A New Approach to Investigation of Discrete Wavelet-Based Multiuser MIMO-OFDM for BPSK Modulation Scheme

A. Vamsidhar, P. Rajesh Kumar and K. Raja Rajeswari

Abstract This paper investigates the approach of discrete wavelet to multiuser (MU) MIMO-OFDM systems and further makes a comparison with the conventional Fast Fourier Transform (FFT) founded MU-MIMO-OFDM. Discrete wavelet-based system is found superior in performance over the FFT based one, where the requirement of cyclic prefix has been eliminated making flexible with greatest selection. The concept of discrete wavelets is a best fit in all the areas of Wi-Fi verbal schemes with OFDM, which is an enduring application for subsequent users. Simulations were created for the double multicarrier schemes. Haar wavelet has been utilized in this paper since it shaded out the performance of its counterparts like Daubechies and Symlet. The proposed wavelet-based scheme superseded the conventional-based system in terms of Bit Error Rate (BER) taking a couple of antennas by means of BPSK and QPSK as dual modulation schemes over the Additive White Gaussian Noise (AWGN) Channel.

Keywords MU-MIMO-OFDM · DWT · Haar · BER · BPSK · AWGN

1 Introduction

An orthogonal frequency division multiplexing (OFDM) scheme is a multicarrier transmission approach, which is based on separating the available spectrum into orthogonal frequencies carrying information undistorted. The multipath propagation in the wireless networks always faces a greatest enemy of multipath fading,

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occurring in both the frequency and spatial domains. This multicourse fading greatly diminishes the performance of an OFDM procedure. OFDM has very exact velocity skills premiums, and these knowledge premiums are splitted into wide variety of subcarriers. The FFT-headquartered common OFDM procedure is used to multiplex the alerts collectively and furthermore decode the received symbols via the receiver. The cyclic prefix is introduced earlier than the transmission of the data, to stay away from the Intersymbol Interference (ISI). The introduction of DWT into this arena greatly enhances the transmission efficiency over FFT method. The sub-band coding in discrete wavelet makes a redundancy in cyclic prefix, hence boosting up the channel efficiencies at a lower error rate.

A. *Binary segment shift keying*

In BPSK, the section of the sinusoidal service is modified in line with the info being transmitted. Symbol 0 or 1 modulates the provider.

Let the service sign accept by means of

$$s(t) = A\,Cos(2\pi f_c t) \tag{1}$$

Then

$$P = \frac{1}{2}A^2 \Rightarrow A = \sqrt{2P} \tag{2}$$

When a symbol is changed, the segment of the provider is modified.

Defining

$$s(t) = b(t)\sqrt{2P}Cos(2\pi f_c t) \tag{3}$$

with $b(t) = 1$ for binary ‘1’ sent and $b(t) = 0$ for binary ‘0’ sent.

Figure 1 suggests the symbols constellation, which clearly is the representation of the intricate envelope of the sign. The distance between the signals on the constellation determines how well the receiver can differentiate between all feasible symbols when the sign has been corrupted by way of noise or when noise is present [1]. The greater the distance, the simpler is the risk of proper symbol detection. The smaller the gap between the symbols, the bigger is the chance of the receiver failing

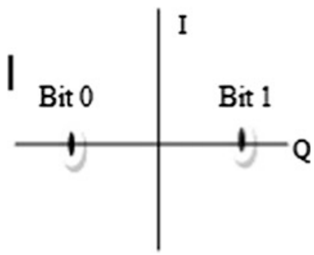

Fig. 1 BPSK constellation diagram

to differentiate between the received symbols which might be whether or not the bit is a 0 or a 1. Within the generation of BPSK alerts, the binary data stream is converted into an NRZ bipolar signal through an NRZ encoder. Then it is utilized to a product modulator whose output is the BPSK signal.

