Performance Improvement of OFDM System using Raised Cosine Windowing with Variable FFT Sizes

Prateek Nigam[1], Monika Sahu[2], Dr.Vijayshri Chaurasia[3]
[1]Department of Electronics and Communication Engineering
AISECT University
[2]Department of Electronics and Communication Engineering
RKDF Institute of Science and Technology
[3]Department of Electronics and Communication Engineering, MANIT, Bhopal

Abstract - Wireless OFDM system is second name of modern communication, and international channel interference (ICI) is need to be suppressed to make communication easier and less noisy. In this paper we are working to reduce the bit error rate (BER). Now to reduce BER we have proposed the raised cosine windowing in the OFDM system with variable FFT size and we have found that the performance of system increases significantly.

Keywords: OFDM, ICI, Raised Cosine Window, FFT & BER.

I. INTRODUCTION

Orthogonal Frequency Division Multiplexing is a special case of multi-carrier modulation and widely used in wireless communication system like wireless local area network and digital audio broadcasting (DAB). However one of the problems in OFDM systems is its sensitivity to phase offset and frequency offset caused by Doppler frequency drift and multipath fading [1]. In such situations, the orthogonality of the carriers is no longer maintained, which consequences in Intercarrier Interference (ICI). ICI results from the other sub-channels in the same data block of the same user. ICI problem will become more complicated when the multipath fading is present. If ICI is not properly reduced it results in power leakage among the subcarriers, thus degrading the system performance [2].

Some techniques are previously developed for reducing the effect of ICI: Frequency domain equalization but it only reduce the ICI caused by fading distortion which is not the major source of ICI [3]. Time Domain Windowing only reduce the ICI caused by band limited channel which is also not the major source of ICI. The major source of ICI in OFDM is its vulnerability to frequency offset errors between the transmitted and received signals, which may be caused by the Doppler shift in the channel or by the difference between the transmitter and receiver local oscillator frequencies.

II. OFDM SYSTEM DESCRIPTION

A basic OFDM system contains modulation method, serial to parallel transmission, parallel to serial transmission and IFFT/FFT [4]. Fig 1 illustrates the block diagram of OFDM scheme. The input data stream is changed into parallel data stream and mapped with modulation method. Then the symbols are mapped with inverse fast Fourier transform (IFFT) and converted to serial stream. The OFDM symbol is then transmitted through the channel.

To see how OFDM works, it is necessary to look at the receiver. As this acts as a bank of demodulators, translating every carrier down to DC. The consequential signal is integrated over the symbol period to regenerate the data from that carrier. The similar demodulator also demodulates the other carriers. Since the carrier spacing equal to the reciprocal of the symbol period means that they will have a whole number of cycles in the symbol period and their contribution will sum to zero - in other words there is no interference contribution.

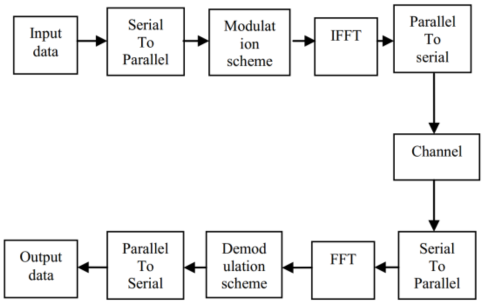

Fig. 1. OFDM Architecture

Serial to Parallel Conversion: In an OFDM system, each channel could be broken into various sub-carriers. Make the use of sub-carriers makes optimal use out of the frequency spectrum but also requires additional processing by the transmitter and receiver. This additional processing is essential to convert a serial bit stream into several parallel bit streams to be divided among the individual carriers. Once the bit stream has divided among the individual sub-carriers, every sub-carrier is modulated as if it was an individual channel before all channels are combined back together and transmitted as a whole. The receiver provides the reverse process to divide the incoming signal into appropriate sub-carriers and then demodulating these individually before reconstructing the original bit stream.

