Optimization of OFDM Systems and Reducing Bit Error Rate (BER) Using Smoothening Filter

Rajeev Kumar Yadav #1, Abhinav Shukla*2,

#Research Scholar, Department ECE , Vedica Institute of Technology, RKDF University Bhopal

*Professor, Department of Department ECE , Vedica Institute of Technology, RKDF University Bhopal Gandhinagar ,Airport Bypass Road, Bhopal (MP), India

[1]rajeevkumaryadav0123@gmail.com

[2] abhinav.shukla@hotmail.com

Abstract— *The wireless history of communication is trending, and the future will be wireless communication, which is expected to be much more advanced. Modern wireless communication systems are all equipped with OFDM technology and can be found almost anywhere. The high data rate in wireless technology is due to OFDM and the inclusion of other research being invented with hardware as well as soft computing techniques. Inter channel interference (ICI) is a barrier to achieving optimum system performance, and it must be reduced in order to develop efficient communication that is easier to maintain and less noisy. This paper proposes an efficient method for optimising OFDM systems and lowering bit error rates (BER). We have proposed raised cosine framebuffer with 16-QAM modulation to accomplish high data rate and less noise effect. The OFDM system was designed with multiple carriers with variable FFT size, as evidenced by simulation results that show improved performance over the previous system.*

Keywords — ***Multi Career OFDM, Raised Cosine Window, 16-QAM, ICI, FFT & BER.***

Introduction

I. Introduction

Future commercial and defence wireless systems will need to support higher data rates while remaining reliable in the face of spectrum constraints and multipath fading environments. Communication and control systems must be able to communicate reliably in the face of hostile jamming and other involvement without increasing emitted capacity or requiring a larger bandwidth. One of the most difficult challenges in wireless communication is operating in a time-varying multipath fading environment with limited power. Another issue is the limited availability of frequency spectrum..

Time, frequency, or space diversity could be abused to improve unwavering quality without increasing discharged power. The received signal is inspected at a higher rate in time diversity, yielding and over one example for each transmitted image. Similar data is sent over multiple carriers in frequency diversity [1]. Both diversity procedures necessitate more bandwidth. To take advantage of space diversity, similar information is transmitted or received via multiple antennas. Using distinct antennas at the receiver and transmitter enhance the effectiveness of a wireless communication link without increasing the transmitted power or bandwidth [2]. As a result, the design and implementation of Multiple Input Multiple Output (MIMO) communication methodologies is an appealing research topic.

The technique of orthogonal frequency division multiplexing (OFDM) is widely used in wireless communication frameworks. OFDM has been adopted by a few wireless communication benchmarks due to its adequacy in multipath channel conditions, such as the IEEE 802.11a neighbourhood (LAN) requirement and the IEEE 802.16a metropolitan region network (MAN) standard. The combination of OFDM and MIMO frameworks yields better results by adding greater diversity pick up to the standard OFDM frameworks, which use a single antenna at both the receiver and the transmitter. Multiple-Input Multiple-Input Multiple-Output (MIMO) antenna system are an example of spatial diversity. This framework achieves high data rates while not increasing total transmit power or bandwidth [5]. It is also observed that the use of multiple antennas at both the transmit and receive results in a significant increase in limit.

As shown in Fig 1.1 below, the communication process consists of five fundamental components: source data, transmitter, channel, receiver, and client data.

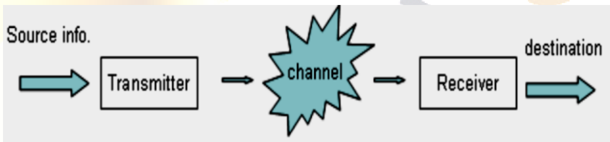

Figure 1.1 Basic elements of communication systems.

1. The information source:- sends out a message-carrying signal. The message could be in various forms, such as a simple frame, such as a sound signal, or a digital form, such as a bit stream from a computer. Typically, the message signal from the source is a baseband signal.
2. Transmitter: It works with message signals in some way to deliver a signal suitable for transmission to a receiving point over a specific channel. The transmitted signal is always significantly higher than the message signals' most extreme frequency segment.
3. Channel: A channel is a type of media that is utilised to transport a signal from the sending to the receiving end. During transmission, disturbance and various types of interfering signals are added to the signal.

4. 4. Receiver: It takes input and attempts to reconstruct the original signal from it, despite the fact that the signal is a mutated version of the transmitted signal.

