Improvised OFDM analysis using Discrete Wavelet Transform

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***Abstract*— Communication is one of the important aspects of life. With the rapid growth in the field of data transmission and communication there also exist a demand in its advancement and its improved versions to meet the needs satisfactorily. The FFT based OFDM system has an advantage that they are more prone to multipath fading. And the disadvantage is that the signal transmitted, gains high Peak to Average Power Ratio (PAPR). Hence to resolve this major disadvantage of FFT based OFDM system, instead of FFT, another technique of Discrete Wavelet Transform (DWT) is proposed and simulated in terms of PAPR, and bit error rate (BER) scenario.**

Keywords—ofdm; ifft; dwt; papr; ber (key words)

I. INTRODUCTION

In an Orthogonal Frequency Division Multiplexing (OFDM) system, there are large number of narrow band orthogonal sub-channels or sub carriers that are transmitted in parallel together sharing the available transmission bandwidth of the communication system. There is very minimum separation between the subcarriers is such that the spectrum can be utilized efficiently. The use of OFDM mainly depends upon how the system handles the multipath interference at the receiving end of the system. There are two basic effects caused by multi path, that are frequency selective fading and inter symbol interference (ISI). The "flatness" perceived by a narrow-band carrier overcomes the former carrier, and modulates at a very low symbol rate, this process makes the symbols much longer than impulse response of the channel, and hence results in diminishing the later carrier. The use of powerful error correcting codes in combination with time and frequency interleaving yields even more robustness against frequency selective fading in the system, Further the trade-offs of inter symbol interference ISI can be reduced with the insertion of an extra guard interval between each OFDM symbols. This shows that an equalization technique is not much necessary at both transmitting and receiving end. There are two main drawbacks with OFDM, the large dynamic range and power of signal (referred to as peak-to average power ratio [PAPR]) and the sensitivity of an OFDM system to frequency prone errors. In this paper daubichies wavelet family is used to reduce the PAPR in the system. Finally we compare BER performance of our proposed wavelet based OFDM with the conventional OFDM over different channels to show the enhanced performance of our proposed OFDM model.

II. FACTORS AFFECTING OFDM TRANSMISSION

A. Peak to Average Power Ratio (PAPR).

PAPR is the ratio between the maximum power and the average power of the complex pass band signal s(t). In OFDM system with N subcarriers, the maximum power occurs when all of the N subcarrier components happen to be added with identical phases, on the other hand the probability of the occurrence of the maximum power signal decreases as N increases in turn reducing the efficiency of the system.

B. Bit Error Rate (BER).

The Bit Error Rate is termed as the number of bit errors divided by the total number of transferred bits during a studied time interval The transmission BER is the number of detected bits that are incorrect before error correction, divided by the total number of transferred bits. The information BER, approximately equal to the decoding error probability, is the number of decoded bits that remain incorrect after the error correction, divided by the total number of decoded bits.

III. MODULATION THROUGH IFFT

A. The data can be modulated into a complex waveform that occurs at the Inverse Fast Fourier Transform (IFFT) stage at the transmitter end. The chosen modulation scheme can be completely independent of specific channel that is being used and on the basis of the requirements of channel in the system. It is thus possible that different modulation scheme can be used by each individual sub carrier. The IFFT process is used to modulate each sub-channel onto the appropriate carrier without cyclic prefix [1]. We transmit the following N values (N=Nfft=length of FFT/IFFT) for a single OFDM symbol. X0,X1,X2,X3……….Xn-1 .Let consider a cyclic prefix of length Ncp, (where Ncp<N), is formed by copying the last Ncp values from the above vector of X and by adding those Ncp values to the front part of the same vector X. With a cyclic prefix length Ncp, (where Ncp<N), the following values constitute a single OFDM symbol.

If T is the duration of time in seconds of the an OFDM symbol, then due to the addition of cyclic prefix of length Ncp in the symbol, the total duration of an OFDM symbol becomes T+Tcp, where Tcp=Ncp*T/N. Thus the number of samples allocated for cyclic prefix can be calculated as Ncp=Tcp*N/T, where N is the length of FFT/IFFT in the system, and T is the period of IFFT/FFT and Tcp is the duration of cyclic prefix.

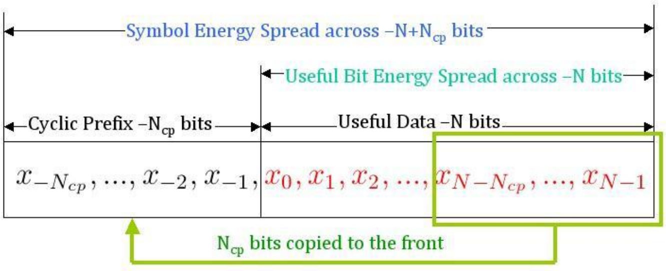

Figure 1. OFDM symbol

B. *Conventional OFDM system*

The process of conventional OFDM system is shown below, in it the input signal is being modulated before reshaping, afterwards its Fourier transformation is being done then is being allowed to be reshaped again before amplification, after being amplified the signal is allowed to channelize this is a process at transmitter end. At receiver end the reverse process of transmitter is opted to get the output signal.

