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A Novel BER Analytical Performance Of DWT Based OFDM Using Various Channel Over DFT Based OFDM

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Abstract

OFDM has been widely adopted in many applications due to its good spectral performance and low sensitivity to impulse noise and multipath channels. In OFDM that a cyclic prefixes (CP) is appended to each symbol in order to mitigate the effect of Inter-Symbol-Interference (ISI) and inter carrier interference (ICI). However, this reduces the spectral efficiency. A perfect reconstruction using wavelet based OFDM provides good orthogonality and with its use Bit Error Rate is improved. Wavelet based system does not require CP, so spectrum efficiency is increased. In this paper, we are presenting BER analysis of conventional and wavelet based OFDM in LTE using different modulation techniques like QAM 2, QAM 4, QAM 16, QAM 256 and PSK.

KEYWORDS: DWT, DFT, BER, QAM, CP, ISI and ICI

1. INTRODUCTION

Orthogonal frequency division multiplexing (OFDM) is a multicarrier modulation technique which divides the available spectrum into a number of parallel subcarriers and each subcarrier is then modulated by a low rate data stream at different carrier frequency.

OFDM offers immunity, high spectral efficiency to the multipath delay and low inter symbol interference (ISI). OFDM is a modulation technique which enables user data to be modulated onto the number of tones. The information is modulated on a tone by adjusting the phase of tone, amplitude, or both tone and amplitude. In the most basic form, a tone may be disabled or present to indicate a one or zero bit of information. However in such cases either phase shift keying (PSK) or quadrature amplitude modulation (QAM) is typically employed. An Orthogonal frequency division multiplexing system takes a data stream and splits it into N parallel data streams and each data stream at a rate 1/N of the original rate. Each stream is then mapped to a tone at a unique frequency and when combined together using the inverse fast Fourier transform (IFFT) yields the time domain waveform to be transmitted.

OFDM is a wideband wireless digital communication technique that is based on block modulation. With the wireless multimedia applications becoming more and more popular, the required bit rates are achieved due to OFDM multicarrier transmissions. Multi carrier modulation is commonly employed to combat channel distortion and improve the spectral efficiency. Multicarrier Modulation schemes divide the input data into bands upon which modulation is performed and multiplexed into the channel at different carrier frequencies so that information is transmitted on each of the sub carriers, such that the sub channels are nearly distortion less. In conventional OFDM system, IFFT (Inverse Fast Fourier Transform) and FFT (Fast Fourier Transform) are used to multiplex the signals together and decode the signal at the receiver respectively. In this system, the Cyclic Prefix is added before transmitting the signal to channel. But in wavelet based transmission technique has

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stronger ability of suppressing ISI and ICI than the conventional OFDM scheme. Two types of modulation schemes are used in this paper which is Conventional and non-convention modulation schemes. BPSK, QPSK and QAM are the parts of conventional modulation schemes whereas Differential BPSK and Differential QPSK are the nonconventional modulation schemes. BPSK is the one of the simplest forms of digital modulation.The phase of the constant amplitude carrier signal moves between zero and 180 degree. Differential PSK is a non coherent form of phase shift keying which avoids the need for a coherent reference signal at receiver. The non coherent receivers are easy and cheap to build, and hence are widely used in wireless communications [4]. The QPSK is a multilevel modulation technique; it uses 2 bits per symbol to represent each phase. Compared to BPSK, it is more spectrally efficient but requires more complex receiver. In differentially-encoded QPSK (DQPSK), the phase-shifts are 0°, 90°, 180°, -90° corresponding to data '00', '01', '11', '10'. This kind of encoding may be demodulated in the same way as for non-differential PSK but the phase ambiguities can be ignored. QAM is the method of combining two amplitude modulated signals into one channel. It may be an analogy QAM or a digital QAM. Analogy QAM combines two amplitude modulated signals using the same carrier frequency with a 90 degree phase difference. Adaptive channel equalizers utilize channel estimates to overcome the effects of inter symbol interference. Diversity techniques utilize the channel estimate to implement a matched filter such that the receiver is optimally matched to the received signal instead of the transmitted one. Maximum likelihood detectors utilize channel estimates to minimize the error probability. One of the most important benefits of channel estimation is that it allows the implementation of coherent demodulation. Coherent demodulation requires the knowledge of the phase of the signal.

