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Performance Analysis of Adaptive MIMO Based OFDM using FFT and DWT

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Fast Fourier Transform (FFT)

A B S T R A C T

In this paper we examine the performance of Discrete Wavelet Transform (DWT) based Multiple Input Multiple output (MIMO) Orthogonal Frequency Division Multiplexing (OFDM) system using adaptive modulation and compare with DWT based MIMO OFDM system and Fast Fourier Transform (FFT) based MIMO OFDM system. Wavelet based OFDM has lot of advantages compare to the FFT based OFDM like there is no need of cyclic prefix, flexibility and optimal resolution. DWT with Haar mother constructed multi carrier in addition to the predictable OFDM is less than the consequence of taking multiple antennas scheme while taking BPSK and QPSK as dual modulation schemes in additive white Gaussian noise channel (AWGN). Based on the performance of bit error rate to the signal to noise ratio, the DWT constructed multicarrier scheme was established to be higher than the predictable OFDM. While using adaptive modulation in DWT based MIMO OFDM system with BPSK results in higher BER performance than DWT based MIMO OFDM system.

Introduction:

In wireless communication systems proposal the wavelets require valuable applicability, by way of channel characterization, interference modification, modulation then multiplexing numerous access communication, Ultra Wide Band(UWB) communication, cognitive radio in addition interacting[7]. The Discrete Wavelet Transform (DWT) is cast off in a multiplicity of signal processing solicitations, such by means of video compression, Internet communications compression, plus object recognition also numerical study [8].

An Orthogonal Frequency Division Multiplexing (OFDM) scheme remains a multi Carrier modulation as well as multiplexing scheme Which employs a similar processing method letting The synchronized broadcast of data arranged several Thoroughly spread out, orthogona sub carriers. The Distortion is the greatest enemy of all types of Communication systems which is caused by the multi Path fading channel. Multi path fading occurs in both Domain i-e time domain as well as frequency domain. The multi path fading is greatly reduced an Orthogonal Frequency Division Multiplexing (OFDM). An OFDM is very extraordinary speeds Data rates, these data rates are spilted into number of subcarriers. The OFDM has lot of advantages, spectral efficiency is very high, to reduce the impulse noise over the channel, robustness against co-channel interference and inter symbol interference. The loss of efficiency is caused by cyclic prefix or guard interval. The wavelet transforms are used to develop the effectiveness of OFDM scheme centralized scheduling due to the fact that the inter cell interference impact of a scheduled user is not known and therefore has not been considered by the central scheduler. The FFT based conventional OFDM system Are used to multiplexing the signals together and also Decode the data symbol by the receiver respectively.

The cyclic prefix is added before the transmitting signal, to evade the inter-symbol interference (ISI) in addition to inter-carrier interference (ICI). The cyclic prefix is nothing but periodic extension that is to increase the delay spread. But, the CP is reduced the spectral suppression of the channels. Ripple transforms are used to as the alternative platforms for replacing the FFT based OFDM system. Discrete wavelet transform is mainly used in the OFDM system. It has Low Pass Filter (LPF) plus High Pass Filter (HPF) functional as a Quadrature Mirror Filters Technique it also satisfying perfect renovation as well As orthonormal bases properties. This is also called as sub-band coding subsequently these signals is distributed into sub-signals of low also high frequencies correspondingly.

OFDM:

The distortion is the greatest enemy of all types of communication systems which is caused by the multi path fading channel. The multi path fading is greatly reduced in Orthogonal Frequency Division Multiplexing (OFDM). Due to its high-speed data transmission and effectiveness in combating the frequency selective fading channel, OFDM technique is widely used in wireless communication nowadays. Orthogonal frequency division multiplexing (OFDM) is a multi-carrier transmission technique, which divides the available spectrum into many subcarriers, each one being modulated by a low data rate stream. The block diagram of OFDM system is shown in fig: 1.

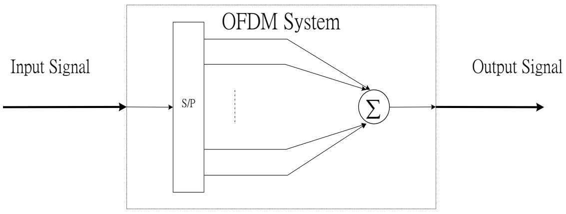

Fig: 1. OFDM System.

