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Enhancing the Performance of STBC-OFDM System by using Discrete Wavelet Transform

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Abstract*: The rapidly growing technology has created it attainable for the communication systems to transfer information nearly every place on this planet. However the restricted bandwidth allotted to an outsized range of users restricts the information measure accessibility to the users. This situation creates a technological challenge to develop the information transmission schemes that are information measure economical. Multicarrier regulation is such a plan, to the point that transmits the data by isolating the serial high information rate streams into various low information rate parallel information streams. Orthogonal Frequency Division Multiplexing (OFDM) might be a sensibly multi-transporter regulation, that partitions the available range into assortment of parallel subcarriers and each subcarrier is then adjusted by a low rate data stream at entirely unexpected bearer recurrence. The routine OFDM frameworks fabricate utilization of IFFT and FFT at the transmitter and recipient individually.*

DWT-OFDM is another approach to this conventional FFT based mostly OFDM system. Discrete wavelet transform (DWT), wavelet Packet transform (WPT) and Invariant wavelet Packet transform (IWPT) are broadly considered as an economical approach to exchange FFT within the standard OFDM systems because of its higher time-frequency localization, bit error rate improvement, interference minimization, improvement in bandwidth efficiency and many more benefits.

Wavelet based OFDM is utilized in order to get rid of the utilization of cyclic prefix that decreases the information measure wastage and also the transmission power is additionally reduced. The BER performance of the OFDM system had been considerably improved by 4 decibel at BER of 10-2.9 when DWT was utilized in place of standard FFT methodology. Afterwards, all the wavelets were compared to search out the optimum wavelet among all.

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I. Introduction

Performance of wireless communication is difficult jobs in multiple-input/multiple-output system beneath completely different diversity theme in presence of co-channel interference. All theoretical analysis for MIMO systems within the survey are often divided into two categories: capability analysis for the system potency [3]-[9] and performance analysis for the system responsibility [10]. Though the capability analysis and performance analysis target two completely different aspects of MIMO systems, each of them powerfully have confidence random matrix theory and matrix selection distributions. A MIMO system are often designed otherwise. One configuration is transmit/receive diversity (TRD) that has been wide used attributable to its Simplicity and smart performance.

The TRD systems are a sort of wireless systems as well as ancient receive diversity united of its special cases [10]–[12]. The performance of TRD systems depends on their operational environments while not [13]–[15] or with [4]–[7] co-channel interferences, and therefore the treatment is especially targeted on the classical Rayleigh or Rician weakening channels. Diversity combining could be a well-known technique to mitigate the performance degradation of multipath weakening and co-channel interference (CCI) in wireless systems. in depth analysis of transmitter or receiver diversity has been conducted over the last many decades to characterize the performance completely different diversity- combining strategies for various numbers of antennas and different weakening distributions. [3,4,5] and therefore the references therein). For a point-to-point communication link while not CCI, it's well-known that maximal-ratio combining (MRC) is the combining technique in terms of increasing the signal-to-noise ratio (SNR) at the combined output. However, combining within the presence of CCI is far additional complicated than MRC and usually needs data regarding the CCI that will not be on the market [6],[8]. Thus, in apply several wireless systems can use MRC even within the presence of CCI. The result of co-channel interference (CCI) on the MIMO MRC systems wasn't self-addressed. However, it's accepted that the MRC theme is optimum (in the sense that it maximizes the output SNR) solely within the absence of CCI. In apply, thanks to its relative simplicity compared to the additional complicated combining schemes that take under consideration CCI [9], [10], [11], [12], the result of CCI is an vital issue for a additional realistic assessment of the performance of MIMO MRC systems. general, adaptive FFTs change their directional beam patterns thus on maximize the ratio at the output of the receiver. Applications have enclosed the event of receiving systems for deed desired signals within the presence of sturdy interference, a technique famed as reduction.

