International Journal of Advanced Technology in Engineering and Science
Vol. No. 11, Issue No. 05, May 2023
www.ijates.com
ijates
ISSN 2348 - 7550

A Self Cancellation approach for Inter–Carrier signal conjunctions with OFDM environment

Kavitha BL

Sambhram Institute of Technology, Bangalor

Abstract

In this paper a survey on ICI Reduction Techniques in OFDM is presented. OFDM is also known as Multicarrier modulation technique and this OFDM system is very sensitive to carrier frequency offset which cause loss of orthogonality and amplitude reduction of OFDM signal and lead to Inter Carrier Interference(ICI),which is one of the major weakness of OFDM system. In this paper various ICI self-cancellation (ICI-SC) techniques to minimize ICI are studied and reviewed. In this paper the transmitters implement the algorithm pair wise data modulation, windowing, data extension or ISI-free cyclic prefix (CP) .

Index Terms :*Inter Carrier Interference, cyclic prefix*

I. INTRODUCTION

OFDM is a special form of multicarrier modulation technique which is used to generate waveforms that are mutually orthogonal and then distributes the data over a large number of carriers that are spaced apart at precise frequencies. This spacing provides the "orthogonality" in this technique which prevents the demodulators from seeing frequencies other than their own. OFDM is a promising candidate for achieving high data rates in mobile environment because of its multicarrier modulation technique and ability to convert a frequency selective fading channel into several nearly flat fading channels. OFDM technology has been chosen as the transmission method of many standards, such as Digital Subscriber Line (DSL), European Digital Audio and Video Broadcasting terrestrial (DAB/DVB-T), European HIPERLAN/2 and IEEE 802.11 a/g for wireless local area networks (WLAN), Worldwide Interoperability for Microwave Access (WiMAX), etc. The OFDM eliminates the ISI but the sensitive to frequency offset errors due to Doppler shift of the mobile radio channels, mismatch of the local oscillator of the transmitter and the receiver. The more deviation in the carrier frequency will violate the orthogonality between the subcarriers which give rise to ICI which degrades the system performance.

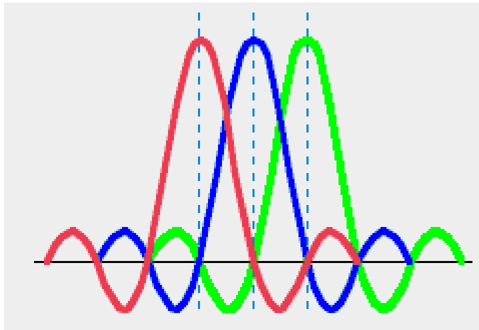

Fig.1 depicts: Frequency Spectrum of OFDM

Transmission. If two signals are said to be orthogonal then their dot product is zero. As the subcarriers are orthogonal then the spectrum of each subcarrier has a null at the centre frequency of the other subcarrier in the system.

The OFDM eliminates the ISI but it is more sensitive to frequency offset errors due to Doppler shift of the mobile radio channels, mismatch of the local oscillator of the transmitter and the receiver. The more deviation in the carrier frequency will violate the orthogonality between the subcarriers which give rise to ICI which degrades the system performance

This paper discusses all the prominent ICI reduction technique described above. The rest paper is organized as follow section II. Discusses OFDM system model and ICI .section III describes various ICI reduction techniques and in section IV conclusion is given.

