Study and Analysis of Haar Wavelet Transform using Hamming Code in Communication System

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Abstract *- The modern wireless correspondence time is encouraging everyone in this world and to keep it overhauling is a prime need among researchers. The QoS and the touch error rate are the elements by which we measure the efficiency of the system. Symmetrical Fre quency Division Multiplexing (OFDM) and Multiple Input and Multiple Output (MIMO). Giving of enhanced symmetry which is based on the wavelet changes of OFDM and improvement of the BER. Increasing of the spectral efficiency we doesn't require the cyclic pre fix which is based on the wav elet syste m. In the impending of the fourth generation LTE, utilizing of wavelets in place of fourier change based OFDM is proposed. Utilization of the wavelets based OFDM Systems we have analyzed the performance of the BER and this work is done with the SUI channel mode and hamming code which altogether reduces the error rate.*

Keywords : OFDM, MIMO, BER, Daubechies and Haar Wavelet Filters.

I. INTRODUCTION

Advanced correspondence system is a system in which data is conveyed from one highlight another by utilizing a finite set of discrete images. This system has been the subject of numerous research over the previous fifty years of its presentation. Thusly, during the last three decades, the development and utilization of computerized correspondence systems, has extensively increased are as yet becoming more and more attractive due to the ever increase in demand for information correspondence, ease of regeneration of advanced signs, high flexibility and accessibility of choices for information processing in contrast with analogue transmission [1, 2]. Square graph of a commonplace computerized correspondence system is appeared in Figure 1.1.

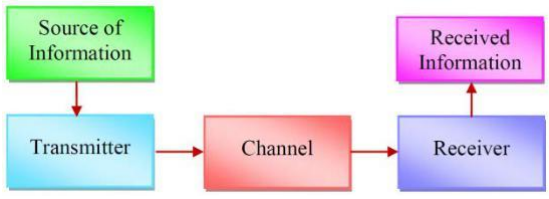

Figure 1.1. A standard digital communication system

The requirement for higher information speed is exponentially increasing, fundamental reason being the accessibility of keen phones, with ease and social networking websites. Steady improvement in wireless information rate is in demand[3].

One of the fundamental advantages of advanced correspondence systems is that they are less subject to bending and interference, in contrast with analogue correspondence systems, as paired computerized circuits operate in one of the two states (for example state 0 or 1) and hence disturbance must be large enough to change the circuit operating point from one state to the other. Such two-state operating systems ease signal regeneration and hence prevent noise and other disturbances from gathering in transmission. What's more, with computerized techniques, extremely low error rates delivering profoundly reliable signals are possible through error detection and correction [2]. Notwithstanding the mentioned advantages, computerized correspondences has some other significant advantages as follows:

- Digital circuits available in advanced correspondences are reliable and can be produced requiring little to no effort
- Digital hardware lends itself to flexible implementation
- Digital correspondence techniques offer themselves normally to flag processing capacities that protect against interference and sticking, or that provide encryption and security
- A great deal of information correspondence can be carried out, from computer to computer, or from computerized instruments or terminal to computer. Such advanced terminations are normally best served by computerized correspondence joins.

With the target of creating a coordinated effort entity among different telecommunications affiliations, the third Generation Partnership Project (3GPP) was established in 1998. It started taking a shot at the radio, core network, and service architecture of a worldwide applicable 3G technology specification. Even however 3G information rates were already real in theory, introductory systems like Universal Mobile Telecommunications System (UMTS) didn't immediately meet the IMT-2000 requirements in their reasonable deployments. The mix of High Speed Downlink Packet Access (HSDPA) and the subsequent expansion of an Enhanced Dedicated Channel, otherwise called High Speed Uplink Packet Access (HSUPA), prompted the development of the technology referred to as High Speed Packet Access (HSPA) or, more casually, 3.5G[9].