Modulation with the Inverse FFT: The modulation of data into a complex waveform occurs at the Inverse Fast Fourier Transform (IFFT) stage of the transmitter. At this time, the modulation scheme can be chosen completely independently of the specific channel being used and can be chosen based on the channel requirements. In detail, it is possible for each individual sub-carrier to use a different modulation scheme. The function of the IFFT is to modulate each sub-channel onto the appropriate carrier.

Cyclic Prefix Insertion: Because wireless communications systems are susceptible to multi-path channel reflections, a cyclic prefix is additional to decrease ISI. A cyclic prefix is a repetition of the first section of a symbol that is appended to the end of the symbol. Additionally, it is important because it enables multi-path representations of the original signal to fade so that they do not interfere with the subsequent symbol.

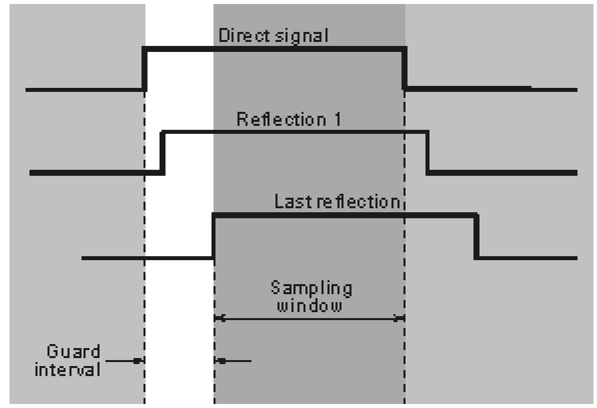

Fig. 2. Guard Interval

The data to be transmitted on an OFDM signal is spread across the carriers of the signal, every carrier taking part of the payload. This decreases the data rate taken by each carrier. The lower data rate has the benefit that interference from reflections is much less serious. This is achieved by addition a guard band time or guard interval into the system. This ensures data is only sampled when the signal is stable and no new delayed signals arrive that would alter the timing and phase of the signal.

The distribution of the data across a large number of carriers in the OFDM signal has some further advantages. Nulls cause by multi-path effects or interference on a given frequency only affect a small number of the carriers, the residual ones being received correctly. By using error-coding methods, which does mean adding further data to the transmitted signal, it enables several or all of the corrupted data to be reconstructed within the receiver. This could be done because the error correction code is transmitted in a different part of the signal.

III. PROPOSED METHODOLOGY

The proposed approach is for existing OFDM system is given below. Proposed methodology added the raised cosine windowing technique with variable FFT sizes which significantly reduces the interference in system. The block diagram is shown in fig. below with the flow chart of execution is algorithm for simulation of system.

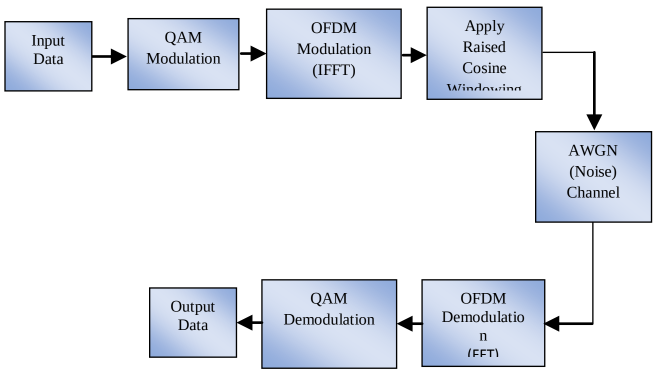

Fig. P.1 Block Diagram of Proposed Methodology

The block diagram shows the Proposed Methodology for OFDM Technique. The Cosine Window technique is used to minimize the error probability and BER is calculated with SNR.