II. Problem Domain

High capability is terribly crucial in wireless as it is needed for future application. it's vital so as to extend information transferred in just once. Today‘s channel suffers from attenuation as a result of multipath within the channel [13]. The increasing demand for capability in wireless systems has driven considerable analysis aimed toward achieving higher output on a given information measure [15-17]. From [13] - [20] it's mentioned that antenna diversity and multiple antennas at each transmitter and receiver will improve the wireless data rate among constant information measure and power received. Also, it's mentioned that multiple antennas area unit well-tried to introduce strength against channel attenuation and interference. In multi-element antennas, mutual coupling depends on the antenna part separation, pure mathematics of array and antenna components, location of antenna components in the array, frequency, substrate thickness and constant, near-field scatters, and direction of arrival (DOA) of the incoming wave [18].

III. Scope

Interferers causes the most degradation to system performance. This may follow from the fact that a single high-power interferer has more variation and therefore more impact on BER than a sum of many lower-power interferers. In this thesis we will proposed a novel technique for reduction of co-channel interference and improve the utility of transmit/receive diversity in presence of channel fading.

IV. Literature Survey

“Performance Evaluation of STBC-OFDM Wi MAX System using Graphics Processing Unit (GPU)” [1]

In this paper, author‘s proposed an efficient implementation of multiple input multiple-output orthogonal frequency division multiplexing (MIMO-OFDM) worldwide interoperability for microwave access (WiMAX) communication system using GPU. The WiMAX system uses space time block code (STBC) and maximal ratio receive combining (MRRC), The processing time for FFT and MRRC under CPU and GPU environment are analyzed and presented.

The conclusion of this paper is: The speedup for different FFT points and the speedup for MRRC-OFDM system in case of 1 × 2 antenna and 1 × 4 antenna system is presented. The computation throughput of the GPU architecture is shown to outperform the conventional sequential CPU architecture. The GPU is specifically designed to provide the baseband solutions and to make the baseband processing more promising.

“Optimizing Performance of WIMAX System Based on WPM” [2]

In this paper The WIMAX system based on WPM is presented for optimizing the bit error rate (BER) performance of WIMAX system.

The results of simulation show BER performance of WPM system is better than OFDM in AWGN channel, A comparison of ICI in both technique shows the wavelet transform-based multicarrier is better than Fourier transform based multicarrier. There are about 2 db improvement bit error rate performance compared with conventional WIMAX based OFDM in both AWGN and fading channel with the WIMAX based WPM.

“Generic Approach to the Performance Analysis of Correlated Transmit/Receive Diversity MIMO Systems With/Without Co-Channel Interference” [3]

In this paper the performance of Optimal transmit/receive diversity (TRD) in general correlated fading with co-channel interference is formulated. whereby the theory of matrix-variant distributions can be invoked to obtain exact solutions in terms of special functions. The solutions are very general including most of existing results as a special case and allowing for the correlation structures of both signal and interferers to be arbitrary at both transmitter and receiver ends. Numerical results are presented to validate the theoretical analysis.

“Performance Analysis of MIMO-MRC in Double-Correlated Rayleigh Environments” [4]

In this paper author consider multiple-input multiple-output (MIMO) transmit beam forming systems with maximum ratio combining (MRC) receivers. The operating environment is Rayleigh fading with both transmit and receive spatial correlation. Authors presented exact expressions for the probability density function (pdf) of the output signal-to-noise ratio, as well as the system outage probability. They also derived exact closed-form expressions for the symbol-error rate. The new expressions are used to prove that MIMO-MRC achieves the maximum available spatial diversity order, and to demonstrate the effect of spatial correlation. The analysis is validated through comparison with Monte Carlo simulations.

V. MIMO

Multiple Input, Multiple Output (MIMO) technology may be a wireless technology that uses multiple transmitters and receivers to transfer a lot of knowledge at a similar time. MIMO technology takes advantage of a radio-wave development known as multipath wherever transmitted data bounces off walls, ceilings, and alternative objects, reaching the receiving antenna multiple times via totally different angles and at slightly different times. MIMO technology leverages multipath behavior by using multiple, ―smart‖ transmitters and receivers with another ―spatial‖ dimension to dramatically increase performance and range. MIMO permits multiple antennas to send and receive multiple spatial streams at a similar time. this permits antennas to transmit and receive at the same time.