5. Information user: This refers to the person or thing for whom the message is meant.

In the OFDM demodulator, fading distortion in the channel creates ICI. For demodulated data, the ICI pattern fluctuates from frame to frame, but it is invariant for all symbols inside a demodulated data frame. The problem of noise enhancement arises when compensating for fading distortion in the temporal domain. As a result, the frequency domain equalisation procedure is used to reduce ICI utilising appropriate equalisation techniques.

The frequency discrepancy between the transmitter and receiver, as well as the Doppler shift, are the primary causes of ICI. Because of multipath components, mobile communication networks are frequency selective fading in nature.

II. SYSTEM MODEL

The power range of an OFDM signal is wide. As a result, if this Signal is delivered via a band-limited channel, some bits of the Signal range will be shut out, resulting in inter-carrier interference. Examine the signal's range of transmission.

The spectrum of the signal wave form should be given more care in order to reduce interference. The Signal is windowed to achieve this. Fundamentally, windowing is a method of extending a fair capacity to the network.

signal wave frame that has been sent To get back the initial Signal, a similar window is used on the beneficiary side. If the window capacity result meets the Nyquist minimal symmetry measurement, the ICI is not required.

By obtaining the Inverse Discrete Fourier Transform (IDFT) of the sought recurring reaction, an underlying motive reaction is deduced in the windowing approach. An information window is then applied to the motivation reaction, which refines it.

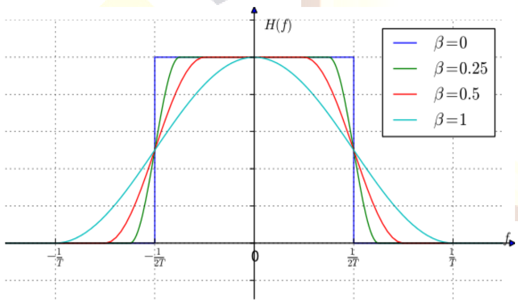

Figure 2.1 Raised-cosine filter

Because of its ability to minimise intersymbol interference, the raised-cosine filter is frequently used as a Smoothening Filter in digital modulation (ISI). It gets its derived from the fact that the non-zero fraction of the frequency spectrum in its most basic form (β=1) is a cosine function that has been 'raised' to sit just above f (horizontal) axis.

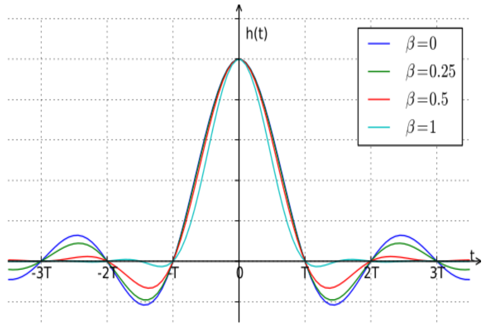

Figure 2.2 Impulse response of Smoothening Filter.

The elevated channel is an implementation of a low-pass Nyquist channel, i.e. one with minimal symmetry. This implies that its variety has odd symmetry around $\frac{1}{2T}$, where T is the communications system's symbol period.

Figure 2.2 Smoothening Filter Impulse Responses. Its frequency-domain representation is a piece - wise function.

As part of the increased with window effort, an increased cosine window is used. When beta is moved off factor, the side lobe of the OFDM range shrinks, resulting in increased cosine work. The drop in ICI is caused by the decrease in ICI control at the inside lobe level.

III. PROPOSED METHODOLOGY

The suggested work is based on the elevated cosine windowing system, which is used to optimise the performance of the OFDM system by eliminating the inter carrier interface ICI impact. The proposed system is divided into three sections, as shown in Figure 3. There is one transmitter, one receiver, and one AWGN.

A. Transmitter

In the transmitting end, there is indeed a 16 QAM modulator that modulates the input signal first, equivalent to any other OFDM system, but then there is a serial to parallel converter that converts the modulated signal in parallel before passing through into the IFFT modulation. A cyclic prefix is added to the IFFT modulated signal so that the recipient can quickly identify the start bit and end bit of the symbol. The Gaussian smoothing Filter is then applied to the ready-to-transmit signal.

B. Channel

Here between transmitter and receiver is an adaptive white Gaussian noise channel. Some noise levels are introduced into the signal as a result of the channel's fundamental properties.

