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Effects of QO-STBC Coded DWT Based MIMO CDMA Wireless Communication System under Different Equalization Technique

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Abstract : **This paper incorporates a comprehensive BER simulation study undertaken on the effectiveness of a Quasi Orthogonal Space time block code (QO-STBC) encoded DWT Based MIMO CDMA wireless communication system. The Code Division Multiple Access (CDMA) is a promising technique for high bit rate transmission in wireless communications systems. The QO-STBC encoded DWT Based MIMO CDMA system under present study has incorporated various digital modulation schemes QAM, QPSK, BPSK, DPSK over Additive White Gaussian Noise (AWGN) channel .The channel encoded 4 x 4 antenna (four transmitting antenna and four receiving antenna) configuration and three linear signal detection schemes (Equalizers) such as Minimum Mean Square Error (MMSE), Zero Forcing (ZF) and Single Value Decomposition (SVD). The simulation results clarify that a significant improvement of system performance is achieved in BPSK modulation and MMSE equalization.**

Index Terms: Q-OSTBC, MMSE, ZF, SVD, MIMO-CDMA.

I. INTRODUCTION

As the requirements for wireless communication quickly enhancing, the recent technologies employing multiple access technologies, high data transfer rates and flexible bandwidth allocation by using the significant inventions of science and tech worlds [1]. Recent communication systems Orthogonal Frequency Division Multiplexing (OFDM) is a widespread modulation technique. Its advantages are high spectral efficiency, robustness against inter-symbol interference, ease of implementation using the fast Fourier transform (FFT) and simple equalization techniques.

Now a day's wavelet has been developed as a new signal processing tool which enables the analysis on several the timescales of the local properties of compiles signals. In our previous work presented in [2], Performance Analysis of Wavelet Based MC-CDMA System with Implementation of Various Antenna Diversity Schemes on fading environment has been investigated. In this paper we propose this system with Alamouti and MRC (Maximum Ration Combining) schemes different digital modulation techniques are used over AWGN and Rayleigh fading channel.

Our proposed paper is highlighted QO-STBC encoded DWT based MIMO CDMA system in different equalization schemes under AWGN channel using different modulation schemes. We preferred MIMO over other technologies because of its ability to increase the data rate that is to provide multiple forms of the same signal at the receiver without consuming much time [3]. Besides, the use of channel equalization schemes has enriched our proposal because it protects the data from Inter -Symbol- Interference (ISI) by adding redundant bits and exploiting the original transmitted data structure [4]. In our proposed DWT based MIMO CDMA system, the Bit Error Rate (BER) performance of Minimum Mean Square Error (MMSE), Zero Forcing (ZF), Singular Value Decomposition (SVD) and Q-less QR decomposition based channel equalization techniques are compared [5].

Orthogonal space-time block codes (O-STBCs) reach full transmit diversity and allow independent single-complex symbol maximum-likelihood (ML) decoding, which make the attracting for multi-input multi-output (MIMO) communication systems. However, full-diversity rate-one O-STBCs do not exist for MIMO systems with more than two transmits antennas. For systems with four transmit antennas, the rate limitation of O-STBCs is overcome by quasi-orthogonal space-time block codes (QO-STBCs) at the expense of diversity loss and increased decoding complexity. Full-rate full diversity QO-STBCs are then obtained by rotating signal constellations for some transmitted symbols in the codeword

The rest of this paper is organized as follows. Section II presents the mathematical model of the QO-STBC code. The proposed model describe in section III. The simulation results of BER performance for three channel estimation are given in section IV. Finally section V contains the conclusions.

II. MATHEMATICAL MODEL

Consider a system with four transmit antennas (i.e. M = 4) and four receive antennas (i.e. N=4. In what follows, assume that perfect channel state information (CSI) is available at the receiver but unavailable at the transmitter. Also assume that the channel is quasi-static, i.e. the channel coefficients are constant within one block of code transmission and independently realized from block to block. Let A_{12}, A_{34}, be two Alamouti codes as in [6].