OFDM can be viewed as either a modulation technique or a multiplex technique. Modulation technique viewed as the relation between input and output signals. Multiplex technique Viewed by the output signal which is the linear sum of the modulated signals.

MIMO:

In wireless communication systems. The MIMO has been developed for several years for wireless systems. Solitary of the earliest MIMO to wireless Communications uses came in mid1980 by the break- through developments by Jack Winters and Jack Saltz of Bell Laboratories. They strained to send symbol as of many users on the similar frequency/time channel with many antennas both at the transmitter in addition to receiver.Later then, a number of academics as well as engineers have completed important contributions in the area of MIMO. Now MIMO technology has aroused interest because of its Possible applications in digital television, wireless local area networks, metropolitan area networks and mobile communication. Comparing to the Single-input-single-output (SISO) system MIMO provides enhanced system performance under the same transmission conditions. First, MIMO system greatly increases the channel capacity which is in proportional to the total number of transmitter and receiver arrays. Second, MIMO system provides the advantage of spatial variety, each one transmitting signal is detected by the whole detector array, which not only improved system robustness and reliability, but also reduces the impact of ISI (inter symbol interference) and the channel fading since each signal determination is based on N detected results. In other words, spatial diversity overs N independent replicas of transmitted signal. Third, the Array gain is also increased, which means SNR gain achieved by focusing energy in desired direction is increased. On the other hand, MIMO also cost more energy including both the transmission energy and the circuit energy consumption

MIMO OFDM:

Comparing to the Single input-single-output (SISO) system Multi Input Multi Output (MIMO) provides enhanced system performance under the same transmission conditions. MIMO OFDM system greatly increases the channel capacity, spectral efficiency and reduces the multi path fading.

FFT BASED MIMO OFDM:

FFT:

Fast Fourier transform (FFT) is one of the techniques used to transform the time domain signal into frequency domain signal.

$$DFT\ X[k] = \sum_{n=0}^{N-1} x[n] e^{-j\frac{2\pi}{N}kn}$$

Inverse DFT and DFT are critical in the implementation of an OFDM system.

$$IDFT\ x[n] = \frac{1}{N}\sum_{k=0}^{N-1} X[k] e^{j\frac{2\pi}{N}kn}$$

FFT based MIMO-OFDM has lot of advantages, to improve the communication performance, to improve spectral efficiency, to reduced multi path fading. To get number of subcarriers to inculcate we have to provide appropriate IFFT order. Cyclic prefix is added at each symbol length to avoid inter carrier interference (ICI) and inter symbol interference (ISI).

$$X_K = \frac{1}{\sqrt{N}}\sum_{n=0}^{N-1} x_n e^{2\pi jkn/N}$$

$$x_n = \frac{1}{\sqrt{N}}\sum_{K=0}^{n-1} X_K e^{-2\pi jkn/N}$$

N= number of sub carriers

FFT based MIMO OFDM as shown in the figure: 2&3

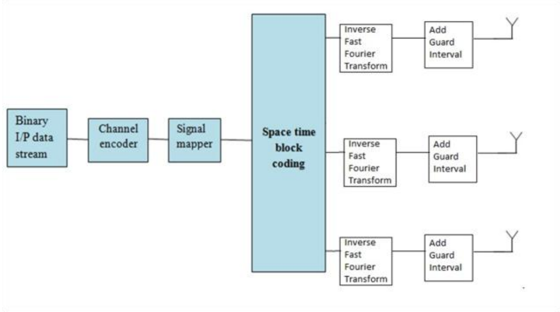

Fig:2. FFT based MIMO OFDM transmitter

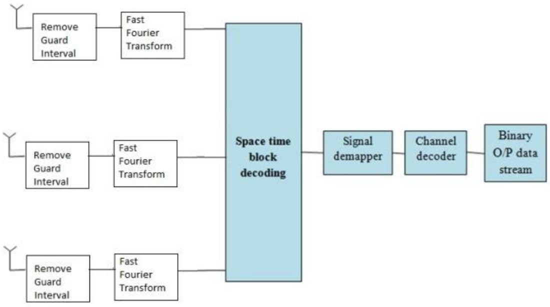

Fig: 3. FFT based MIMO OFDM receiver

DWT based MIMO-OFDM:

Discrete Wavelet Transform is planned as high presentation digital signal processing method for procedure in applying multicarrier modulation. The system project include of an inverse discrete wave-let transform (IDWT) as modulator at the transmitter as well as a discrete ripple transform (DWT) as demodulator at the side of receiver.