C. Receiver

The receiver is the final destination. Signals are acquired at this terminal, and the input signal is converted from serial to parallel. FFT is used to demodulate an OFDM signal. Conversion from parallel to serial. Demodulate earned parallel to serial converted data using 16 QAM.

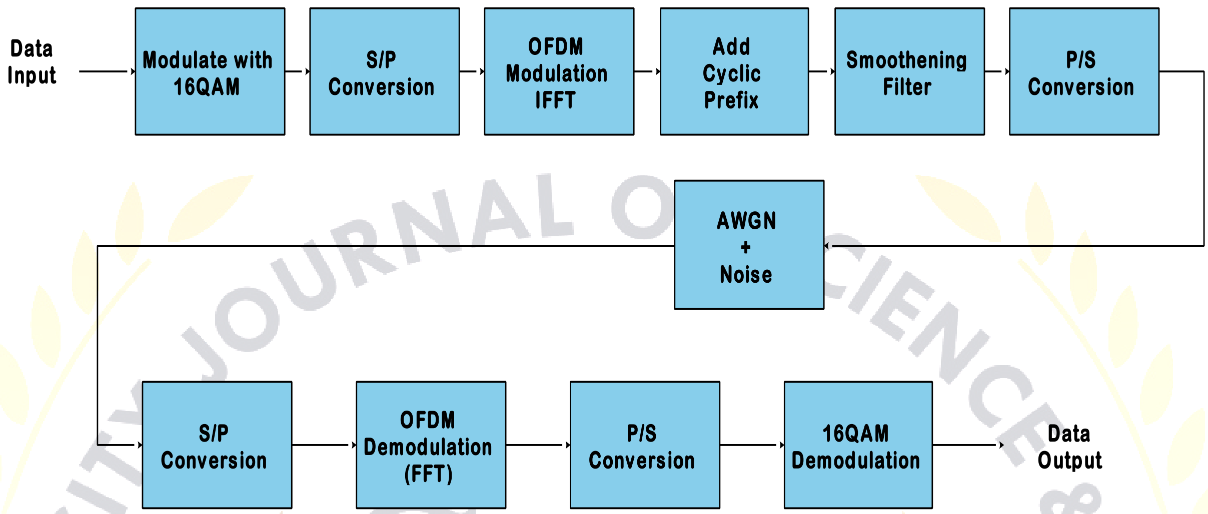

Figure 3.1 Block diagram of proposed system.

Step 1. Create Simulation Environment.

Step 2. FFT ($2^{11}/2^{12}/2^{13}$)

Step 3. SNR (0 to 10)

Step 4. Generate data to be transmitted over network.

Step 5. Modulate with 16-QAM

Step 6. Serial to Parallel Conversion

Step 7. OFDM Modulation(IFFT)

Step 8. Adding Cyclic Prefix

Step 9. Apply Smoothening Filter

Step 10. Prepare OFDM symbols per carrier.

Step 11. Parallel to Serial Conversion.

Step 12. Transmit signal through AWGN channel and Add noise.

Step 13. OFDM Symbol conversion

Step 14. OFDM Demodulation FFT

Step 15. Parallel to Serial Conversion.

Step 16. Demodulate with 16 QAM.

Step 17. Calculate Bit error Rate

Step 18. Calculate and Display results

IV. SIMULATION OUTCOMES

The simulation of the described earlier wireless communication system is carried out here. The simulation is carried out while keeping various parameters in mind, and it also aids in the analysis of the system. The suggested methodology's simulation results are compared with the previous results of the reference paper. The simulation graph depicts the bit - error characteristics for various signal-to-noise ratios (SNR). The characteristics that are changed to simulate the system are the number of symbols and carriers. The characteristics are compared with the original results for different FFT sizes of 1024, 4096, and 16384.