II. OFDM SYSTEM MODEL

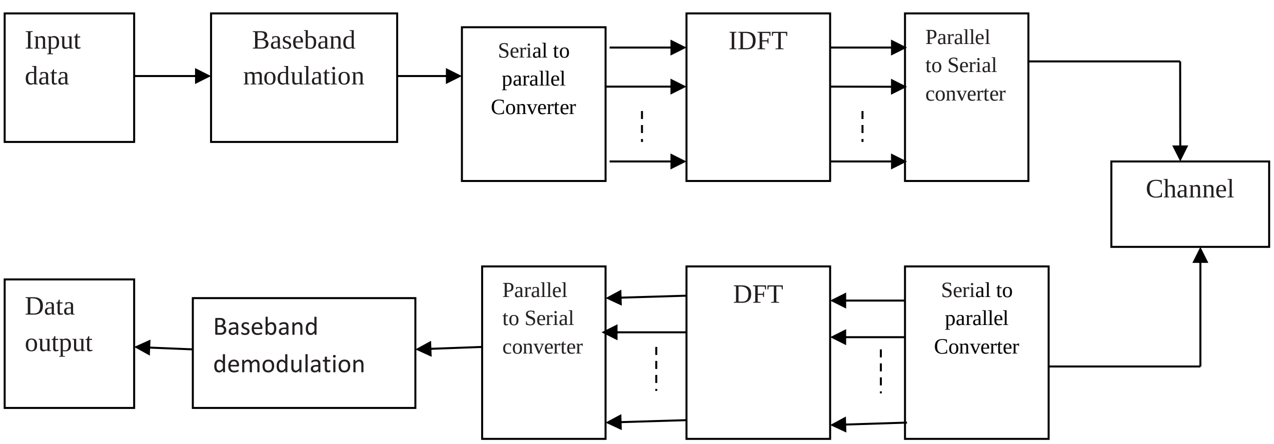

Fig 2: Block Diagram of FFT Based OFDM Syste

Fig.2 depicts the block diagram of FFT based OFDM system. The basic OFDM model consists of the input data from the data source is modulated by using any modulation technique e.g., BPSK ,16 QAM etc. The modulated serial data is converted to parallel data using a serial to parallel converter. The frequencies selected are orthogonal frequencies. In this block, orthogonality in subcarriers is introduced. In IFFT, the frequency domain OFDM symbols are converted into time domain OFDM symbols. Guard interval is introduced in each OFDM symbol to eliminate inter symbol interference (ISI) and converted to serial stream. The complete OFDM symbol is transmitted through the channe On receiver side this symbol are converted back to parallel stream and mapped with FFT then with demodulation scheme and converted to serial data as output data.

III ICI (INTER CARRIER INTERFERENCE) REDUCTION METHOD

Various methods are introduced to reduce the ICI for the OFDM system ICI selfcancellation and the ICI mitigation. The different ICI selfcancellation techniques are pair wise data modulation, data extension, windowing and ISI free cyclic prefix.

3. 1: ICI SELF CANCELLATION USING PAIR-WISE DATA MODULATION

In this analysis considers only the impairments due to carrier frequency offset. Frequency offset alone does not cause intersymbol interference (ISI).

Often a cyclic prefix is used in OFDM to eliminate the ISI and ICI caused by errors in sampling time or distortion in the channel. This use of a cyclic prefix is not considered in this analysis.[2],[3].

The method maps the data to be transmitted onto adjacent pairs of subcarriers rather than onto single subcarriers,so that $a_{o,i}=-a_{1,i}, a_{2,i}=-a_{3,i},....a_{N-2,i}=-a_{N-1,i}$

This results in cancellation of most of the ICI in the values z0,i...........$z_{N-1,i.}$

For example, the decoded value for the zeroth carrier is given by

$$z0i = exp(j\theta 0)\{(c0 - c1)a0.i + (c2 - c3)a2,i + \cdots .+(cN - 2 - c_N - 1)aN - 2, i\}$$

The ICI now depends on the difference between the adjacent weighting coefficients rather than on the coefficients themselves. As the difference between adjacent coefficients is small, this results in substantial reduction in ICI. If adjacent coefficients were equal, then the ICI would be completely cancelled. Thus this process can be considered as cancelling out the component of ICI which is constant between adjacent pairs of coefficients. ICI cancellation depends only on the coefficients being slowly varying functions of offset. It does not depend on the absolute values of the coefficients and so improves the performance for any frequency offset.