2 FFT Centered MU-MIMO-OFDM

MIMO (Multi-input Multi-output) strategies use many antennas at either the transmitter or receiver (array of antennas) in Wi-Fi communication systems [2]. First, MIMO approach broadly raises the channel potential, which is in proportion to the whole number of transmitter and receiver arrays. 2D MIMO procedure presents the capabilities of spatial style, each and everyone's transmitting sign is detected via the entire detector array, which was most powerful increased system robustness and reliability, however, in addition reduces the influence of ISI (intersymbol interference) and the channel fading, since the truth that every sign option is based on N detected outcome. In unique phrases, spatial sort over's N impartial replicas of transmitted sign. 1/3, the Array collect can also be multiplied, this means that SNR receive completed with the help of focusing vigour in desired course is multiplied. In contradiction, MIMO utilizes extra power at transmission process and increases the circuit power consumption.

The block diagram representation of Transmitter and Receiver of FFT-situated MIMO-OFDM is proven in Fig. 2 and Fig. 3 respectively. In the Transmitter block diagram, the input data is encoded and sent by means of the sign mapped. Then, it is handed via a space Time Block Coder (STBC) where the sign is splitted and inverse FFT is participated on the output of STBC. Look after Interval is introduced for the inversed modified sign as a way to hinder the channel interference and transmitted via multiple antennas. The receiver operation is relatively the reverse of transmitter operation.

