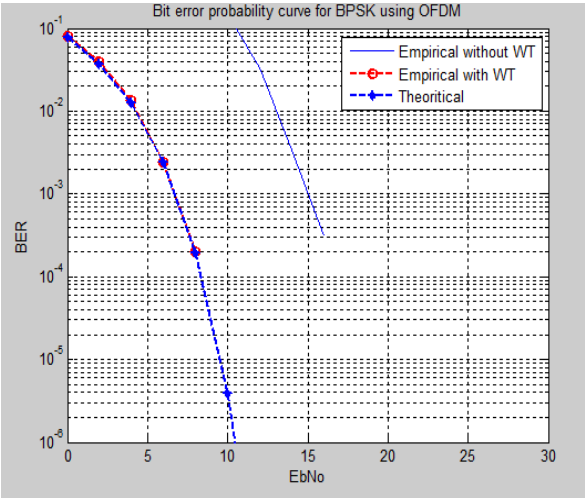

Figure 4.3 Simulation result for DWT of HAAR based system for AWGN channel

Table II of SNR value verses BER for FFT and DWT for OFDM

SNR in db	2	4	6	8
BER for FFT	0.4467	0.3092	0.1366	0.0043
BER for DWT	0.0797	0.0386	0.0134	0.0026

Form the above graphs we can conclude that the DWT-HAAR is best among all the OFDM output.

V CONCULSION AND FUTURE SCOPE

In this paper from the simulation result we can come to conclusion that the performance of wavelet based OFDM is best when compare to the FFT based OFDM which is used in earlier communication systems we have observed that the BER curves obtained in the matlab software using different modulation technique like 16 QAM and PSK. In the wavelet based OFDM different types of filter can be used with the HAAR wavelets available, they provide their efficient performance at the decreased BER value for different interval of SNR value and we can conclude that BER curves obtained from wavelet based OFDM are better than the DFT based OFDM in wireless communication systems The properties of the OFDM can be leads to design and implementation of the developed communication system for 4G technology and Cognitive RadioWavelet based OFDM gives the good result in the very low SNR condition also with the combination of the adaptive filters and the parameter intersymbol interference and inter carrier interference are more immune.

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