3. 2 ICI SELF CANCELLATION USING WINDOWING

Basically windowing is the process of multiplying a suitable function to the transmitted signal wave form. Thesame window is used in the receiver side to get back the original signa[4]l. The ICI will be eliminated if the product of thewindow functions satisfies the Nyquist vestigial symmetry criterion. It can only reduce the ICI caused by band limited channel which is not the major source of ICI.The above method cannot address to it.

Windowing is done frame by frame & hence it reduces the spectral efficiency to a large extent. Hence the method is not effective one. Many kinds of windows are there rectangular window, Hannimg , Hamming, Blackmann Windows

$$D(\phi) \equiv \mathcal{F}\{\theta^{\text{rec}}\} = \sum_{n=-\infty} \theta^{\text{rec}}(n) e^{-j\phi n}$$
$$= e^{j\left(\frac{N-1}{2}\right)\phi} \left(\frac{\sin \frac{N\phi}{2}}{\sin \frac{\phi}{2}} \right), \ \phi \in \mathcal{R}.$$

A N-point rectangle window is defined as $\theta_{rec}(n) = 1$, $0 \leq n \leq N-1$ and $\theta_{rec}(n) = 0$, else. The Dirichlet kernel, which defines the DTFT of the rectangle window.

Dual-window technique to reduce the signal degradation due to the existent of subcarrier frequency offset in orthogonal frequency-division multiplexing (OFDM) system. Here the tow pulse shaping windows are used after the IDFT block for even numbers and the number of co-efficient of subcarrier N. The receiver selects the even number and the odd number of subcarriers through their corresponding windows which are possessed of both window-matching and anti-matching functions without any additional bandwidth efficiency consumption [6].

3.3 ICI SELF CANCELLATION USING ISI FREE CYCLIC PREFIX

The ISI-free part of the CP is linearly combined with its corresponding part in the OFDM signal to suppress the ICI power The ICI self-cancelation scheme and proved that if the length of a CP is extended long enough so that the length of ISI free samples in the CP is equal to the length of the OFDM symbol, the ICI effect can be completely removed with linear time-varying channel assumption.[7][9].

The N-point inverse FFT Type equation here.(IFFT) output can be expressed as

$$x_t(n) = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} x_F(k) e^{j\frac{2\pi kn}{N}}, \qquad n = 0, 1, \ldots, N-1. \tag{1}$$

To combat ISI, a CP is inserted before transmission. After the CP insertion, the equivalent baseband time-domain

Transmitted signal $\check{x}_t(n)$ can be expressed as

$\check{x}_t(n)=x_t((n)_N)$, $-N_g \leq n \leq -1$ ....(2)

where Ng is the length of the CP. We further assume that the length of the CP is relatively longer than the maximum delay spread, and there are q samples in the CP that are not affected by the ISI, i.e., q Ng − L + 1. The interval [−q, −1] is commonly known as the ISI-free region.

