ISSN:0974-5823 Vol. 6 No.3 December, 2021

International Journal of Mechanical Engineering

INVESTIGATION ON A BIT ERROR RATE BASED OFDM SYSTEM

Dr Purnima K Sharma
Department of ECE Associate Professor Sri Vasavi Engineering College(A)
purnima.kadali@gmail.com
Dr Udara Yedukondalu
Associate Professor Department of ECE Sri Vasavi Engineering College (A)
Tadepalligudem-534101, A. P, India
drykudara@gmail.com.
Dr V Vijayasri Bolisetty
Associate Professor Aditya College of Engineering & Technology Surampalem - 533437AP. India
vasudha.tweety@gmail.com

Abstract
Although tremendous research has conducted on high speed communications but still number of research works which are reported in literature are fails to meet the real time requirement. The main drawbacks in the conventional communication techniques are low spectral efficiency, lack of high rate, interferences, etc. The OFDM communication model overcomes the drawbacks of conventional communicational model and offers the high data rate, and high spectral efficiency. Compared to conventional approaches the 4th generation Long term evolution application has better spectral efficiency in terms of accuracy and high data rate, the4th generation Long term evolution approach is formed by the collaboration of OFDM and MIMO. Although OFDM has many advantages over FDM but it suffers from inter carrier interference and inter symbol interference when multiple carriers are used and due to this interferences loss of Orthogonality happens, in order to overcome these interferences usage of cyclic prefix has became mandatory. But usage of cyclic prefix shows huge negative impact on bandwidth efficiency as the cyclic prefix approach consumes nearly 20% of bandwidth and BER performance too affected. In this paper a novel wavelet based OFDM model is presented which is mainly intended to provide good Orthogonality and better spectral efficiency using various modulation techniques, the unique thing in the usage of wavelet based OFDM is it does not need any spectral efficiency and absence of the cyclic prefix increases bandwidth efficiency when bandwidth increases simultaneously spectral efficiency increases. Finally the usage of the wavelet based OFDM shows improved BER over conventional FDM communication model. The simulation results indicates the usage of wavelet based OFDM in place of DFT based OFDM in LTE and finally the comparison between wavelet based OFDM and DFT based OFDM.

1. INTRODUCTION

Basic concept of OFDM is the orthogonality principle. Orthogonality principle can be explained that any two vectors must be linearly independent from each other. Here the subcarriers must be orthogonal to each other. This means that even if waveforms overlap, the orthogonality ensures zero interference. An overlap of sub carriers is seen in frequency domain of sub carriers; hence we don't have ICI in the band efficiency [2][5][7] OFDM is a digital modulation technique which uses multiple carriers, that use abundant tightly spaced orthogonal subcarriers. Initial data is sent inform of a single stream which is then converted to parallel form [3]. The parallel data or small chunks of data is then coded and then modulated on to a sub-carrier. These sub-carriers are modulated using any modulation schemes, usually qudrature amplitude modulation. These subcarriers are modulated at a low symbol rate maintaining same data rates similar to convention single carrier modulation scheme for same bandwidth. This is the reason we observe lower bit rates on sub carrier compared to single carrier. This modulated data is transmitted on multifading channels such as Rayleigh fading channel. In this Project, we use Additive White Gaussian Noise (AWGN) channel. Conventionally, OFDM uses fast Fourier transform for generation and detection. Wavelet Transform seems to have the potential to replace DFT. Using Wavelet transform we can have time-frequency localization. Wavelet transform is able to provide the time as well as the frequency information simultaneously, hence it gives us a time-frequency representation of the signal. Wavelet transforms works almost same as Short-time Fourier transform (STFT) to find the unknown data in particular bandwidth. The problem with STFT is that the window size is fixed for all the data. The problem arises when we take a window size less than that the interested Bandwidth, we cannot completely find out the information from that signal. This is where Wavelet Transform comes in. Wavelet Transform provides us with a variable window size. The advantage of this is we can extract any large chunks of data. Because of this variable size, the resolution of time frequency signals is improved [4]. Wavelet Transform can be briefly described as follows. On passing the time domain signal through several high pass and the low pass filters, which results in either a high frequency or a low frequency signal. This entire process is repeated several times every single time a small part of a signal related to its respective frequency will be removed. This is how it works, on considering a frequency of a signal to be in the range between 1000 Hz. This 1000Hz signal is passed through high pass and low pass filters and divided into two parts. Outputs of this level is a signal with 0-500Hz frequency range and the other part with 500-1000 Hz. The same process is repeated for both signals and further The higher data speed requirement is increasing in exponential