The next generation wireless systems are needed to have high voice quality as compared to current cellular mobile radio standards and supply high bit rate services (upto2mbits/sec). Succeeding generation systems are speculated to have higher quality and coverage, be a lot of powerful and bandwidth efficient and be deployed in diverse environment [21] [22].

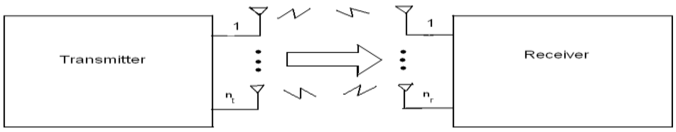

Fig. 1 MIMO System

VI. Fading

Fading (or fading channels) refers to mathematical models for the distortion that a carrier- modulated telecommunication signal experiences over certain propagation media. Short-term fading, also known as multipath induced fading, is due to multipath propagation. Fading results from the superposition of transmitted signals that have experienced differences in attenuation, delay and phase shift while traveling from the source to the receiver. It may also be caused by attenuation of a single signal. Fading refers to the time variation of the received signal power caused by changes in the transmission medium or path.

a) Channel Fading

In wireless communications, signal fading is caused by multi-path effect. Multi- path impact means a signal transmitted from a transmitter might have multiple copies traversing complete different methods to achieve receiver. At the receiver, the received signal ought to be the total of these multi-path signals. as a result of the methods traversed by these signals area unit different; some area unit longer and a few area unit shorter. The one at the direction of light of signal (LOS) ought to be the shortest. These signals move with one another. If signals area unit in part, they might intensify the resultant signal; otherwise, the resultant signal is weakened as a result of out of part. This phenomenon is named channel fading.

b) Fast Fading

Fast fading occurs if the channel impulse response changes rapidly within the symbol duration. In different works, fast fading occurs when the coherence time of the channel TD is smaller than the symbol period of the transmitted

This causes frequency dispersion or time selective fading as a result of doppler spreading.

Fast fading is due to reflections of native objects and therefore the motion of the objects relative to those objects. The receive signal is that the total of variety of signals mirrored from native surfaces, and these signals total during a constructive or destructive manner relative phase shift. Phase relationships rely upon the speed of motion, frequency of transmission and relative path lengths.

VII. Discreet wavelet Transform

The transform function works in two modes high filter (details) and low filter (approximation). Here we tend to discuss the operating method of wavelet transform function rather than typical FFT.

The transmitted signal in the discrete domain, x[k], is composed of successive modulated symbols, each of which is constructed as the sum of M waveforms ϕm[k] individually amplitude modulated. It can be expressed in the discrete domain as:

$$x[k] = \sum_{s} \sum_{m=0}^{M-1} a_{S,m}\, \varphi_m \; [k - sM]$$

VIII. Proposed work

In wireless communication bandwidth play a vital role for successful communication. During the transmission of data, knowledge used a guard band (cyclic prefix) for avoiding a event of interference and collision. For that way cyclic prefix waste the precious bandwidth of spectrum in typical FFT and IFFT carrier signal. In my proposed work we used wavelet transform function for removal of cyclic prefix and utilization of bandwidth. In method of transform function we will be used DWT, WPT/ IWPT.

Orthogonal Frequency Division Multiplexing (OFDM) has been widely adopted in many applications due to its good spectral performance and low sensitivity to impulse noise and multipath channels.It has been widely adopted and standardized in many applications today. It is well known in OFDM that a cyclic prefix (CP) is appended to each symbol in order to mitigate the effect of Inter-Symbol-Interference (ISI). However, this reduces the spectral efficiency. A perfect reconstruction using wavelet transforms in OFDM transceiver counters the degrading effect of ISI, and also conserves bandwidth. In comparison to FFTOFDM, Wavelet Packet Modulation (WPM) offers much lower side lobes in the transmitted signal, which reduces inter carrier interference (ICI) and narrowband interference (NBI). Wavelet tansforms improves spectral efficiency due to the exclusion of CP. Nevertheless, it requires an efficient equalization technique to counter the ISI and ICI. Wavelet based OFDM has been suggested to improve BER performance of transceiver in wireless communication.