2. OFDM SYSTEM DESIGN

Occupied bandwidth is of course directly related to the data rate to transmit. However, the question is, what is the minimum bandwidth required to be taken in order to obtain enough diversity and avoid the loss off all the signal in frequency selective fading environments. On the other hand much bandwidth means also much transmitting power. There is a tradeoff between bandwidth and transmitted power.

The optimal bandwidth is found by channel simulations and field test trials. In Digital Audio Broadcasting (DAB), for example, a bandwidth of 1.5 MHz is a good compromise for the type of propagation conditions that apply. We have seen that the greater the number of carriers, the greater the symbol period on each carrier and so less equalization is needed and the greater is the diversity offered by the system. However, with differential modulation, it is important that the channel dose not vary too much during one symbol period. This is not the case when the receiver is moving because of Doppler Effect and short term fading. In such cases number of carriers will limit the moving speed. This is another trade off of OFDM.

3. BASIC OFDM SYSTEM

The block diagram of OFDM system is shown in fig.1.The input high data rate streams are converted into number of low data rate streams. This parallel stream is then modulated using QPSK or QAM modulation techniques, which is then applied as input to IFFT block producing OFDM samples. These samples are then converted into OFDM signal using Parallel-to-Serial converter (P/S).The signal is then encoded by adding Cyclic Prefix (CP) and is then transmitted over the channel. The reverse process is done at the receiver

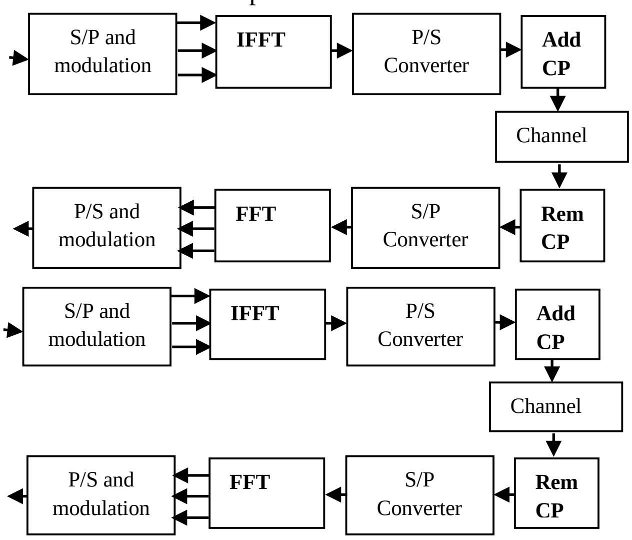

Figure 1: Block diagram of Basic OFDM system

4. CONVENTIONAL OFDM SYSTEMS

Orthogonal Frequency Division Multiplexing (OFDM) is a multicarrier modulation technique in which the spectrum of the subcarriers overlap on each other. The frequency spacing among them is selected in such a way that orthogonality is achieved among the subcarriers.

For typical OFDM system sinusoids of DFT type associate orthogonal basis perform set. In DFT the remodel correlates its signaling with every of curving basis perform , here orthogonal basis functions are the subcarriers utilized in OFDM. At the receiver the signals are combined to get the information transmitted. much, quick Fourier remodel (FFT) and Inverse quick Fourier remodel (IFFT) are used for the implementation of the OFDM system as a result of less range of computations needed in FFT and IFFT. Multiple replicas of the signal are received at the receiver finish attributable to the time dispersive nature of the channel, thus frequency selective fading results and to scale back this interference guard interval is used, that is termed cyclic prefix . Cyclic prefix is copy of the some fraction of image finish.

As long because the channel delays unfold remains among the limit of the cyclic prefix there would not be any loss in orthogonality. For LTE, in the downlink information of various users is multiplexed in frequency domain and access technique is termed Orthogonal Frequency Division Multiple Access (OFDMA). Within the transmission of the LTE access technique used is Single Carrier-Frequency Division Multiple Access (SC-FDMA). High Peak Average Power quantitative relation (PAPR) happens because of random constructive addition of subcarriers and leads to spectrum spreading of signal resulting in adjacent channel interference. So power linearization techniques and compression purpose electronic equipment got to be wont to overcome this downside.