Motivated by the increasing demand for mobile broadband services with higher data rates and Quality of Service (QoS), 3GPP started working on two parallel projects, Long Term Evolution (LTE) and System Architecture Evolution (SAE), which are intended to define both the radio access network (RAN) and the network core of the system[8], and are included in 3GPP Release 8. LTE/SAE, also known as the Evolved Packet System (EPS), represents a radical step forward for the wireless industry that aims to provide a highly efficient, low-latency, packet-optimized, and more secure service. The main radio access design parameters of this new system include OFDM (Orthogonal Frequency Division Multiplexing) waveforms in order to avoid the inter-symbol interference that typically limits the performance of high-speed systems, and MIMO (Multiple-Input Multiple-Output) techniques to boost the data rates. At the network layer, an all-IP flat architecture supporting QoS has been defined[8].

In this paper we have compared the performance of wavelets based OFDM system and utilized HAAR and Daubechies 2 transforms with performance of conventional OFDM system (DFT Based i.e. FFT) for different LTE modulation techniques QPSK and m-QAM. For wavelet based system we have used daubechies2 and haar wavelets. Additive White Gaussian Noise (AWGN) channel is used for transmission. The paper is organized as first of all the conventional(FFT) OFDM system and wavelet (HAAR and Daubechies 2) based OFDM system. The proposed wavelet based OFDM design is presented and then the performance evaluation and the results obtained from the simulation are discussed and Conclusion is summarized[7].

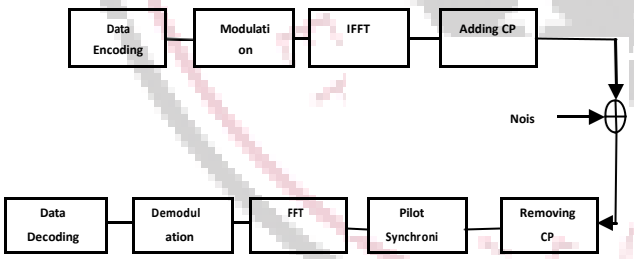

Fig 1.2. DFT based OFDM transmitter and receiver

The revolution of wireless correspondences certainly was one of the most extraordinary Changes underlying our contemporary world in spite of the fact that we may not realize it, everyday our lives are significantly affected by the utilization of radio waves. Radio and television transmissions, radio-controlled devices, mobile telephones, satellite interchanges, and radar and systems of radio route are all examples of wireless correspondences happening around us[6]. However, less than a hundred years back, none of these existed, while the telegraph and telephone were generally normal for correspondence, which required direct wire connection between two places

There mark able advancement in correspondence of today is the result of an Italian scientist, Gugliemo Marconi, as he began experiments utilizing radio waves for correspondence in 1895. These invisible transmittable waves traveled in air, and since the receiving and sending equipment was not connected by wires, the method of correspondence used was then recognized as wireless correspondence. Marconi's first success was in 1897,as he Demonstrated radio's capacity to provide constant contact with ships cruising the English channel[3].

II. CONVENTIONAL OFDM SYSTEM SUI CHANNEL MODEL

For run of the mill OFDM system sinusoids of DFT type associate symmetrical premise perform set. In DFT the system correlates symmetrical premise capacities are the subcarriers utilized in OFDM. At the receiver the signs are combined to get the data transmitted. much, Fast Fourier Transform (FFT) and Inverse Fast Fourier Transform (IFFT) are used for the implementation of the OFDM system as a result of less range of calculations needed in FFT and IFFT[4, 5]. Multiple replicas of the sign are received at the receiver finish attributable to the time dispersive nature of the channel, subsequently frequency selective blurring results and to scale back this interference watch interval is utilized, that is termed cyclic prefix . Cyclic prefix is duplicate of the some part of image finish. As long because the channel delay unfurl remains among the restriction of the cyclic prefix there would not be any misfortune in symmetry. For LTE, in the downlink data of different users is multiplexed in frequency area and access technique is termed Orthogonal Frequency Division Multiple Access (OFDMA).

SUI Channel Model:

The 802.16 IEEE gathering, together with the Stanford University, carried out an extensive work with the intend to develop a channel model for WiMAX applications in rural environments. One of the most significant results obtained was the SUI (Stanford University Interim) spread misfortune model, which is an extension of a early work carried out by AT&T Wireless.

To calculate the median way misfortune utilizing the SUI model, the environment is categorised in three different bunches with their own characteristics:

Category A: uneven terrain with moderate-to-heavy tree densities, which results in the most extreme way misfortune.