$A_{12}=\begin{bmatrix} s_1 & s_2 \\ -s_2^* & s_1^* \end{bmatrix}$, $A_{34}=\begin{bmatrix} s_3 & s_4 \\ -s_4^* & s_3^* \end{bmatrix}$

Here the subscript 12 and 34 are used to represent the s_1, s_2, s_3 and s_4 in the transmission matrix. Now consider the space time block code for M and N equals to 4 according the method given in [7], the matrix for 4x4 antenna configuration can also be constructed as follows :

$B=\begin{bmatrix} A_{12} & A_{34} \\ -A_{34}^* & A_{12}^* \end{bmatrix}=$

$$\begin{bmatrix} s_1 & s_2 & s_3 & s_4 \\ -s_2^* & s_1^* & -s_4^* & s_3^* \\ -s_3^* & -s_4^* & s_1^* & s_2^* \\ s_4 & -s_3 & -s_2 & s_1 \end{bmatrix} \text{------- (i)}$$

Note that it has been proven in [33] maximum diversity of the order of 4*N for a rate one code is impossible in this case. Now, suppose V_i, i = 1, 2…..4 as the i_{th} column of Q, it is easy to see that

$$(V_1, V_2) = 0 \qquad (V_2, V_4) = 0$$

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$(V_1, V_3) = 0 \qquad (V_3, V_4) = 0$

Where $(V_i,V_j)= \sum_{i=1}^{4} (V_i)_i \; (V_j)_i^*$ is the inner product of V_i and V_j. Therefore, the subspace created by V_2 and V_4 is orthogonal to the subspace created by V_3 and V_4 and similar is true for other columns as given by equation (i)

III. COMMUNICATION SYSTEM MODEL

A simulated multiple -user 4 x 4 spatially multiplexed wireless communication system is illustrated in Fig.(1) utilizes Quasi-Orthogonal space-time block and Trellis coding schemes. In such a communication system, the synthetically generated information bits are channel encoded using iterative-based Convolution encoding scheme. The coded bits are digitally modulated using various types of digital modulations such as Binary Phase Shift keying (BPSK), Quadrature Phase Shift Keying (QPSK), Quadrature Amplitude Modulation (QAM), and Differential Phase Shift Keying (DPSK). The complex digitally modulated symbols are block encoded with implemented Q-OSTBC scheme and fed into four transmitting antennas. In receiving section, the transmitted signal is processed with equalization algorithm and the decoded modulated symbols are fed into Q-OSTBC decoder. Its output data demodulated [8].