5. WAVELET BASED OFDM SYSTEM

In previous works use of distinct Fourier rework was proposed for the implementation of OFDM. Wavelet transform show the potential to switch the DFT in OFDM. Wavelet rework could be a tool for analysis of the signal in time and frequency domain together. it's a multi resolution analysis mechanism wherever signal is rotten into completely different frequency elements for the analysis with explicit resolution matching to scale . Using any explicit sort of ripple filter the system will be designed in line with the necessity and additionally the multi resolution signal will be generated by the utilization of wavelets. By the utilization of varying ripple filter, one will style waveforms with selectable time/frequency partitioning for multi user application. Wavelets possess higher orthogonality and have localization each in time and frequency domain. To cut back international intelligence agency and ICI in typical OFDM system use of cyclic prefix is there, that uses 2 hundredth of available information measure, therefore leads to information measure unskillfulness however this cyclic prefix isn't needed in ripple primarily based OFDM system. quality also can be reduced by victimization ripple transform as compared with the Fourier rework as a result of in wavelet quality is O[N] as compared with quality of Fourier rework of O[N log2 N] . ripple primarily based OFDM is simple and also the DFT primarily based OFDM is complicated. Wavelet based OFDM is versatile further and since higher orthogonality is provided by it, there's no a need of cyclic prefixing in ripple primarily based OFDM that is needed in DFT based OFDM to take care of orthogonality therefore ripple based system is a lot of information measure economical as compared with the DFT based OFDM.

In distinct ripple rework (DWT), signal presented can experience many completely different filters and can be decomposed into low pass and high pass bands through the filters. throughout 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 top of 1/2 the highest frequency. The decomposition halves the time resolution as a result of 1/2 the samples area unit accustomed characterize the signal equally frequency resolution are doubled and this decomposition method are perennial once more for getting the ripple coefficients of needed level. 2 forms of coefficients area unit obtained through process, 1st ones area unit called elaborated coefficients obtained through

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high pass filter and second ones area unit referred to as coarse approximations obtained through low pass filter connected with scaling method. After passing the info through filters the destruction method are performed. the entire procedure can continue till the required level is obtained.

6. PROPOSED WAVELET BASED OFDM DESIGN

In this proposed model we are using IDWT and DWT at the place of IDFT and DFT. AWGN channel is used for transmission and cyclic prefixing is not used. Here first of all conventional encoding is done followed by interleaving then data is converted to decimal form and modulation is done next. After modulation the pilot insertion and sub carrier mapping is done then 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 and then pilot synchronization where the inserted pilots at the transmitter are removed then the demodulation is done.

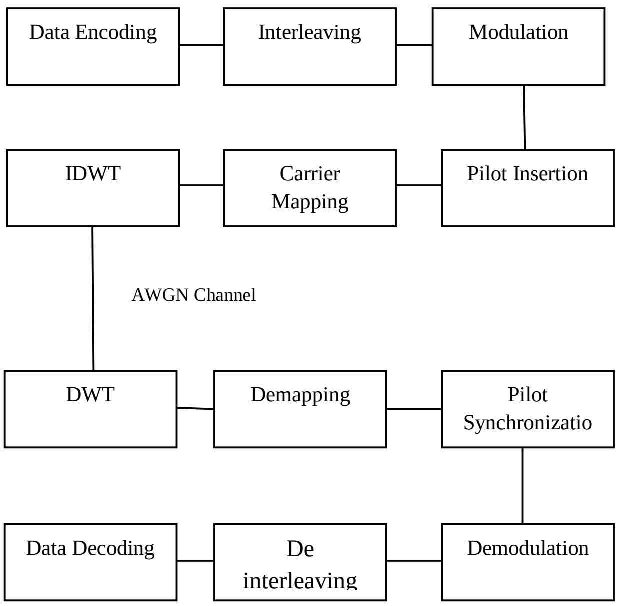

Figure 2: Wavelet based proposed OFDM system design

Demodulated data is converted to binary form and the de-interleaved and decoded to obtain the original data transmitted.