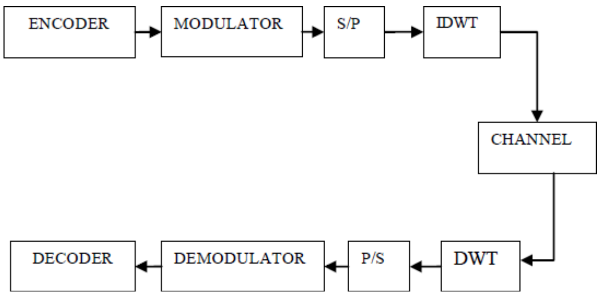

Fig.2 Block Diagram of encoded DWT-OFDM

IX. Result Evaluation

BER of M-QAM signal will be compared with FFT, DWT, WPT and IWPT in AWGN Channel.The Bit Error Rate (BER) with bit size 4 is observed.By taking the value of SNR of all the systems at a particular value of BER, the performance of FFT, DWT, WPT and IWPT OFDM system can be evaluated in AWGN channel. The BER of 10-2.9 is obtained at SNR of 10.5 dB by using FFT based OFDM, SNR of 12 dB by using DWT based OFDM , SNR of 13.5 dB by using WPT based OFDM and SNR of 14.9 dB by using IWPT based OFDM. Hence, there is a significant improvement is shown in the performance of the system by using different wavelet Transforms.The Bit Error Rate (BER) with bit size 16 is observed. By taking the value of SNR of all the systems at a particular value of BER, the performance of FFT, DWT, WPT and IWPT OFDM system can be evaluated in AWGN channel. The BER of 10-2.9 is obtained at SNR of 15 dB by using FFT based OFDM, SNR of 16 dB by using DWT based OFDM , SNR of 17 dB by using WPT based OFDM and SNR of 19 dB by using IWPT based OFDM. Hence, there is a significant improvement is shown in the performance of the system by using different wavelet Transforms. The Bit Error Rate (BER) with bit size 64 is observed.By taking the value of SNR of all the systems at a particular value of BER, the performance of FFT, DWT, WPT and IWPT OFDM system can be evaluated in AWGN channel. The BER of 10-2.9 is obtained at SNR of 23 dB by using FFT based OFDM, SNR of 24 dB by using DWT based OFDM , SNR of 24.5 dB by using WPT based OFDM and SNR of 30 dB by using IWPT based OFDM. Hence, there is a significant improvement is shown in the performance of the system by using different wavelet Transforms.

X. Simulation and Experimental Result Analysis

We compare the performance of the adaptive technique with the orthogonal frequency division multiplexing (OFDM) systems. The key idea of adaptive is to employ the reduction of co- channel interference. Adaptive OFDM aims at providing either BER performance enhancement or power-efficiency improvement over conventional OFDM by incorporating different Transformation Techniques. Here give a parameter table for simulation. Here we demonstrate the result of BER and SNR

Table 1: Simulation Parameter

Modulation scheme (FFT/DWT/WPT/IWP)	M-QAM
Number of subcarrier for OFDM	124
Symbol length	4/16/64
Channel state estimation	Perfect
Signal estimation	Correlated
Channel	Rayleigh fading channel

BER analysis with 4-QAM

The Bit Error Rate (BER) with bit size 4 can be observed in Fig. 6.1. In this result we can analyzed that performance of SNR is improving successively while using Discrete wavelet transform (DWT), Wavelet packet Transform (WPT) and Inverse Wavelet packet Transform (IWPT).