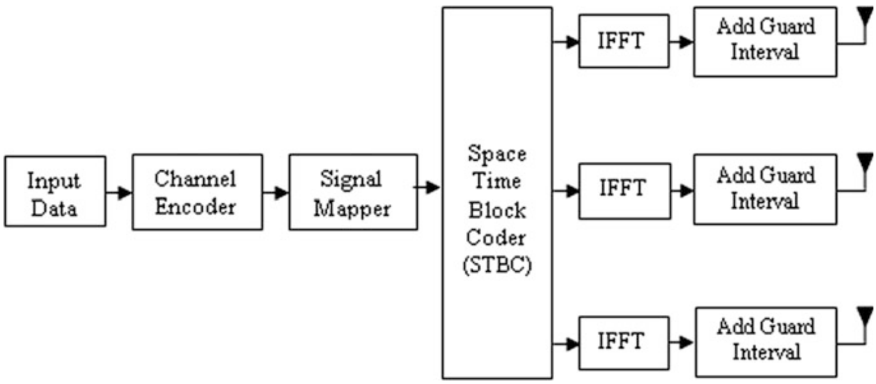

Fig. 2 Block diagram illustration of FFT situated MU-MIMO-OFDM Transmitter

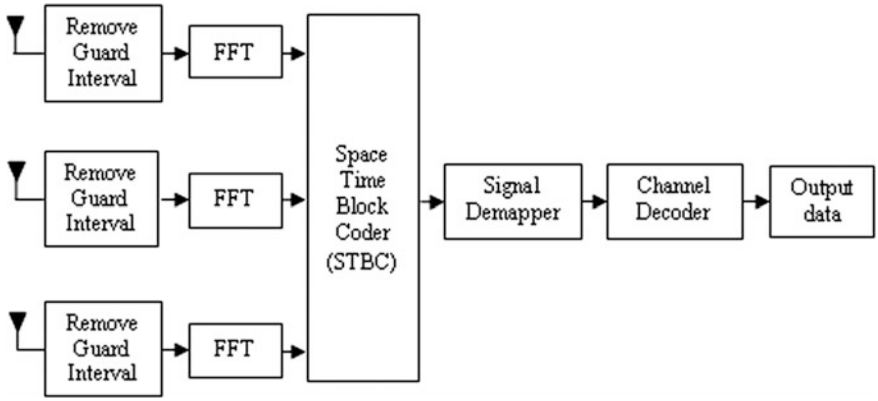

Fig. 3 Block diagram illustration of FFT situated MU-MIMO-OFDM Receiver

3 Wavelet Based MU-MIMO-OFDM

Wavelets developed as a predominant mathematical tool for multidecision continuous time sign differentiations with the help of quality frequencies additionally exotic times in OFDM systems [3]. Now, it has been enhanced into larger frequencies which might be superior that is determined in time, as well as lesser frequencies are better made up our minds in frequency Its Continuous and Discrete time versions are much integrated in many signal-processing applications. Taking this into consideration, the sign stays reproduced via orthogonal wavelet intent; additionally calculate independently converted materials of the time discipline sign [4]. The wavelet even be categorized as two lessons, Continuous ripple develop into discrete ripple change into. A sub-band coding is implemented in discrete wavelet where the sign is analyzed and processes over a series of filter banks. The complete source sign will be split into multiple frequency bands and encrypts each frequency separately on the spectrum. Hence this gives rise to the two steps which might be utilized in signal transmission scheme, namely the decomposition and the reconstruction.

Also,

$$2\sqrt{P} = \sqrt{\frac{2E_b}{T_b}} \tag{4}$$

with

$$E = \frac{1}{2}A^2 T_b \tag{5}$$

where T_b is the bit duration.

Therefore,

$$s_1(t) = \sqrt{\frac{2E_b}{T_b}} Cos(2\pi f_c t) \tag{6}$$

for binary 1 and

$$s_2(t) = -\sqrt{\frac{2E_b}{T_b}} Cos(2\pi f_c t) \tag{7}$$

for binary 0 sent. Hence, defining

$$\phi_{12}(t) = \pm\sqrt{\frac{2}{T_b}} Cos(2\pi f_c t) \text{ for } \quad 0 \leq \text{t} \leq T_b \tag{8}$$

Then the signal set of the BPSK signal is

$$s(t) = \left\{\sqrt{E_b}\phi_1(t), -\sqrt{E_b}\phi_2(t)\right\} \tag{9}$$

The evaluation interval entails of sub-band filter surveyed with the aid of down sampler and the period of synthesis subsequently makes the use of up sampler. Ultimate restoration process can be exhibited by the use of this filter through the channel, giving rise to Quadrature Mirror Filter (QMF) [5]. Each and every stage is engaged with LPFs and HPFs for analyzing frequency intervals and converting them into corresponding DWT coefficients. The approach of restoring the coefficients based on the received symbols is termed as DWT demodulation in other words Inverse DWT. Geared towards every state of filter fiscal institution measurement, the DWT coefficients are up sampled furthermore for the synthesis filter banks.