7. SIMULATION RESULTS

By using MATLAB performance characteristic of DFT based OFDM and wavelet based OFDM are obtained for different modulations that are used for the LTE, as shown in figures 3-5. Modulations that could be used for LTE are QPSK, 16 QAM and 64 QAM (Uplink and downlink). QPSK does not carry data at very high speed. When signal to noise ratio is of good quality then only higher modulation techniques can be used. Lower forms of modulation (QPSK) does not require high signal to noise ratio.

For the purpose of simulation, signal to noise ratio (SNR) of different values are introduced through AWGN channel. Data of 9600 bits is sent in the form of 100 symbols, so one symbol is of 96 bits. 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 DFT based OFDM and wavelet based OFDM are obtained for different modulation techniques. Different wavelet types daubechies2 and haar is used in wavelet based OFDM for QPSK, 16-QAM, 64-QAM.

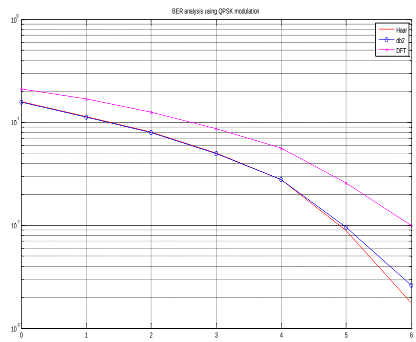

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Figure 3: BER performance of wavelets and DFT based OFDM system using QPSK modulation

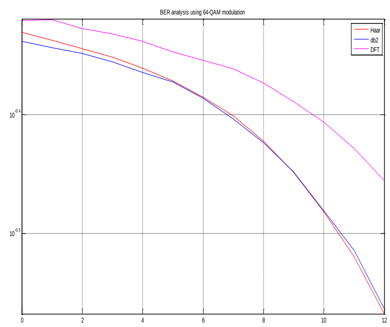

Figure 4: BER performance of wavelets and DFT based OFDM system using 64- QAM modulation

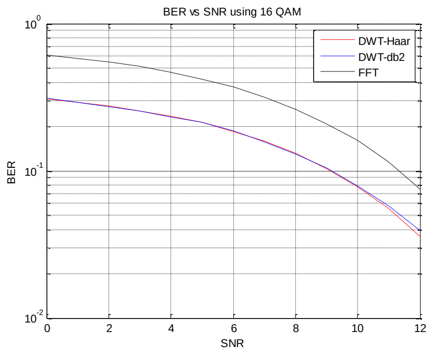

Figure 5: BER performance of wavelets and DFT based OFDM system using 16-QAM modulation

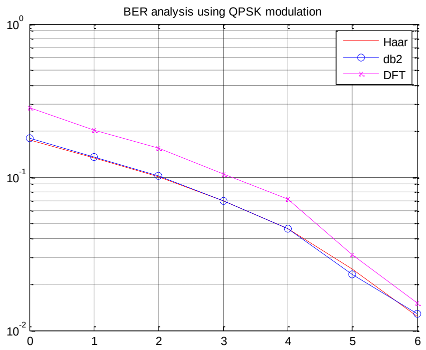

Figure 6: SUI model QPSK modulation scheme

8. CONCLUSION

In this paper we have a tendency to analyzed the performance of rippling primarily {based} OFDM system and compared it with the performance of DFT based OFDM system. From the performance curve we've determined that the BER curves obtained from rippling primarily {based} OFDM area unit higher than that of DFT based OFDM. we have a tendency to used 3 modulation techniques for implementation that area unit QPSK, 16QAM and 64QAM, that area unit utilized in LTE. In rippling based mostly OFDM differing kinds of filters are often used with the assistance of various wavelets offered. We've used daubechies2 and haar wavelets, each offer their best performances at totally different intervals of SNR.

EXTENSION

The BER ANALYSIS improvement is a challenging task in the orthogonal frequency division multiplexing, in our proposed work we use estimated DWT based OFDM algorithm for BER Performance using Rician, Rayleigh and AWGN channel. Estimation of BER Performance is done by using the SUI channel for better performance, High spectral efficiency and low run time complexity.

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