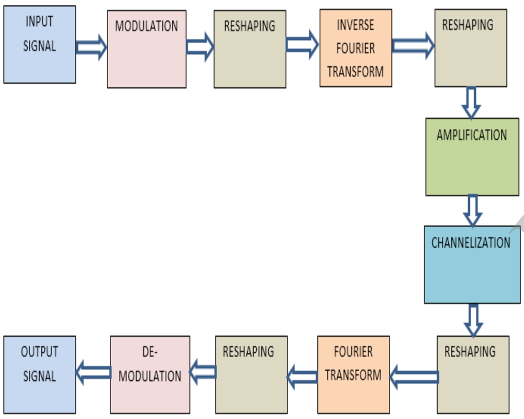

Figure 2. Conventional OFDM system.

C. *Proposed OFDM system*

The proposed system is shown below, in this system all the levels of signal process are same except the transformation process. We had adopted a Discrete Wavelet Transformation method here to decrease the complexity of the system in terms of power and other system related factors that affect the performance of the conventional OFDM system.

In wavelet transform the decomposition of only the low pass coefficients is being performed. Generalization of this process is the wavelet packet transformation technique in which the decomposition is done along both the high and low pass coefficients. Those identities of the system where a signal is sampled down link and then passed through filter (H(z)) is equivalent to passing the signal through a filter(H(z2)) and then its down sampling is done.

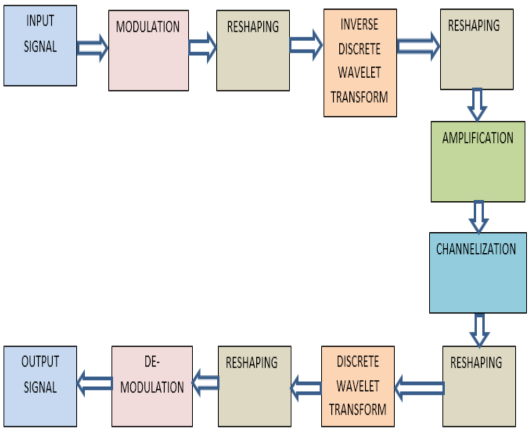

Figure 3. Proposed OFDM system.

Thus the packet transform of a wavelet can be represented below. The frequency time plot of Wavelet transform and wavelet packet transform is also shown below. It is seen that at lower frequencies the time-span is larger as compared to higher frequencies. For the wavelet packet we can decide how to decompose the high and low frequencies parts as after each decomposition we can decide whether to decompose the signal in the low/high frequency domain or not the same data can be transmitted at this scale J but this time with a double higher rate. . Decomposition of the signal in different frequency bands is simply done by successive high pass and low pass filtering of the time domain signal at the same time. First of all the original signal x[n] is allowed to pass through half-band high pass filter g[n] and low pass filter h[n]. Half of the samples can be eliminated after filtering, since the signal now has a highest frequency of f max/2 radians instead of f max which is qualitable. This signal can therefore be sub-sampled by 2, this can simply discard every other such sample. It constitutes one level of decomposition.

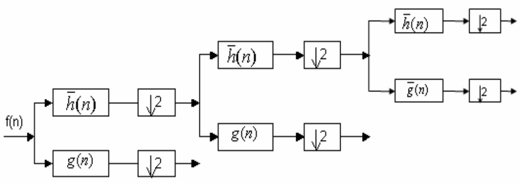

Figure 4. Decomposition of packet

In case of a conventional OFDM system, an input data vector [w] can be treated as being composed of several frequency-domain coefficients. Generation of these coefficients is from random bipolar symbols +1 and -1, these are combined into some complex numbers in a way like the output of IFFT block generate a real sequence in the conventional system. If a Wavelet is implemented in OFDM transmission instead of IFFT, then the input data vector [data] represents a sequence of wavelet-domain detail and approximation coefficients as relatively, and it is given as:

data = [{aJ,k},{wJ,k},{wJ−1,k},...,{w1,k}]

This sequence of data is modulated into a contiguous finite set of dyadic frequency bands and into a finite number of (k) position of time within each scale individually.

D. Simulation results

- The proposed model is being simulated in Simulink.
- On simulating the model it is being observed that the model overcomes the drawbacks of conventional OFDM system increasing its efficiency. The spectrum of input data, output data, transmitted data, received data is shown below respectively.
- Input data.

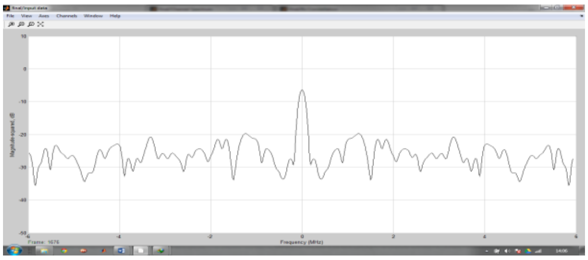

Figure 5. Input data.