As the above flow graph shows the whole procedure of Proposed Methodology in this firstly, we initialize the environmental variables then data has been generated 16 QAM Modulates then OFDM Technique is used after that cosine window with 512, 1024 & 2048. After that channel consider AWGN and vice versa

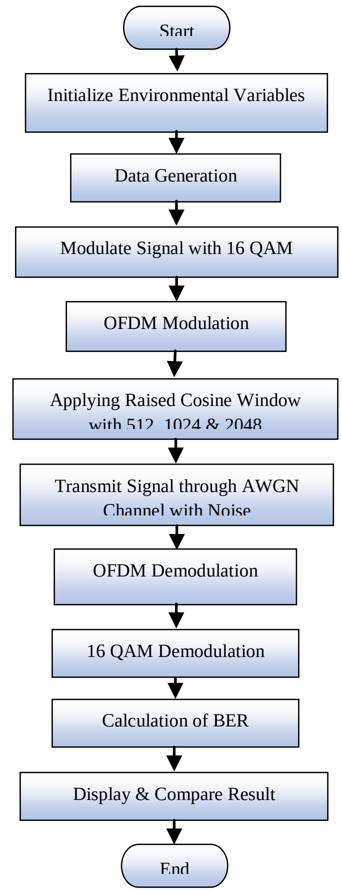

Fig. P.2 Flow chart of Proposed Methodology

IV. SIMULATION RESULTS

In this section, proposed simulations are conducted and to found out the results, shown below. In the proposed approach we have worked towards the reduction of inter channel interference(ICI).

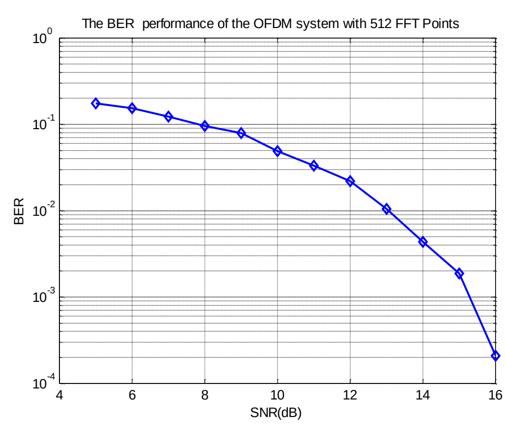

Fig. s.1. BER performance of the system with Raised Cosine Window with 512 FFT points

The complete simulation is performed with different FFT size and raised cosine window. By varying the FFT size the results also vary and increases with increase in FFT size. The simulation results are shown below.

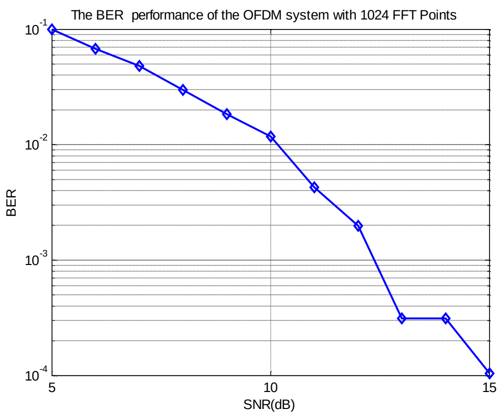

Fig. s.2. BER performance of the system with Raised Cosine Window with 1024 FFT points

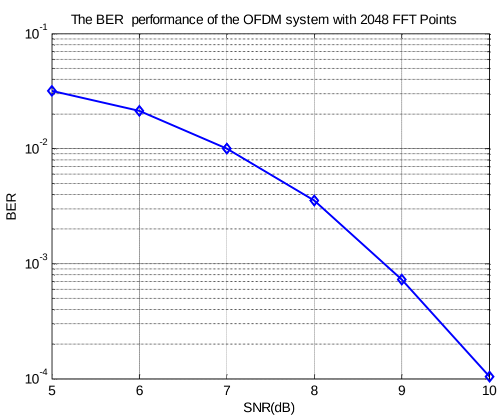

Fig. s.3. BER performance of the system with Raised Cosine Window with 2048 FFT points