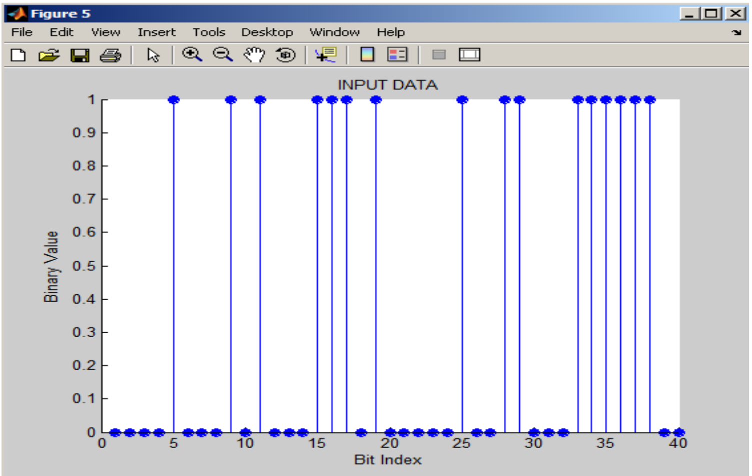

Fig-3: Input Values From The RGB Converted Data

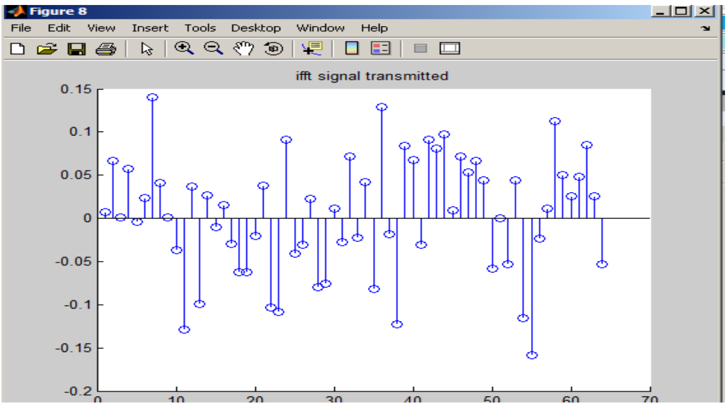

Fig-4:The OFDM input

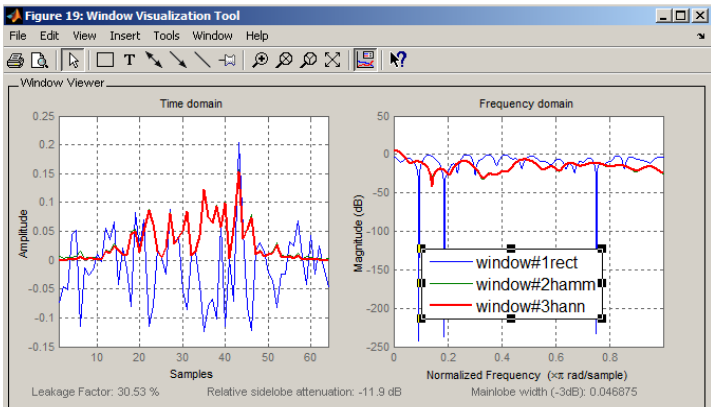

Fig-5:The Cosine Windowing Output In Time-domain And Frequency Domain Of 64 QAM.

International Journal of Advanced Technology in Engineering and Science
Vol. No. 11, Issue No. 05, May 2023
www.ijates.com
ijates
ISSN 2348 - 7550

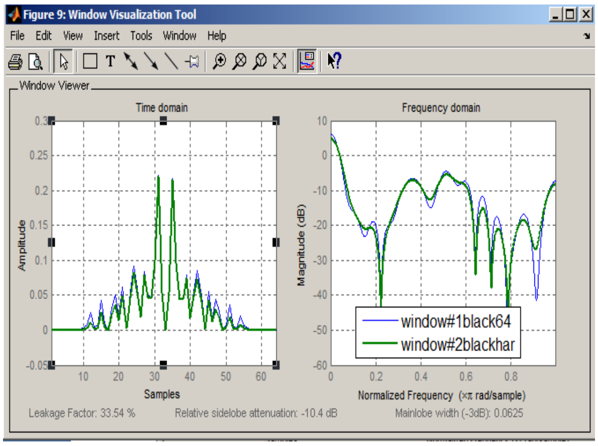

Fig-6:The Cosine Windowing Output In Time-domain And Frequency Domain Using Blackmann And Black-Harris Window Of 64 QAM

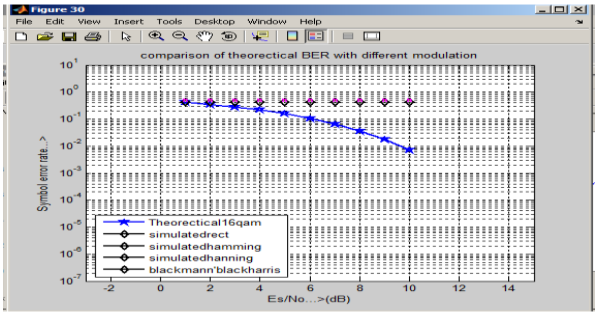

Fig-7:Symbol Error Rate Of 16-QAM.