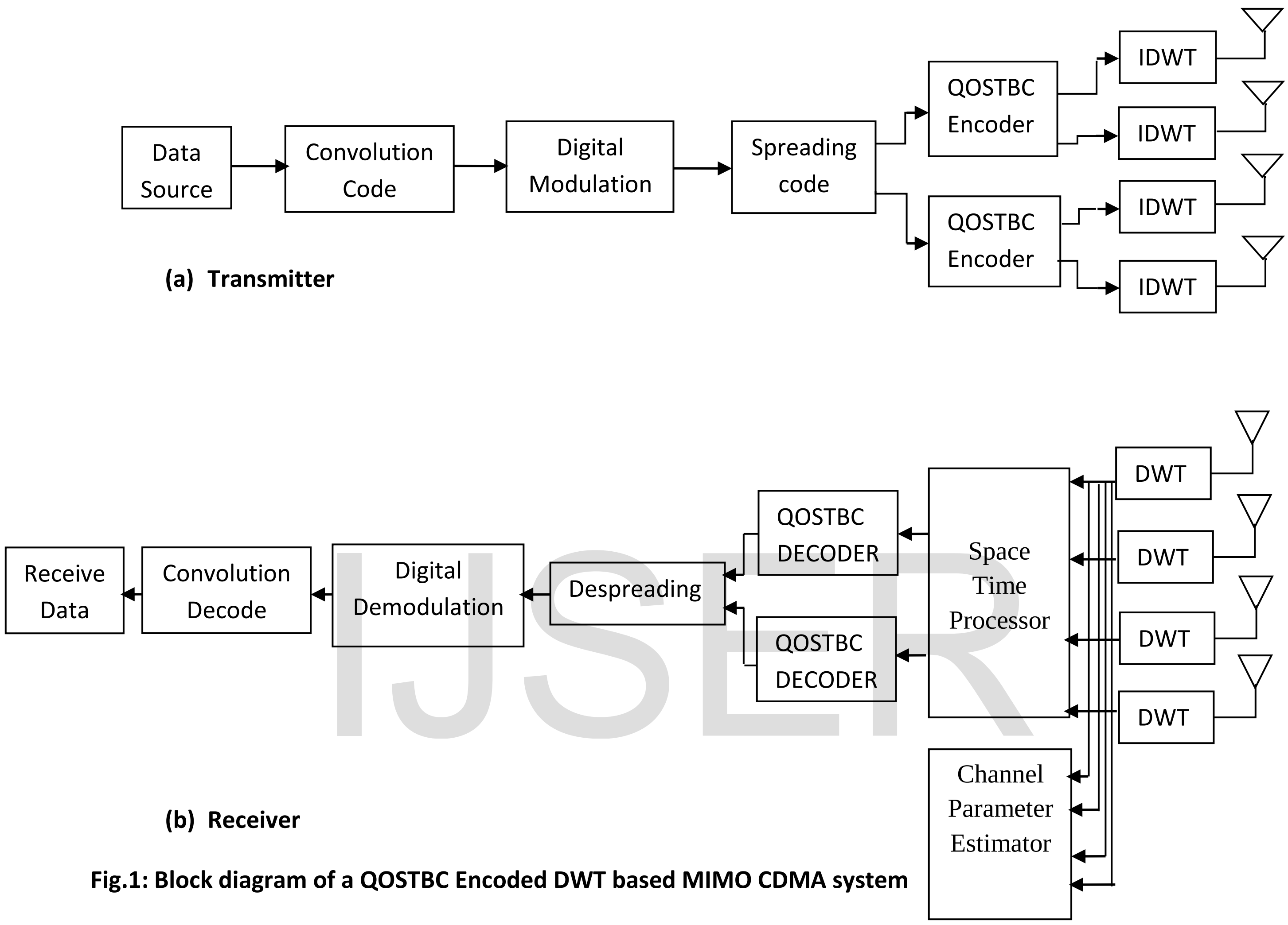

Fig.1: Block diagram of a QOSTBC Encoded DWT based MIMO CDMA system

V.RESULTS AND DISCUSSIONS

We have conveyed computer simulations to evaluate the BER performance of a 4 x 4 spatially multiplexed convolution encoded wireless communication system based on various parameters presented in Table 1. It is assumed that the channel state information (CSI) is available at the receiver and the fading process is approximately constant during each time slot assigned for simultaneous transmission of symbols from four transmitting antennas. The present study focuses the impact of Turbo encoding/decoding on the Q-OSTBC wireless communication system. The results are compared between different modulation techniques. Simulation parameters are shown in table.

Parameter	Parameter Value
No of bits	1024
No. of bits used for synthetic data	0-10
No. of user	1
SNR	0-10 db
Energy per bit	0.5
Modulation and Demodulation	BPSK,QPSK,QAM,DPSK
Equalization Scheme	MMSE,ZF,SVD
Wireless channel	AWGN
Channel coding	Convolution code
Processing Gain	8
No. Of Transmitting Antenna	4
No. Of Receiving Antenna	4

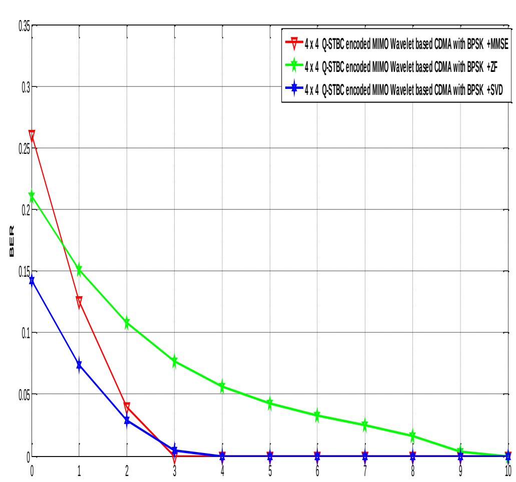

Fig.2: BER analysis of QO-STBC encoded DWT based MIMO CDMA in BPSK modulation with three channel estimation

In Fig. (2) and Fig. (3) show QO-STBC encoded DWT based MIMO CDMA system with BPSK and QPSK modulation performance comparison with three different equalization techniques, respectively. In both cases, the system outperforms in BPSK and shows worst performance in QPSK digital modulations. The BER performance difference is quite obvious in lower SNR areas and the system's BER declines with increase in SNR values. In Fig. (2), it is noticeable under BPSK modulation that for a typically assumed SNR value of 2 dB, the BER values are 0.0395, 0.1076 and 0.0292 for MMSE, ZF and SVD respectively. In this case SVD has a better performance. In Fig. (3), under QPSK modulation the BER values are 0.4917, 0.5017 and 0.4932 for MMSE, ZF and SVD respectively. In this case MMSE and SVD have approximately the same and better performance. In case of BPSK and QPSK digital modulations viz., the system achieves a substantial gain of 10.95, 6.69, 12.28 dB respectively for MMSE, ZF and SVD in BPSK as compared to QPSK.