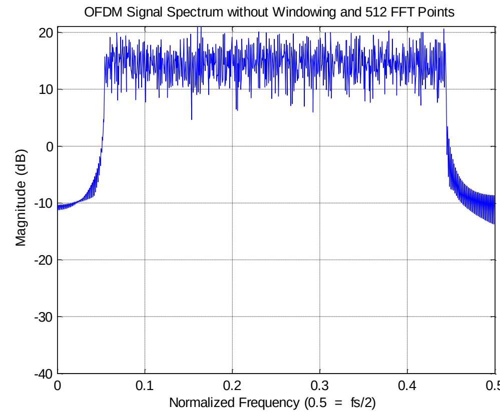

Fig. s.4. Signal Spectrum of the system without window with 512 FFT points

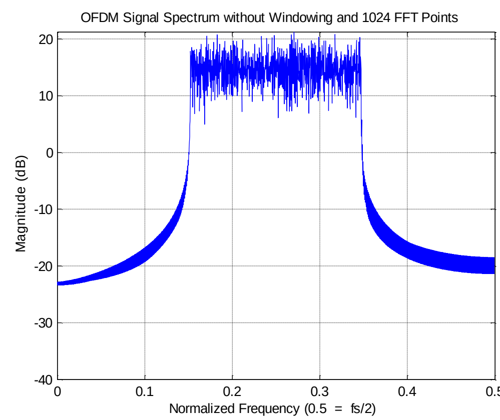

Fig. s.5. Signal Spectrum of the system without window with 1024 FFT points

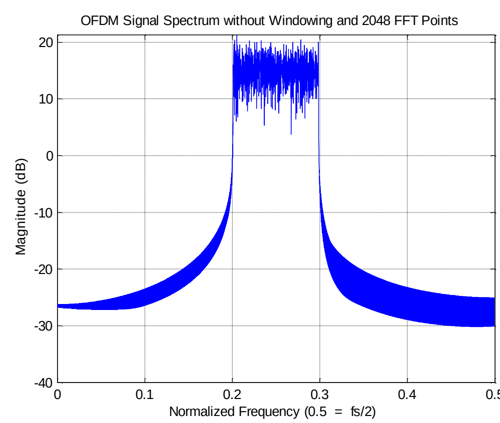

Fig. s.6 Signal Spectrum of the system without window with 2048 FFT points

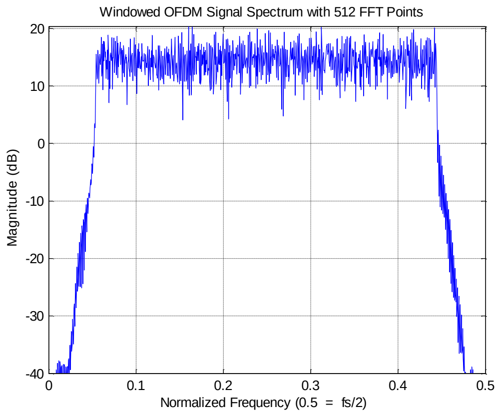

Fig. s.7. Signal Spectrum of the system with Raised Cosine Window with 512 FFT points

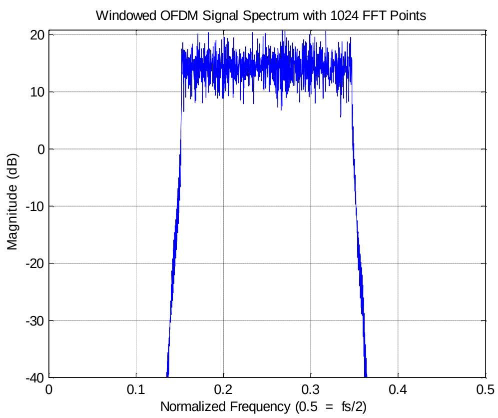

Fig. s.8. Signal Spectrum of the system with Raised Cosine Window with 1024 FFT points

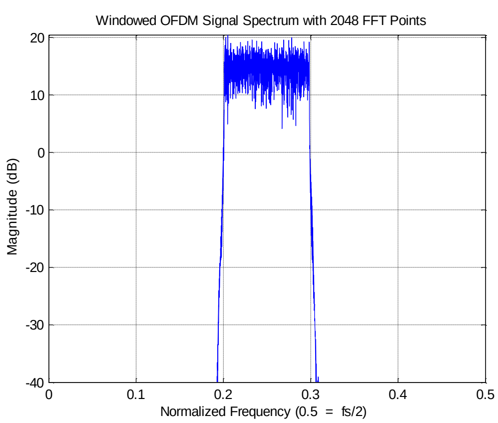

Fig. s.9. Signal Spectrum of the system with Raised Cosine Window with 2048 FFT points