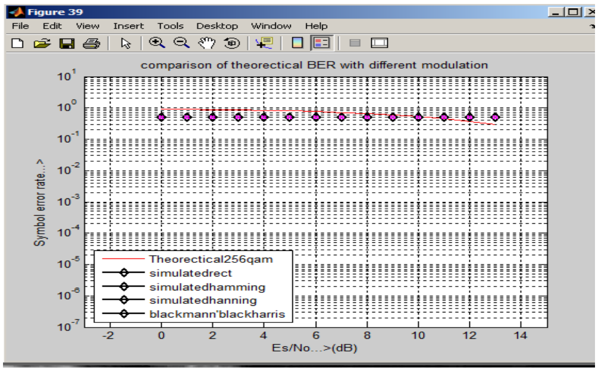

FIG: 8 Symbol Error Rate Of 256-QAM

IV CONCLUTION

In this paper, it has been concluded that ICI is the main problem which minimizes the performance of the OFDM systems. To cancel the effect of ICI in OFDM systems different ICI self-cancellation techniques like data modulation, data extension, windowing and ISI free cyclic prefix. The other advantage is that they can combat the impact of frequency offset at low frequency offsets. In addition, no channel estimation is needed for reducing ICI.

REFERENCES

[1] Z. Wang and G. Giannakis, "Wireless multicarrier communications," IEEE Signal Process. Mag.,vol.17,no.3, pp.29–48,May2000.

[2] J. Armstrong, "Analysis of new and existing methods of reducing intercarrier interference due to carrier frequency offset in OFDM," IEEE Trans. C o mmun .,vol. 47, no. 3, pp. 365–369, Mar. 1999.

[3]Y. Zhao and S.-G. Haggman, "Intercarrier interference self-cancellation scheme for OFDM mobile communication systems," IEEE Trans. C o mm u n ., vol. 49, no. 7, pp. 1185–1191, Jul. 2001.

[4] A. Seyedi and G. Saulnier, "General ICI self-cancellation scheme for OFDM systems," IEEE Trans. Veh. Technol., vol. 54, no. 1, pp. 198–210, Jan. 2005.

[5] M.-J. Hao, "Decision feedback frequency offset estimation and tracking for general ICI self-cancellation based OFDM systems," IEEE Trans. Broadcast., vol. 53, no. 2, pp. 560–566, Jun. 2007.

[6] M. Ma, B. Jiao, and W. C. Y. Lee, "A dual-window technique for enhancing robustness of OFDM against frequency offset," IEEE Commun. Lett., vol. 12, no. 1pp.17–19,Jan.2008.

[7] M.-X. Chang, "A novel algorithm of inter-subchannel interference selfcancellation for OFDM systems," IEEE Trans. Wireless C ommun., vol. 6, no. 8,pp.2881–2893,Aug.2007.

[8] J. Ma, P. Orlik, J. Zhang, and G. Li, "Reduced-rate OFDM transmission for inter-subchannel interference self-cancellation over high-mobility fading channels," IEEE Trans. Wireless C ommun., vol. 11, no. 6, pp. 2013–2023,Jun.2012.

[9] C.-Y. Ma, S.-W. Liu, and C.-C. Huang, "Low-complexity ICI suppression methods utilizing cyclic prefix for OFDM systems in high-mobility fading channels," IEEE Trans. Veh. Technol., vol. 63, no. 2, pp. 718–730, Feb. 2014.

Kavitha BL received the Bachelor of Engineering degree from SJC Institute of Technology in the stream of Electronics and Communication Engineering, chikaballapur in 2011. Currently,s h e is persuing M.Tech in the stream of digital electronics and communication in Sambhram Institute of Technology.