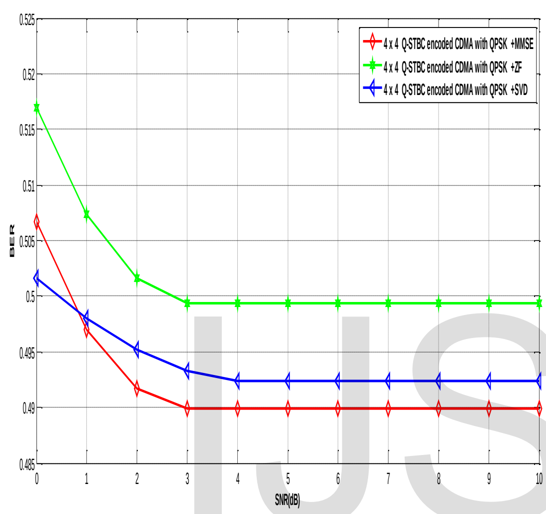

Fig.3: BER analysis of QO-STBC encoded DWT based MIMO CDMA in QPSK modulation with three channel estimation.

In Fig. (4) and Fig. (5), it is observable that the BER performance under DPSK and QAM modulation is 0.2159, 0.3646, 0.2749 and 0.4831, 0.4904, 0.4986 for MMSE, ZF and SVD respectively of the system is improved with the increase in number of iterations in Convolution encoding scheme and the Bit error rate approaches zero at a comparatively low SNR value. Here, the transmitted and retrieved bits at a low SNR value of 2 dB have been represented. From the above estimated bit error rate it is observed that DPSK modulated retrieving capability of the iterative Convolution scheme based Quasi-Orthogonal Space Time Block encoded MIMO wireless communication system is found to be quite satisfactory. In both modulations MMSE equalizer has the better performance. Finally we may conclude that lower order modulation with MMSE equalizer is appropriate for our proposed model.

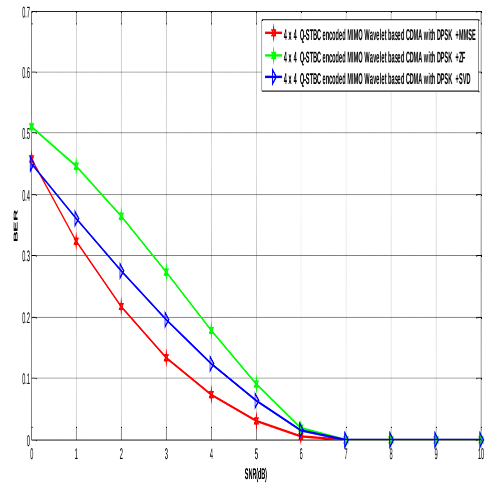

Fig.4: BER analysis of QO-STBC encoded DWT based MIMO CDMA in DPSK modulation with three channel estimation

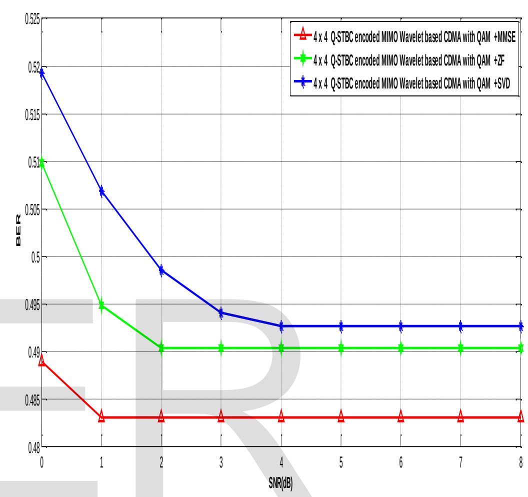

Fig.5: BER analysis of QO-STBC encoded DWT based MIMO CDMA in QAM modulation with three channel estimation

V. CONCLUSIONS

In this research work, we have presented simulation results concerning the adaptation of three channel equalization schemes MMSE, ZF and SVD and Q-OSTBC encoded DWT Based MIMO-CDMA wireless communication system. Over all the performance results of Q-OSTBC encoded MIMO-CDMA and its ability to fulfill the wide range of requirements of tomorrow's ubiquitous wireless communications lead us to conclude that this system is very powerful to be considered in future wireless communication systems. Transmission in the context of system performance, it can be concluded that the Convolution encoded and BPSK-modulated MIMO-CDMA wireless communication system with Minimum Mean Square Error(MMSE) signal detection technique provides satisfactory result for such a QO-STBC encoded DWT based MIMO-CDMA wireless communication system.

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