manner, due to easy availability of smart phones [1], with inexpensive cost and social websites. Continuous improvement in wireless data rate is in demand. Long Term Evolution-Advanced (LTE-A) is the ultimate solution for wireless broadband services. LTE Advanced commonly known as 4G wireless networks and it is an evolution of a LTE Rel-8. IMT-Advanced(International Mobile Telecommunication-Advanced) is related to a family of mobile wireless technologies, known as 4G.Spectrum efficiency and flexible utilization of spectrum is highly required today for different wireless communication related applications. In multicarrier communication the main idea is to divide the data into several streams and using them to modulate different carriers. The two main advantages of multicarrier communication are, first one is there is no requirement of signal enhancement for noise which is required in single carrier because of the equalizers and second is because of long symbol duration reduced effect of fading [2]. The wavelet-based system achieves orthogonality through the use of orthogonal wavelet filters, also referred to as filter banks. The DWT produces narrow side lobes with large power spectral density. No cyclic prefix insertion is required, which can save up to 25% of the bandwidth making wavelet based multicarrier systems more bandwidth efficient and enabling improved BER performance. The wavelet transform represents signals jointly in the time and frequency domains, using multi-resolution analysis. This property of wavelets also makes them suitable for treating signals with exotic spectral properties, for example signals that have time dependent spectral properties.Data of the user is carried parallel on each sub-carrier at a low rate. The combination of the parallel sub-carriers at the destination provide for the high data rates. Since the sub-carriers transmit data at a low rate and thus higher symbol time it is more durable to multipath effects, so this makes more suitable for wide-area non-line of Sight wireless access and also, the use of overlapping orthogonal sub-carriers without guard bands make it more capable than FDM scheme. OFDM resembles CDMA in that it is also a spread-spectrum expertise in which energy generated at a particular bandwidth is spread across a wider bandwidth making it more durable to intrusion and ”jamming”. Multiple Input Multiple Output (MIMO) is one of the most popular Advanced Antenna Technologies which is used in LTE and Ultra Mobile broadband(UMB). The attractive feature of MIMO is, it offers good throughput. The transmitter and receiver have multiple antennas in MIMO giving multiple flavors based on the number of antennas present on both sides.

In olden days people used to communicate with distant counterparts by make usage of traditional approaches like sending the information with birds, sending people as ambassador to convey the information. Most of the researchers termed 21stcentury as Communication arena due to the high end technological advancement in this area which makes communication fast and reliable. The intense research classified communication into two categories a) wire based communication b) wireless based communications. Wire based communications is considered as most useful tool in world wars to convey information from one end to another in1940’s and optical fiber plays a crucial role in wire based communication mechanism and after completion of war the dominance of United States of America (USA) and Union of Soviet Socialist Republics (USSR) over the world makes the research on communication so fast that in two decades communication research grows from daily life communication to satellite communication and this development mainly because of wireless communication.

2. RELATED CONTENT

2.1 OFDM and its Orthogonality

In orthogonal frequency division multiplexing communication model, the sub carrier used are orthogonal to each other. The Orthogonality helps in employing the overlapping between the sub carriers in the respective frequency domain. The accuracy of communication model is based on how effective the bandwidth is used and this is technically termed as spectral efficiency or bandwidth efficiency, the acquired bandwidth efficiency is free of Inter carrier interference and the absence of Inter carrier interference (ICI) is mainly because of usage of Orthogonality in orthogonal frequency division multiplexing.

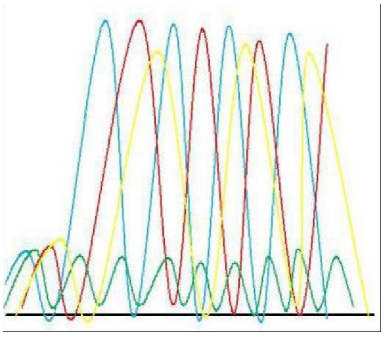

Figure 1: Orthogonality in orthogonal frequency division multiplexing (OFDM)

2.2 Basic OFDM System

The orthogonal frequency division multiplexing block diagram is illustrated as follows in figure 2. The input random signal data rate streams (high) are converted into data rate streams (low). The important aspect in the OFDM block diagram is the modulation technique which modulates the low data rate streams in parallel way and this parallel stream given input to the IFFT block which transforms the frequency data to time data before it reaches the channel. Adding the cyclic prefix acts as the guard interval and the reverse of transmission is accomplished at receiver end.

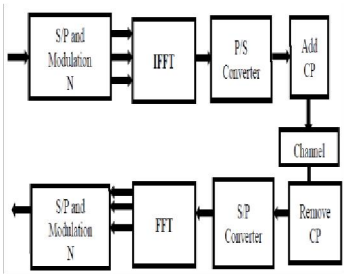

Figure 2: Block diagram of Basic OFDM system

2.3 MIMO OFDM System

The below block diagram represents the MIMO-OFDM system which comprises of transmitters and receivers in multiple way.