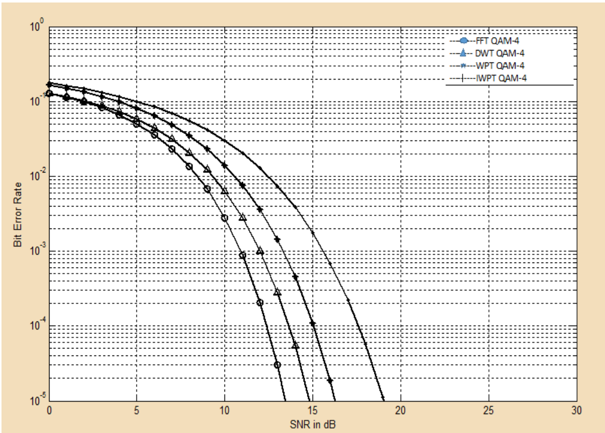

Fig.3 Comparison of BER with different Transform for bit size 4.

By taking the value of SNR of all the systems at a particular value of BER, the performance of FFT, DWT, WPT and IWPT OFDM system can be evaluated in AWGN channel. The BER of 10-2.9 is obtained at SNR of 10.5 dB by using FFT based OFDM, SNR of 12 dB by using DWT based OFDM , SNR of 13.5 dB by using WPT based OFDM and SNR of 14.9 dB by using IWPT based OFDM. Hence, there is a significant improvement is shown in the performance of the system by using different wavelet Transforms. The numerical observation results is shown in Table 2.

Table 2: Simulation Results for 4-QAM

S.No.	Technique	BER	SNR (dB)
1	FFT	$10^{-2.9}$	10.5
2	DWT	$10^{-2.9}$	12
3	WPT	$10^{-2.9}$	13.5
4	IWPT	$10^{-2.9}$	14.9

BER analysis with 16-QAM

The Bit Error Rate (BER) with bit size 16 can be observed in Fig. 6.2. In this result we can analyzed that performance of SNR is improving successively while using Discrete wavelet transform (DWT), Wavelet packet Transform (WPT) and Inverse Wavelet packet Transform (IWPT).

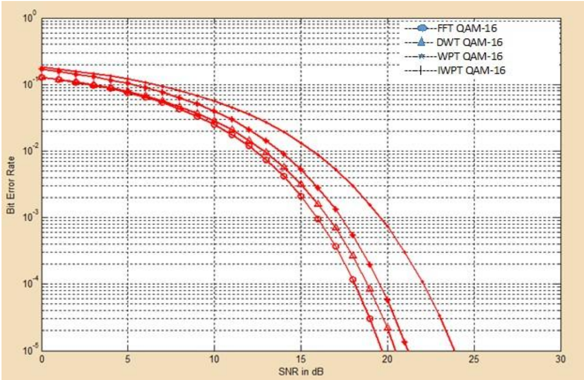

Fig.4 Comparison of BER with different Transform for bit size 16.

XI. Conclusion

Initially the BER performance of FFT based OFDM system has been compared with different wavelet Transform based system and the simulations have been carried out using MATLAB. The wavelet based OFDM transmitter needs to transmit multiple data as compared to FFT- OFDM as data contains the zero padding components. In FFT-OFDM, the cyclic prefix is employed in order to minimize the inter-symbol interference. But its drawback is that it reduces the spectral containment of the channel, power efficiency and data throughput. To overcome these drawbacks, wavelet based OFDM is used as an alternative method. Cyclic prefix is not required in wavelet based OFDM systems as wavelets possess orthonormal nature, thus satisfy the perfect reconstruction property. It is found that the BER performance of wavelet based OFDM surpasses FFT-OFDM in AWGN channel. The BER is significantly improved by replacing FFT with different wavelet based OFDM system.

FFT based OFDM system using 4-QAM, 16-QAM and 64-QAM modulation technique under AWGN channel has been considered as the benchmark and compared with the FFT, DWT, DWP and IWPT OFDM system. An improvement of SNR has been achieved at 10-2.9. Afterwards, all the Transform techniques are compared to find the best among all. The IWPT outperforms all the other Transform. The BER for all the wavelet families is mentioned in table 2, 3, 4.

DWT, WPT and IWPT has come up as an effective technique to be used in multicarrier modulation because of its good time-frequency localization properties, ICI and ISI suppression and flexibility.

In this paper we proposed a novel technique for improvement of SNR and compared the result with different Wavelet transform. In this Methodology we achieved better SNR by using different Wavelet transform.

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