V. CONCLUSION AND FUTURE SCOPES

As we seen in the proposed methodology section that OFDM wireless communication system is simulation with raised cosine window with different FFT lengths, and the outcome of the system in simulation results section has also displayed. Now here we can say that the existing system is perform better if we simulate the system with raised cosine window and it enhances if the FFT size increases. We have found that the system with raised cosine window and 2048 FFT size gives better results. In upcoming era of advancement the improvement in windowing techniques and faster processing devices system will perform more better than present.

REFERENCES

[1] NI, J. H., LIU, Z. M. “A joint ICI estimation and mitigation scheme for OFDM systems over fast fading channel”. In Proceedings of Global Mobile Congress, Shanghai (China), 2009, p. 1 – 6.

[2] HWANG, T., YANG, C.-Y., WU, G., et al. “OFDM and its wireless applications: a survey”. IEEE Transactions on Vehicular Technology, 2009, vol. 58, no. 4, p. 1673 – 1694.

[3] G. Y. Li and G. Stuber, “OFDM for Wireless Communications”. Springer, Inc., 2006.

[4] M. Russell and G. L. Stu¨ber, “Interchannel interference analysis of OFDM in a mobile environment,” in Proc. 1995 IEEE Veh. Tech. Conf., pp. 820–824.

[5] G. Y. Li and L. Cimini, “Bounds on the inter-channel interference of OFDM in time-varying impairments,” IEEE Trans. Wireless Commun., vol. 49, pp. 401–404, Mar. 2001.

[6] A. Stamoulis, S. Diggavi, and N. Al-Dhahir, “Intercarrier interference in MIMO OFDM,” IEEE Trans. Signal Process., vol. 50, pp. 2451–2464, Oct 2002.

[7] H.-C.Wu, “Analysis and characterization of Intercarrier and interblock interferences for wireless mobile OFDM systems,” IEEE Trans. Broad- cast., vol. 52, no. 2, pp. 203–210, Jun. 2006.

[8] M. Russell and G. L. Stüber, “Interchannel interference analysis of OFDM in a mobile environment,” in Proc. IEEE Veh. Technol. Conf., Jul. 1995, vol. 2, pp. 820–824.

[9] L. Yang, G. Ren, and Z. Qiu, “A novel Doppler frequency offset estimation method for DVB-T system in HST environment,” IEEE Trans. Broadcast., vol. 58, no. 1, pp. 139–143, Mar. 2012.

[10] Jun Ma, Philip V. Orlik, Member, Jinyun Zhang, and Geoffrey Ye Li, “Reduced-Rate OFDM Transmission for Inter-

Subchannel Interference Self-Cancellation over High-Mobility Fading Channels" IEEE Transactions On Wireless Communications, VOL. 11, NO. 6, JUNE 2012.

[11] Cheng TAO,Jiahui QIU,Liu LIU "A Novel OFDM Channel Estimation Algorithm with ICI Mitigation over Fast Fading Channels" Radio Engineering, Vol. 19, No. 2, June 2010 347.

[12] Erdal Panayırcı, Habib S ¸enol, and H. Vincent Poor, "Joint Channel Estimation, Equalization, and Data Detection for OFDM Systems in the Presence of Very High Mobility" IEEE Transactions On Signal Processing, Vol. 58, No. 8, August 2010 4225.

[13] Sili Lu, and Naofal Al-Dhahir, "Coherent and Differential ICI Cancellation for Mobile OFDM with Application to DVB-H" IEEE Transactions on Wireless Communications, Vol. 7, No. 7, July 2008 1.

[14] Sili Lu and Naofal Al-Dhahir, "Reduced-Complexity Hybrid Time/Frequency Channel Estimation for DVB-H" IEEE 2007.