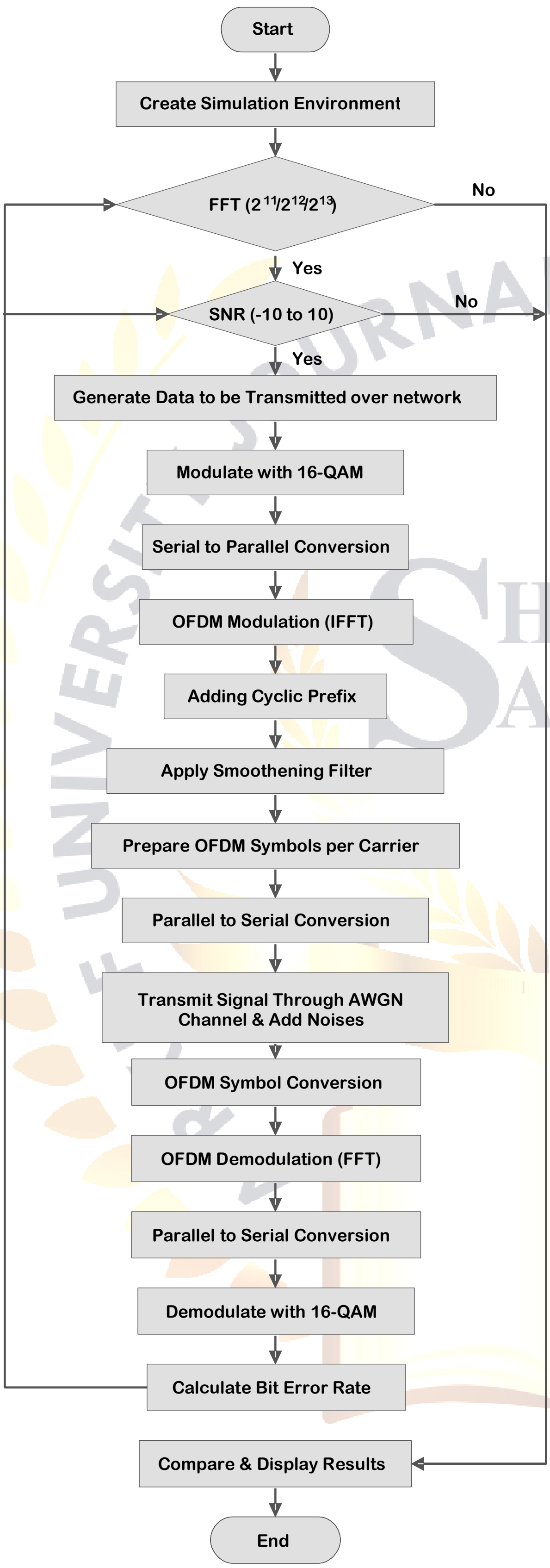

Figure 3.2 Flow chart of Proposed System

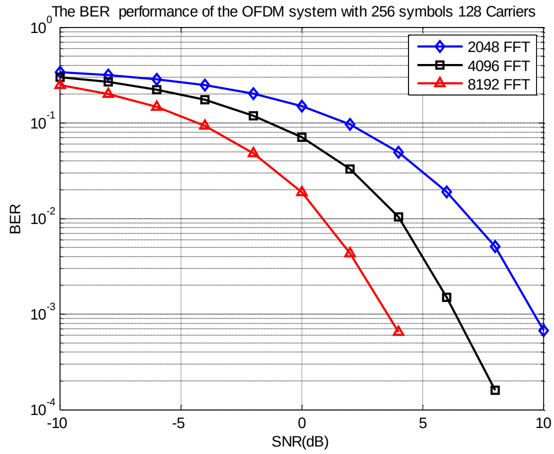

Fig. 4.1 Performance of Proposed System using 128 Carriers and 256 Symbols with Different FFT Sizes

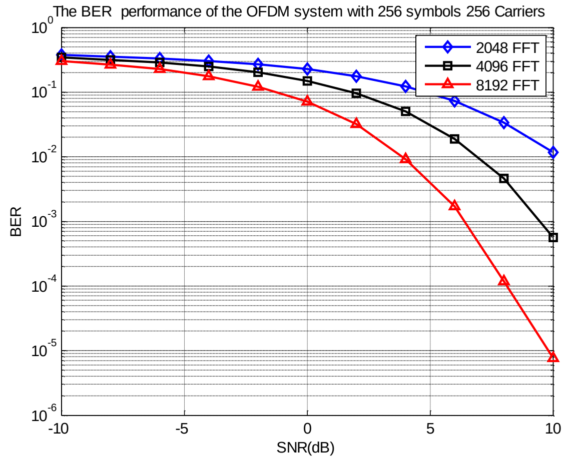

Fig. 4.1 Performance of Proposed System using 256 Carriers and 256 Symbols with Different FFT Sizes

V. CONCLUSION AND FUTURE SCOPE

The suggested system employs a signal smoothening filter, and the simulation results demonstrate that the proposed methodology works better with the system, generates less error, and consumes less power than past projects. The methodology also makes use of 16-QAM modulation, which is ideal for higher data rates and greater available bandwidth. In the future, the system could be outfitted with a better hybrid detection and filtering methodology to decrease error level and increased system reliability and stability.