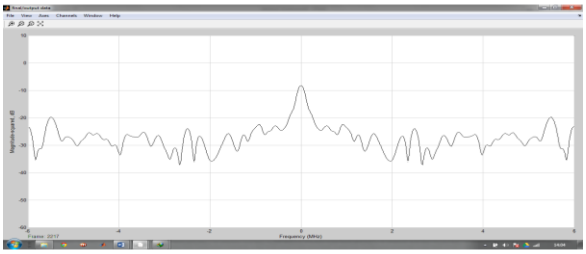

Figure 6. Output data.

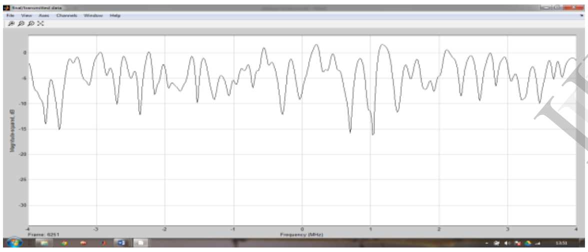

Figure 7. Transmitted signal

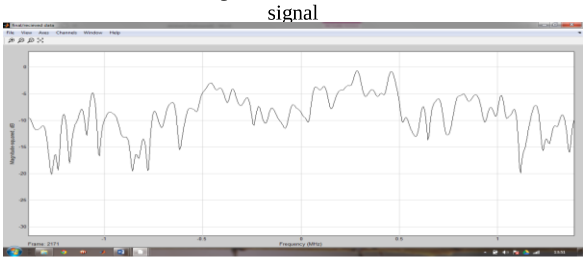

Figure 8. Received signal

IV. CONCLUSION

In this paper a novel method of discrete wavelet transform is used to transmit the signal through OFDM transmitter. The excellent orthogonality offered by DWT reduces complexity of the system, increases the rate of transmission, and uses the spectrum more efficiently. Simulation results of proposed Daubechies-DWT based OFDM show a very good SNR gain improvement and a BER performance as compared with conventional IFFT-OFDM, and FFT-OFDM in an AWGN channel. The proposed Daub-IDWT method has least sensitivity to variations of channel parameters. This work will further be continued for designing a Daub-IDWT multicarrier code division multiple access systems with improved SNR under the specific severe channel conditions.

REFERENCES

[1] M.SRINIVASA RAO, K.VENKATA TEJA, J.DURGA HARIKA, K.MURALI, B. RAM MOHAN “Reduction of Paper in OFDM System Using Haar Wavelet Based Approach”, International Journal of Engineering and Innovative Technology (IJEIT) Volume 3, Issue 7, January 2014.

[2] R.Bodhe, S. Narkhede, and S.Joshi, “DESIGN OF SIMULINK MODEL FOR OFDM AND COMPARISON OF FFTOFDM AND DWT-OFDM.,” International Journal of Engineering Science and Technology (IJEST) Vol. 4 No.05 May 2012.

[3] Hikmat N. Abdullah, Fadhil S. Hasan “Performance Evaluation of Complex Wavelet Packet Modulation (CWPM) System over Multipath Rayleigh Fading Channel ”, Journal of Signal and Information Processing, 2012, 3, 352-359

[4] S. D. Dissanayake, J. Armstrong ” Comparison of ACO-OFDM, DCO-OFDM and ADO-OFDM in IM/DD Systems ”, JOURNAL OF LIGHTWAVE TECHNOLOGY, VOL. 31, NO. 7, APRIL 1, 2013.

[5] Shaodan Ma and Tung-Sang Ng “ Semi-Blind Time-Domain Equalization for MIMO-OFDM Systems ”, IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, VOL. 57, NO. 4, JULY 2008.

[6] Saumya Tripathi, Abhinav Rastogi, Kapil Sachdeva, Mohit Sharma, Pankaj Sharma “PAPR Reduction in OFDM System using DWT with Non linear High Power Amplifier” International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-2,Issue-5,April2013

[7] R. W. Bauml, R. F. H. Fischer, and J. B. Huber, “Reducing the peak-to-average power ratio of multicarrier modulation by selected mapping,” Electron. Lett., vol. 32, pp. 2056–2057, Oct. 1996.

[8] A. J. Paulraj, D. A. Gore, R. U. Nabar, and H. Bolcskei, “An overview of MIMO communications—A key to gigabit wireless,” Proc. IEEE, vol. 92, no. 2, pp. 198–218, Feb. 2004.

[9] D. Gesbert, M. Shafi, D. Shiu, P. J. Smith, and A. Naguib, “From theory to practice: An overview of MIMO space-time coded wireless systems,” IEEE J. Sel. Areas Commun., vol. 21, no. 3, pp. 281–302, Apr. 2003

[10] J. H.Winters, J. Salz, and R. D. Gitlin, “The impact of antenna diversity on the capacity of wireless communication systems,” IEEE Trans. Commun., vol. 42, no. 2–4, pp. 1740–1751, Feb.–Apr. 1994.