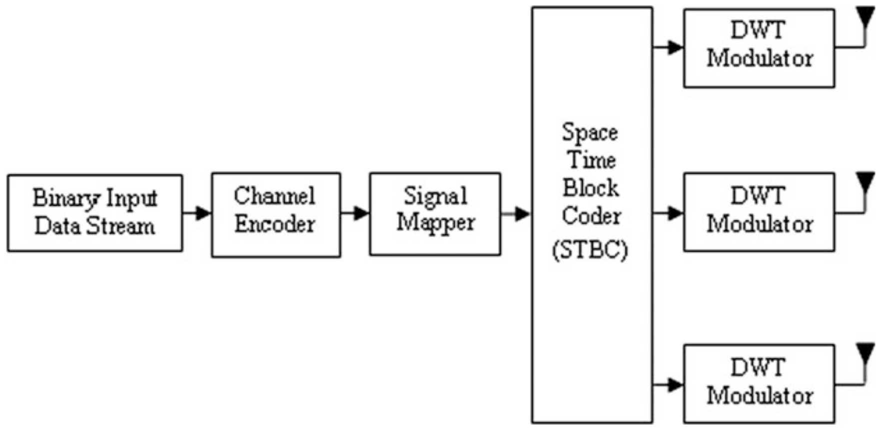

Fig. 4 Block diagram representation of DWT based MU-MIMO-OFDM Transmitter

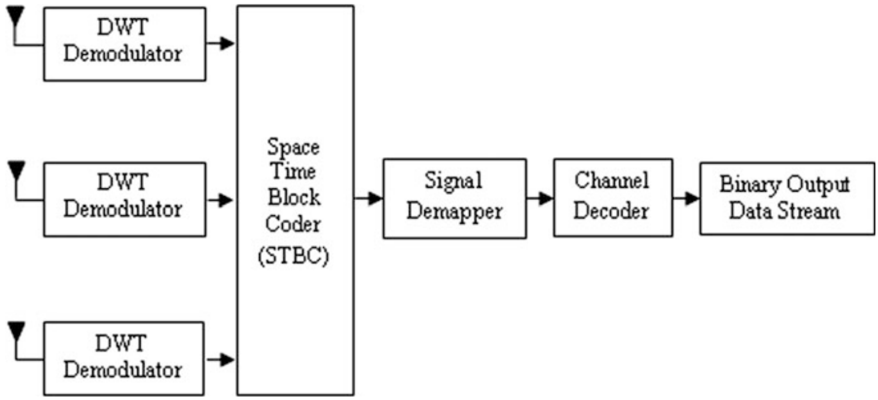

Fig. 5 Block diagram representation of DWT based MU-MIMO-OFDM Receiver

The block diagram representation of transmitter and receiver of DWT situated MU-MIMO-OFDM is shown in Fig. 4 and Fig. 5 respectively. Except the guard interval blocks, all the blocks remain same compared to the FFT centered ones.

4 Simulation Outcomes

Figure 6, Fig. 7, and Fig. 8 show the graphical illustration of thought and sensible procedure of Daubechies, Symlet, and Haar wavelets respectively. It has been proven from the simulated results that the Haar mother wavelet supersedes the opposite two within the performance. The simulations outcomes are centered on BER versus SNR (signal-to-noise Ratio) for QPSK modulation scheme under the MIMO-OFDM methods.

The above Figure shows that the theoretical and practical approaches of the first two wavelets are not smooth enough and has a high BER at some points of SNR, but whereas the Haar version gives a smooth curve with diminishing BER over an increased SNR.

Figure 9 illustrates the performance analysis of the DWT based MU-MIMO-OFDM for BPSK modulation scheme under AWGN channel. The theoretical and the simulated versions depicted clears that the simulated version gives a low BER.

Figure 10 and Fig. 11 determines the illustration of FFT headquartered MU-MIMO-OFDM and DWT headquartered MU-MIMO-OFDM for 10^4 and 10^6 transmitted symbols respectively. Right here a 64-user case is regarded with a couple of antennas at the transmitter and at the receiver. The simulation outcomes are obtained by utilizing BPSK and QPSK modulation schemes under AWGN Channel. It can be clearly observed that the BER of DWT based MU-MIMO-OFDM outperforms the FFT based one. Comparison analysis states