The suggested ICI revocation signal smoothening filter method Utilizes the separability of the ICI coefficient system to completely eliminate ICI experienced OFDM structures and provide massive BER change that essentially coordinates the BER implementation of OFDM architectures without ICI by any means.

Further investigation on self ICI cancellation procedure for improving performance and Extended Kalman filter process can be supposed to apply under various channel situations including such Rayleigh fading channel, urban area channel, rural area channel, and so on.

REFERENCES (SIZE 10 & BOLD)

[1] Chang He, L. Zhang, J. Mao, Aijun Cao, P. Xiao and M. A. Imran, "Output SNR analysis and detection criteria for optimum DCT-based multicarrier system," 2016 International Symposium on Wireless Communication Systems (ISWCS), Poznan, 2016, pp. 59-64.

[2] A. Ijaz et al., "Enabling Massive IoT in 5G and Beyond Systems: PHY Radio Frame Design Considerations," in IEEE Access, vol. 4, no. , pp. 3322-3339, 2016.

[3] L. Zhang, A. Ijaz, P. Xiao, A. Quddus and R. Tafazolli, "Single-rate and multi-rate multi-service systems for next generation and beyond communications," 2016 IEEE 27th Annual International Symposium on Personal, Indoor, and Mobile Radio Communications (PIMRC), Valencia, 2016, pp. 1-6.).

[4] L. Wen, R. Razavi, M. A. Imran and P. Xiao, "Design of Joint Sparse Graph for OFDM System," in IEEE Transactions on Wireless Communications, vol. 14, no. 4, pp. 1823-1836, April 2015.

[5] X. Wang, T. Wild, F. Schaich and S. ten Brink, "Pilot-Aided Channel Estimation for Universal Filtered Multi-Carrier," 2015 IEEE 82nd Vehicular Technology Conference (VTC2015-Fall), Boston, MA, 2015, pp. 1-5.

[6] R. Razavi, P. Xiao and R. Tafazolli, "Information Theoretic Analysis of OFDM/OQAM with Utilized Intrinsic Interference," in IEEE Signal Processing Letters, vol. 22, no. 5, pp. 618-622, M

[7] L. Zhang, P. Xiao, A. Zafar, A. Quddus, and R. Tafazolli, "FBMC system: An insight analysis on double dispersive channel impact", IEEE Transactions on Vehicular Technology, 2016.

[8] M. Rodrigues and I. Darwazeh, "Fast OFDM: A proposal for doubling the data rate of OFDM schemes", IEEE/IEE International Conference on Telecommunications, 2002.

[9] W.H Chen, C. Smith, and S. Fralick, "A fast computational algorithm for the discrete cosine transform", IEEE Transactions on Communications, vol. 25, no. 9, pp. 1004-1009, Sep 1977.

[10] Zhongde Wang, "Fast algorithms for the discrete W transform and for the discrete fourier transform", IEEE Transactions on Acoustics, Speech, and Signal Processing, vol. 32, no. 4, pp. 803-816, Aug 1984.

[11] P. Tan and N. C. Beaulieu, "A comparison of DCT-based OFDM and DFT-based OFDM in frequency offset and fading channels", IEEE Transactions on Communications, pp. 2113-2125, Nov 2006.

[12] N. Al-Dhahir, H. Minn, and S. Satish, "Optimum DCT-based multicarrier transceivers for frequency-selective channels", IEEE Transactions on Communications, vol. 54, no. 4, pp. 760-760, April 2006.

[13] X. Ouyang and J. Zhao, "Single-tap equalization for fast OFDM signals under generic linear channels", IEEE Communications Letters, vol. 18, no. 8, pp. 1319-1322, Aug 2014.

[14] V. Sanchez, P. Garcia, A. M. Peinado, J. C. Segura, and A. J. Rubio, "Diagonalizing properties of the discrete cosine transforms", IEEE Transactions on Signal Processing, pp. 2631-2641, Nov 1995.

[15] J. Zhao and A. Ellis, "Transmission of 4-ASK optical fast OFDM with chromatic dispersion compensation", IEEE Photonics Technology Letters, vol. 24, no. 1, pp. 34-36, Jan 2012.