Category B: uneven environment yet rare vegetation, or high vegetation however level terrain. Intermediate way misfortune condition is regular of this category.

Category C: mostly flat terrain with light tree densities. It corresponds to minimum path loss conditions.

Typically, for the three previous categories, the general scenario is as follows:

- Cells are < 10 km in radius
- Receiver antenna height in the range of 2 to 10 m.
- Base station antenna height between 15 and 40 m.
- High cell coverage requirement (80-90%)

According to IEEE 802.16 documentation, the SUI model is a suitable propagation model for WIMAX and BFWA (Broadband Fixed Wireless Applications) implementations. In order to investigate the performances of OFDM based BWA an accurate channel model needs to be considered. Usually all the wireless channels are characterized by path loss (including shadowing), multipath delay spread, fading characteristics, Doppler spread, and co-channel and adjacent channel interference.Ricean distribution can be used for characterization of narrow band received signal fading.

III. WAVELET BASED OFDM SYSTEM

In previous works utilization of Discrete Fourier Transform was proposed for the implementation of OFDM. Wavelet change show the potential to switch the DFT in OFDM. Wavelet Transform could be an apparatus for examination of the sign in time and frequency area together[4]. it's a multi resolution investigation mechanism wherever signal is distorted into completely different frequency elements for the examination with explicit resolution coordinating to scale. Utilizing any explicit kind of wavelet filter the system will be designed in line with the necessity and furthermore the multi resolution sign will be generated by the usage of wavelets. By the use of shifting wavelet filter, one will style waveforms with selectable time/frequency dividing for multi user application[6]. Wavelets possess higher symmetry and have confinement each in time and frequency space . Because of good symmetry wavelets area unit capable of reducing the power of the ISI and ICI, which ends from loss of symmetry. To scale back international intelligence agency and ICI in ordinary OFDM system utilization of cyclic prefix is there, that uses 2 hundredth of available data measure, therefore leads to data measure unskillfulness however this cyclic prefix isn't needed in wavelet fundamentally based OFDM system. quality additionally can be reduced by discrete wavelet change as compared with the Fourier change as a result of in wavelet quality is O[N] as compared with nature of Fourier change of O[N log2 N] . wavelet essentially based OFDM is simple and furthermore the DFT basically based OFDM is complicated[7]. Wavelet based OFDM is versatile further and since higher symmetry is provided by it, there's no a need of cyclic prefixing in wavelet essentially based OFDM, that is needed in DFT based OFDM to take care of symmetry therefore wavelet based system is a great deal of data measure economical as compared with the DFT based OFDM.

In Discrete Wavelet Transform (DWT), signal presented can experience numerous completely different filters and can be decomposed into low pass and high pass groups through the filters. all through decomposition the high pass filter can take away the frequencies below 1/2 the best frequency and low pass filter can take away frequencies that area unit on 1/2 the highest frequency[8]. Two types of coefficients area unit obtained through process, first ones area unit called elaborated coefficients obtained through high pass filter and second ones area unit referred to as coarse approximations obtained through low pass filter connected with scaling method. After going the data through filters the destruction method are performed. the entire procedure can continue till the required level is obtained[9].