DWT:

The wavelet transform is a tool for carving up data into components of different frequencies, allowing one to study each component separately.

In Discrete Wavelet transform, the time-windowed complex exponentials are replaced by wavelet "carriers", at different scales *(j) and* positions on the time axis *(k). These functions are* generated by the translation and dilation of a unique function, called "wavelets mother" and denoted by *ψ (t).*

$$\Psi_{J,K}(t) = 2^{-j/2}\,\Psi\left(2^{-j}t - k\right)$$

The essential modification among the conventional OFDM as well as DWT multicarrier scheme is the removal of the cyclic prefix blocks in the transmitter otherwise in the receiver parts. The block diagram proposal of multicarrier transceiver arithmetical system constructed on DWT is shown in Figure.

In Wavelet based OFDM (DWT OFDM), the time-windowed complex exponentials are replaced by wavelet "carriers", at different scales *(j)* and positions on the time axis *(k).*

To obtain finite number of scales, scaling function ϕ *(t)* is used. DWT-OFDM symbol now can be considered as weighted sum of wavelet and scale carriers, as expressed in below equation. This is close to the Inverse Wavelet Transform (IDWT).

$$S(t) = \sum_{j \le J} \sum_{k} w_{j,k}(t).\psi_{j,k}(t) + \sum_{k} a_{J,k}.\phi_{J,k}(t)$$

$w_{j,k}$ = Sequence of wavelet

$a_{J,k}$ = Approximation coefficients.

The Block diagram of DWT based MIMO OFDM system is shown in fig: 4& 5.

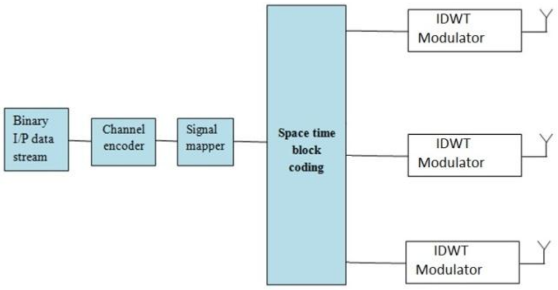

Fig: 4. DWT based MIMO OFDM transmitter

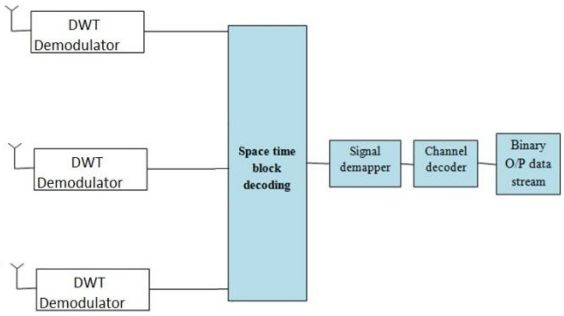

Fig: 5. DWT based MIMO OFDM receiver

Proposed adaptive DWT modulation based MIMO-OFDM:

In this proposed method we are making use of adaptive modulation at the transmitter and adaptive demodulation at the receiver. Bi-orthogonal wavelet shows the property of linear phase effectively. That is necessary for signal and images processing. This property is useful for decomposition & reconstruction process in wavelet transform.

In adaptive modulation, the IDWT Haar transform output is given as feedback to it through the IDWT IBO transform at the transmitter and in adaptive demodulation, the DWT Haar transform output is given as feedback to it through the DWT BO transform at the receiver.The block diagram of DWT based MIMO OFDM system with adaptive modulation is shown in fig: 6, 7, 8 & 9.