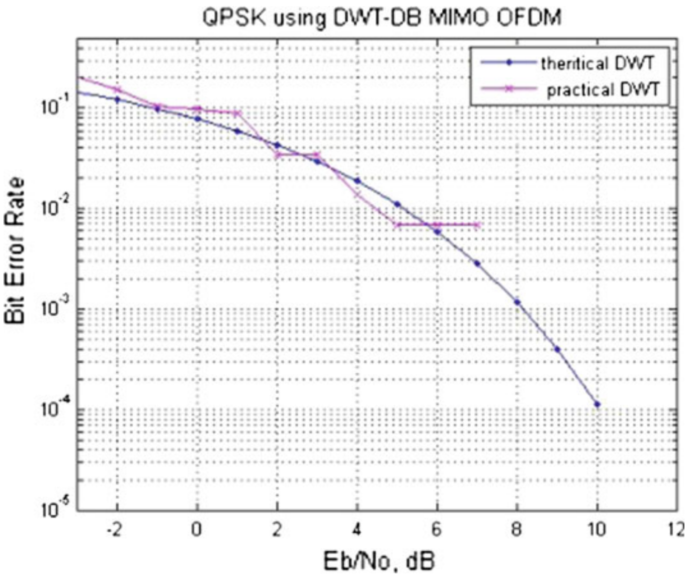

Fig. 6 QPSK based MIMO-OFDM using Daubechies Wavelet

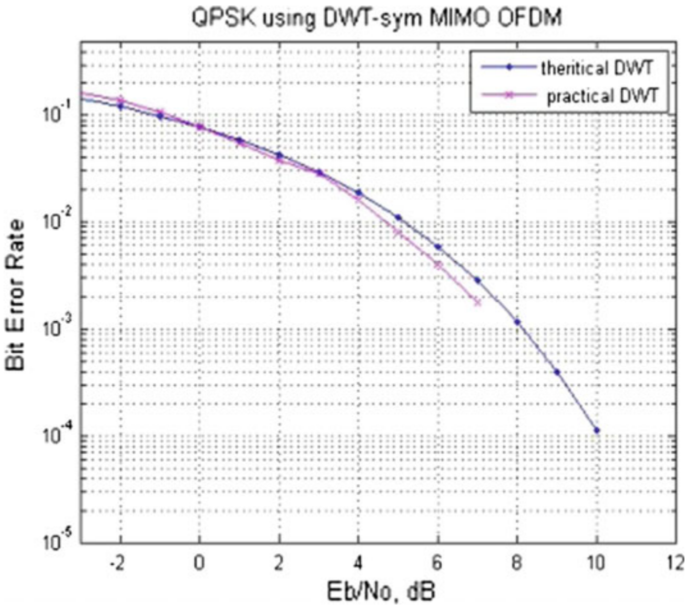

Fig. 7 QPSK based MIMO-OFDM using Symlet Wavelet

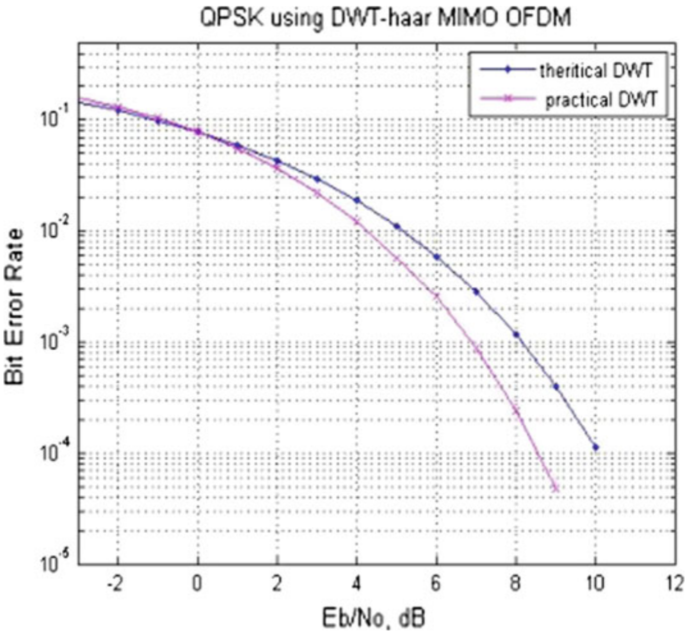

Fig. 8 QPSK based MIMO-OFDM using Haar Wavelet

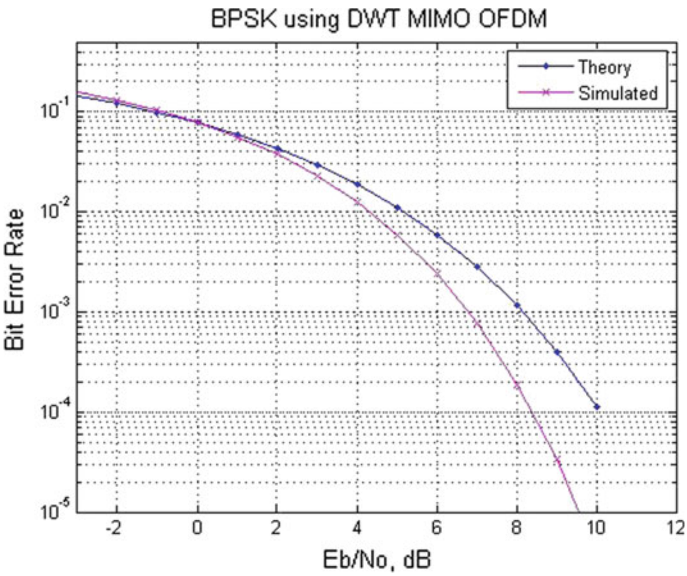

Fig. 9 BER versus E_b/N_o for DWT based MU-MIMO-OFDM for BPSK Modulation Scheme

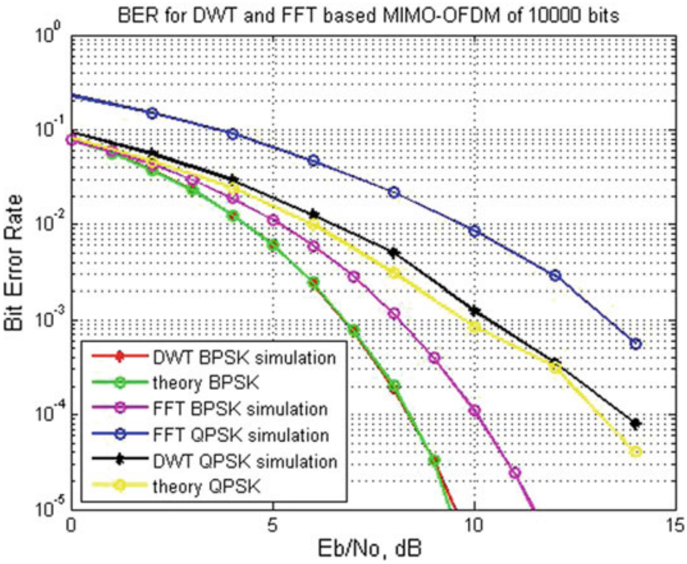

Fig. 10 BER versus E_b/N_o for FFT and DWT based MU-MIMO-OFDM for 10^4 transmitted symbols

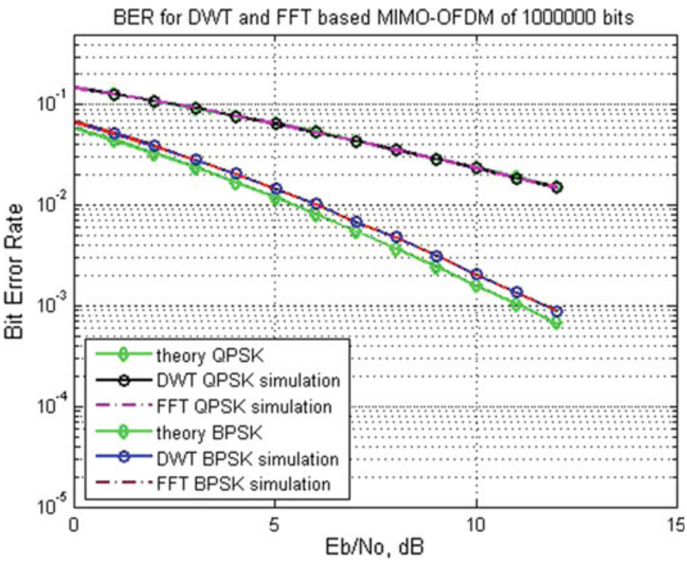

Fig. 11 BER versus E_b/N_o for FFT and DWT based MU-MIMO-OFDM for 10^6 transmitted symbols

that the bandwidth usage is potentially higher in the former case whether the safeguard intervals present or not.

5 Conclusion

To enhance the efficiency of an OFDM system, MIMO is a greatest approach. By evaluating the simulation outcomes, DWT founded MU-MIMO-OFDM outperformed the FFT-headquartered MU-MIMO-OFDM, which is based on the representation of BER. The need for cyclic prefix has been removed thus achieving a higher transmission capability. An impressive low Bit error rate with the discrete wavelet process gathered higher competencies in the new WiFi verbal exchange method for achieving excessive capabilities. Although, the information price by means of BPSK is lesser to QPSK, the BER performance of BPSK is sophisticated than QPSK. An increase in the antenna array at both the ends acquires assets by gathering additional energy which makes the BER to decrease furthermore.

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