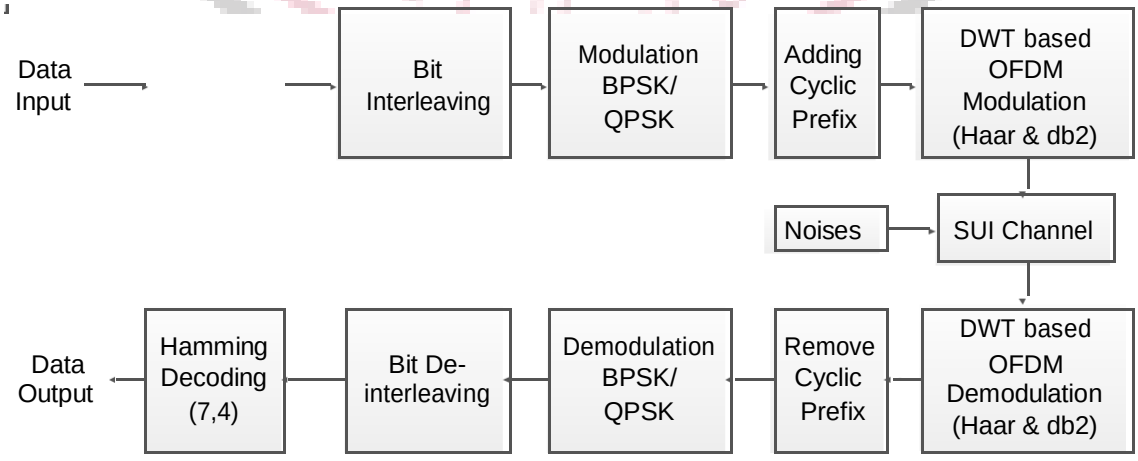

Fig 4.2. Block Diagram of the Proposed Model

IV. PROPOSED METHODOLOGY

In this proposed model we are using IDWT and DWT at the place of IDFT and DFT. SUI channel is used for transmission with cyclic prefix. Here first of all Hamming (7,4) encoding is done followed by interleaving then data is converted to decimal form and modulation is done next.

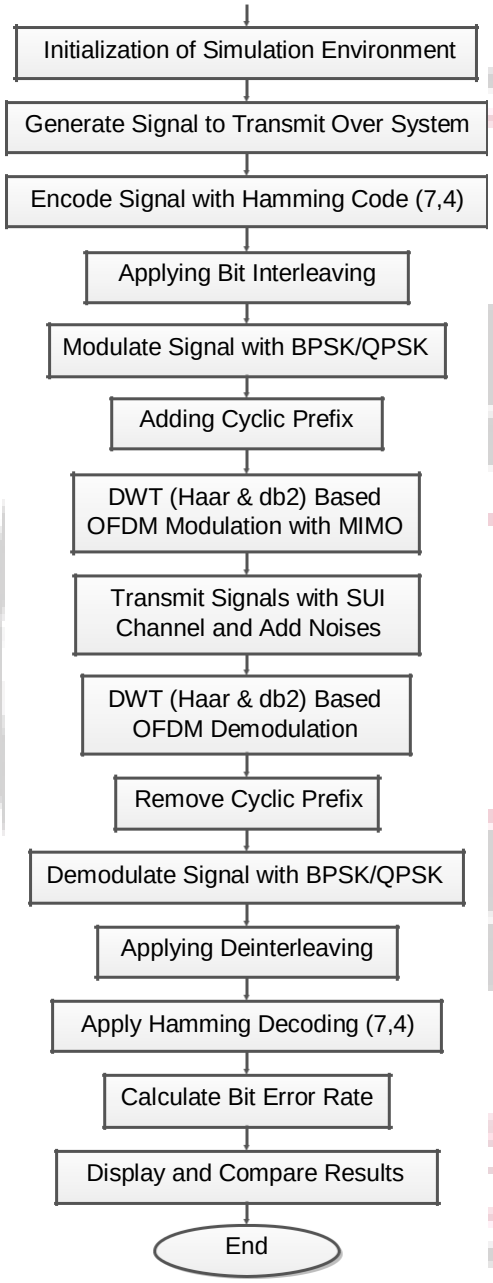

Fig 4.1. Flow chart of the Proposed Model

After modulation it comes the IDWT of the data, which provides the orthogonality to the subcarriers. IDWT will convert time domain signal to the frequency domain. After passing through the channel on the signal DWT will be performed with Hamming Encoding and Decoding Process. Demodulated data is converted to binary form and the de-interleaved and decoded to obtain the original data transmitted.

The wavelet transforms are HAAR and Daubechies 2, which significantly reduces the error rate. The block diagram of the proposed methodology shown in below figure.

The execution of the proposed algorithm is explained in figure 4.1. The steps are showing the characterization of the proposed communication model and its working.

V. SIMULATION RESULTS

The proposed OFDM MIMO system is proposed with the unconventional (Non-DFT based transform) wavelet transform based OFDM system and to reduce the error rate system is equipped with Hamming codes and the wireless channel model is SUI channel model which was designed for the modern wireless communication system.