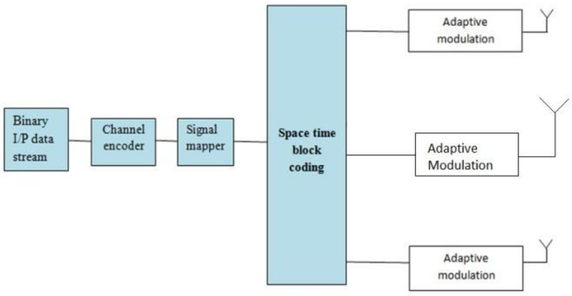

Fig: 6. DWT based MIMO OFDM transmitter with adaptive modulation

Fig: 7. Adaptive Modulation

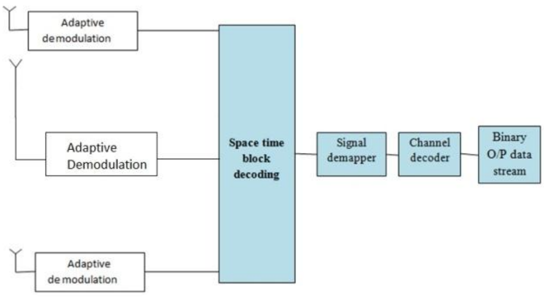

Fig: 8. DWT based MIMO OFDM receiver with adaptive Demodulation

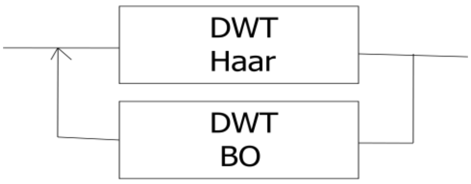

Fig: 9. Adaptive Demodulation

Simulation Results:

The simulation results based on BER (Bit Error Rate) versus SNR (Signal to Noise Ratio) while comparing FFT based multi-carrier modulation with DWT based multi-carrier modulation using QPSK as well as BPSK in AWGN channel. The probability of bit error rate for DWT based MIMO-OFDM is fewer than the probability of bit error rate for FFT based MIMO-OFDM system which is shown in figure (10).

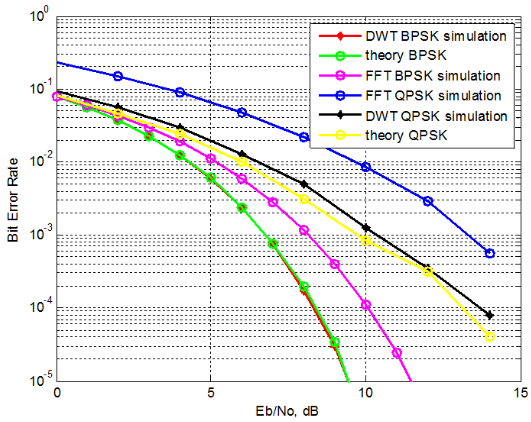

Fig: 10. BER performances of FFT based and DWT based MIMO OFDM without adaptive modulation for BPSK and QPSK.

And further improvement of bit error rate performance of DWT based MIMO OFDM can be achieved by making use of adaptive modulation as shown in figure (11).

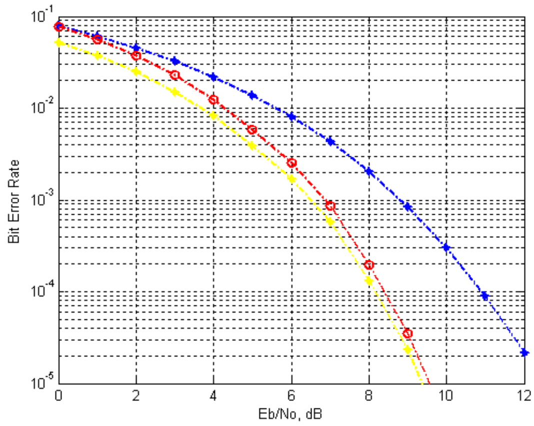

Fig: 11. BER performance of DWT based MIMO OFDM with adaptive modulation (yellow, DWT MIMO OFDM (red) and FFT MIMO OFDM (blue) with BPSK.

Conclusion:

The bit error rate performance in DWT based MIMO OFDM with BPSK modulation scheme is more efficient than FFT based MIMO OFDM. By applying the adaptive modulation method in DWT MIMO OFDM, the simulation results of bit error rate to signal to noise ratio gives better BER performance comparing to the DWT MIMO OFDM and FFT MIMO OFDM with BPSK in AWGN channel.

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