The input data (digital) is generated by binary source generator as shown in below figure and the binary data is modulated with modulation approach such as BPSK, QPSK and QAM with several different constellations. The serial to parallel performs the task to convert the serial data to the parallel mode in N various sub streams. Then these various sub streams are modulated through the IFFT modulation block. The IFFT block in the block diagram in design to transform the frequency to time domain for obtaining the delay related issues at the channel and then guard interval named CP is inserted to tackle the issues like ICI/ISI. The OFDM symbols are initialized in the time domain which has specified length before giving it to the channel then the operation is performed in the inverse direction to remove all the operations which are performed and gets the output as OFDM signal in MIMO format.

3. PROPOSED METHOD

Wavelet Transform is an significant mathematical function, because as a tool for multi resolution dissolution of continuous time signal by different times and frequencies. In wavelet transform, higher frequencies are sophisticated decided in time, as well as lesser frequencies are better decided in frequency. Happening this intellect, the signal remains reproduced through an orthogonal wavelet intention, in growth the transform is calculated alone changed parts of the time domain signal. The wavelet transform can be classified as two categories, continuous ripple transform and discrete ripple transform. The Discrete Ripple Transform could be observed by way of sub-band coding. The signal is analyzed and it accepted over a filter bank succession. A sub-band coding method is defined as full-band source signal is spitted into distorted frequency bands as well as encrypt every band separately established on their spectrum energy. The sub-band coding methodology learning starts from the digital filter bank method; it can be defined as a set of filters with has distorted centre frequencies. Double channel filter bank is mostly used in growth the effective way to tool the discrete ripple transform. Generally, the filter bank plan has double steps which are used in signal transmission scheme. proposed Method Wavelet Transform is an significant mathematical function, because as a tool for multi resolution dissolution of continuous time signal by different times and frequencies.

In wavelet transform, higher frequencies are sophisticated decided in time, as well as lesser frequencies are better decided in frequency. Happening this intellect, the signal remains reproduced through an orthogonal wavelet intention ,in growth the transform is calculated alone changed parts of the time domain signal. The wavelet transform can be classified as two categories, continuous ripple transform and discrete ripple transform. The Discrete Ripple Transform could be observed by way of sub-band coding. The signal is analyzed and it accepted over a filter bank succession. A sub-band coding method is defined as full-band source signal is spitted into distorted frequency bands as well as encrypt every band separately established on their spectrum energy. The sub-band coding methodology learning starts from the digital filter bank method; it can be defined as a set of filters with has distorted centre frequencies. Double channel filter bank is mostly used in growth the effective way to tool the discrete ripple transform. Generally, the filter bank plan has double steps which are used in signal transmission scheme.

RESULTS AND DISCUSSIONS

Fig. 3 shows the MMSE/LS schematic view of previous work, implemented on Mat lab, done by K. Murali, M. Sucharitha, T. Jahnavi, N. Poornima, and P. Krishna Silpa [1]. In this work Least Square Error (LSE) and Minimum Mean Square Error (MMSE) algorithms are used to time varying analysis of channel estimation methods in OFDM.

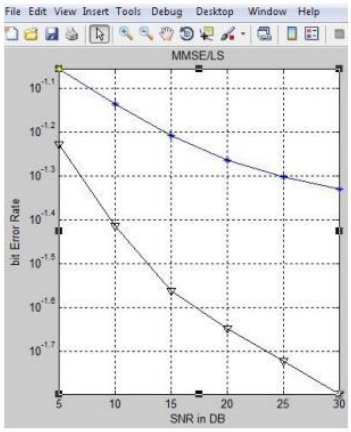

Fig 3: MMSE/LS graph for bit error rate of previous work, implemented in Mat lab.

Table 1. Analysis of bit error rate based on previous LSE and MMSE algorithm

Type of estimation	SNR (in dB)	BER
LSE	5	0.08477
	10	0.07336
	15	0.06195
	20	0.05458
	25	0.04992
	30	0.04669
MMSE	5	0.05923
	10	0.03847
	15	0.02744
	20	0.02248
	25	0.01891
	30	0.01592

Table 1 shows the bit error rate (BER) analysis with channel estimation in OFDM wireless communication system using Least Square Error (LSE) and Minimum Mean Square Error (MMSE) algorithm of previous work

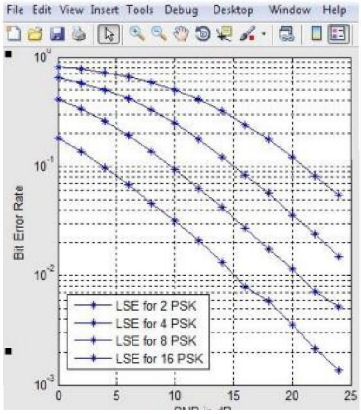

Fig 4: PSK in LSE graph for bit error rate of proposed work, implemented in Mat lab.