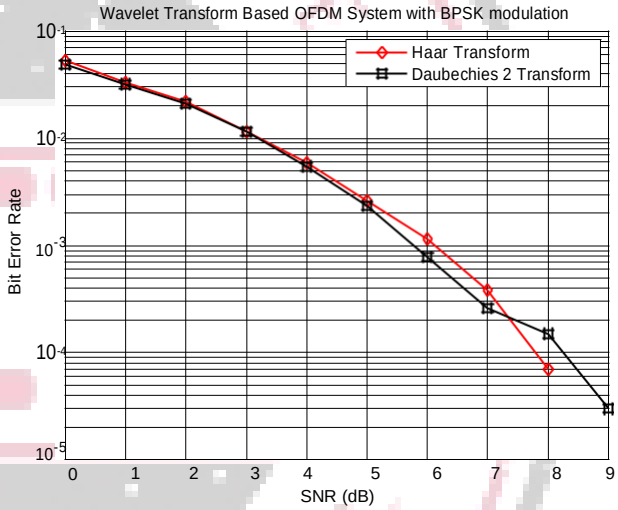

Fig. 5.1 Performance outcomes with BPSK Modulation

The system is analyzed with bipolar phase shift keying(BPSK) and quadrature phase shift keying(QPSK). The simulation outcomes are shown in below figures.

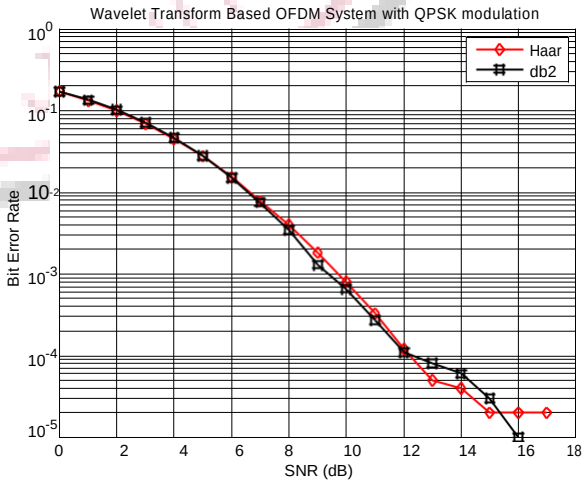

Fig 5.2 Performance outcomes with QPSK Modulation

For the purpose of simulation, signal to noise ratio (SNR) of different values are introduced through AWGN channel. Averaging for a particular value of SNR for all the symbols is done and BER is obtained and same process is repeated for all the values of SNR and final BERs are obtained.

Firstly the performance of wavelet based OFDM are obtained for different modulation techniques. Different wavelet types daubechies2 and haar is used in wavelet based OFDM for QPSK and BPSK. The sysm and performance comparison is shown in the below tables 5.1 and 5.2.

Table 5.1: Results Comparison

SNR	Proposed Work	Existing Work
0	1.8×10^{-1}	2.8×10^{-1}
2	1×10^{-1}	1×10^{-1}
4	4.5×10^{-2}	1.2×10^{-2}
6	1.7×10^{-2}	1.1×10^{-3}
8	3.5×10^{-3}	-
10	7×10^{-4}	-
12	1.1×10^{-4}	-
14	6×10^{-5}	-
16	1×10^{-5}	-

Table 5.2 Comparison of Proposed Systen with Existing System

Particulars	Proposed System	Existing System
System	OFDM Based Wireless LTE System	OFDM Based Wireless LTE System
OFDM Technology	Wavelet Transforms (Haar and Daubechies2)	Wavelet Transforms (Haar and Daubechies2)
Modulation	BPSK, QPSK	QPSK, 16-QAM and 64-QAM
Wireless Channel Model	SUI Channel	AWGN Channel
Noise Model	AWGN	AWGN
Encoding	Hamming Codes(7,4)	-
Symbols	100	100

VI. CONCLUSION

In this paper we have analyzed the performance of unconventional OFDM system which is based on wavelets and compared it with the performance of QPSK and BPSK Modulation techniques based OFDM system. From the performance outcomes we determined that the BER curves obtained from OFDM area unit higher than that of DWT based OFDM. In Haar and Daubechies based wavelet OFDM the BER is performed better than the existing work done without Hamming codes. We've used daubechies2 and haar wavelets, each offer their best performances at absolutely different intervals of SNR.

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