Fig. 4 shows the Least Square Error (LSE) for Phase Shift Keying (PSK) schematic view of proposed work, implemented on Mat lab. In this work, Phase Shift Keying (PSK) is used to evaluate and estimate the bit error rate with channel estimation at different value of M (modulation alphabet)

Table 2. Analysis of bit error rate based on proposed PSK in LSE algorithm

SNR (In dB)	Bit Error Rate			
	2 PSK	4 PSK	8 PSK	16 PSK
0	0.1811	0.4126	0.6485	0.8123
2	0.1383	0.3361	0.58	0.772
4	0.09837	0.2575	0.5016	0.7226
6	0.06871	0.1923	0.4194	0.6584
8	0.04596	0.1383	0.3288	0.5845
10	0.03217	0.0935	0.2502	0.4992
12	0.02082	0.06298	0.1795	0.4104
14	0.0132	0.04214	0.122	0.3219
16	0.007879	0.02726	0.08407	0.2387
18	0.005821	0.01759	0.05725	0.1761
20	0.003549	0.01165	0.03626	0.1207
22	0.002152	0.007192	0.02397	0.08167
24	0.001353	0.005192	0.01498	0.05518

Table 2 shows the bit error rate (BER) analysis with channel estimation in OFDM wireless communication system using Phase Shift keying (PSK) in Least Square Error (LSE) algorithm at different value of M (modulation alphabet) of proposed work.

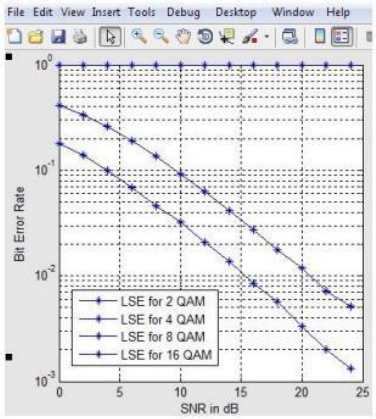

Fig 5: QAM in LSE graph for bit error rate of proposed work, implemented in Mat lab.

Fig. 5 shows the Least Square Error (LSE) for Quadrature Amplitude Modulation (QAM) schematic view of proposed work, implemented on Mat lab. In this work, Quadrature Amplitude Modulation (QAM) is used to evaluate and estimate the bit error rate with channel estimation at different value of M (modulation alphabet).

CONCLUSION

In this paper we analyzed the performance of wavelet based OFDM system and compared it with the performance of DFT based OFDM system. From the performance curve we have observed that the BER curves obtained from wavelet based OFDM are better than that of DFT based OFDM. We used three modulation techniques for implementation that are QPSK, 16 QAM and 64 QAM, which are used in LTE. In wavelet based OFDM different types of filters can be used with the help of different wavelets available The proposed technique can reduce the BER value by increasing the convolution encoder stages which also increase the cost and complexity. The future work for my work will focus on the different encoders than convolution encoder to give high reduction in BER. The effect of other channel type will also studied in this system as a future work scope.

REFERENCES

[1] A. Ian F., G. David M., R. Elias Chavarria, "The evolution to 4G cellular systems: LTE-advanced", Physical communication, Elsevier, vol. 3, no. 4, pp.217-244, Dec. 2010.

[2] B. John A. C., "Multicarrier modulation for data transmission: an idea whose time has come", IEEE Communications magazine, vol. 28, no. 5, pp. 5-14,May 1990.

[3] L. Jun, T. Tjeng Thiang, F. Adachi, H. Cheng Li,"BER performance of OFDM-MDPSK system infrequency selective rici an fading and diversity reception" IEEE Transactions on VehicularTechnology, vol. 49, no. 4, pp. 1216-1225, July 2000.

[4] K. Abbas Hasan, M. Waleed A., N. Saad, "The performance of multi wavelets based OFDM systemunder different channel conditions", Digital signal processing, Elsevier, vol. 20, no. 2, pp. 472- 482,March 2010.

[5] K. Volkan, K. Oguz, "Alamouti coded wavele tbased OFDM for multipath fading channels", IEEEWireless telecommunications symposium, pp.1-5,April 2009.

[6] G. Mahesh Kumar, S. Tiwari, "Performance evaluation of conventional and wavelet based OFDM system", International journal of electronics and communications, Elsevier, vol. 67, no. 4, pp. 348-354, April 2013.

[7] J. Antony, M. Petri, "Wavelet packet modulation for wireless communication", Wireless communication & mobile computing journal, vol. 5,no. 2, pp. 1-18, March 2005.

[8] L. Madan Kumar, N. Homayoun, "A review of wavelets for digital wireless communication", Wireless personal communications, Kluwer academic publishers- Plenum publishers, vol. 37, no. 3-4, pp.387-420, May 2006.