APTIKOM Journal on Computer Science and Information Technologies
Vol. 5, No. 2, 2020, pp. 221~226
ISSN: 2528-2417
DOI: 10.34306/APTIKOM.J.CSIT.40

BER Analysis of SWT Based OFDM ON LTE

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Abstract

We proposed to use singular wavelet transform (SWT) in OFDM based LTE because the SWT based system does not require a cyclic prefix, so spectrum efficiency is increased. SWT is used to analyze signals by the coefficients of SWT in both time and frequency domain. In order to investigate the bit error rate performance a practical channel model is required. Many channel models are proposed to mimic a real world scenario. Out of which Stanford university interim (SUI) channel provides best results so we replaced AWGN channel with SUI channel. We investigated the performance of bit error rates of SWT based OFDM in LTE for different modulation techniques such as QPSK, 64 QAM, 128 QAM under SUI 3 Channel model using SWT based haar and db2 transform. BER is reduced by 2 times when compared to the existing system.

Keywords: LTE, SUI, SWT, BER, SNR

1. Introduction

International Telecommunication Union Radio communication Sector (ITU-R) specified the requirements for 4th generation of cellular systems and International Mobile Telecommunications Advanced project (IMT-Advanced) specified the requirement of data rate. 3GPP's candidate for 4G was LTE-Advanced [1]. Discrete Wavelet Transform is high presentation digital signal processing method for procedure in applying multicarrier modulation [2]. The multimode transmission method using WPM (wavelet packet modulation) and OFDM (orthogonal frequency division multiplexing) is possible and explained. The WPM using the discrete wavelet transform is a multiplexing transmission method in which data is assigned to wavelet sub bands having different time and frequency resolutions is also explained [3].

Another paper proposes an in-depth view on the technologies being considered for Long Term Evolution-Advanced (LTE-Advanced). The new network architecture developed by the Third Generation Partnership Project (3GPP), which supports the integration of current and future radio access technologies, is highlighted. [4]. To meet the present scenario for the demand of higher bit rates, the wireless systems uses the multi-carrier modulation techniques, such as FFT based MCM which is also known as conventional OFDM and wavelet transform based MCM. [5] A closed form formula is derived for the bit error rate (BER) in frequency selective channels in M-ary differential-phase-shift-keying (MDPSK) systems [6]. DWT-OFDM can also support much higher spectrum efficiency than discrete Fourier-based OFDM (DFT-OFDM). The proposed OFDM system was modeled tested, and its performance was found under different channel conditions. [7] The performance of wavelet based OFDM with and without alamouti coding over Rayleigh fading channels is studied and BER shows very good performance.[8] The performance of channel estimation techniques such as least square and linear minimum mean square error for WOFDM is also studied.[9] using 16-QAM modulation the digital audio broadcasting system is designed using viterbi and turbo codes.[10]. Using QAM modulation with FFT size of 128 and guard band size of 32 MIMO OFDM system is designed using hybrid adaptation techniques [11].

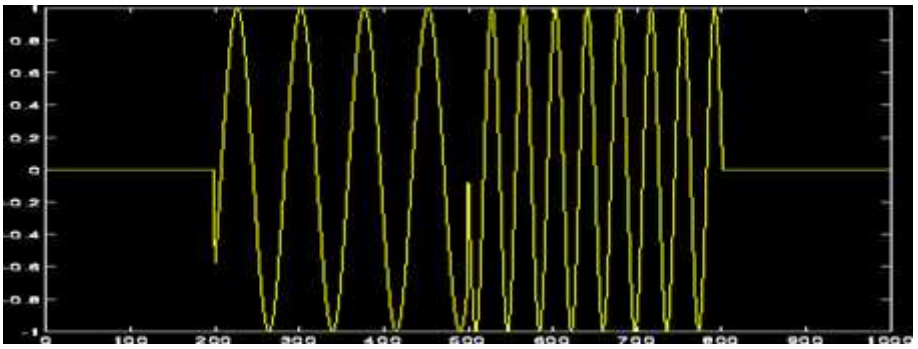

Figure 1. Sinusoidal Signal for Wavelets

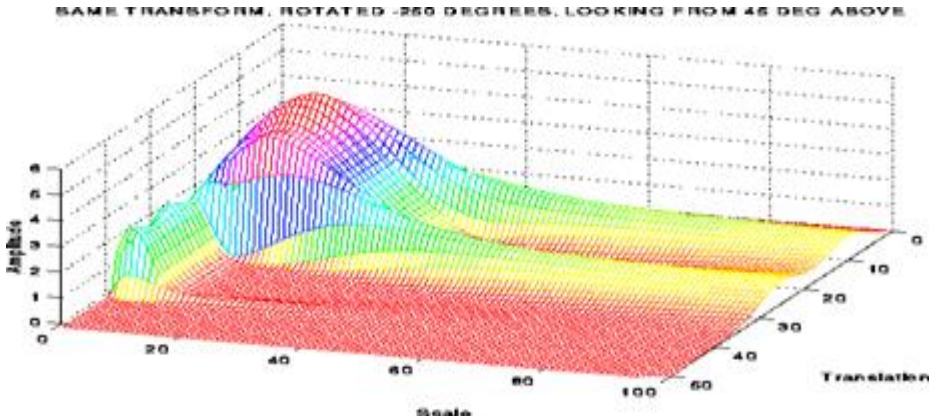

Figure 2. Continuous Wavelet Transform of Sinusoidal Signal for Wavelets

2. System Design

In this proposed model, we are using ISWT and SWT at the place of IDWT and DWT. SUI channel is used for transmission and cyclic prefixing is not used. The input binary digits are passed through the conventional encoder block and then data is interleaved and followed by modulation. After modulation the pilot insertion and sub carrier mapping is done then comes the ISWT of the data, which provides the orthogonality to the subcarriers. ISWT will convert time domain signal to the frequency domain. After passing through the channel on the signal SWT will be performed and then pilot synchronization where the inserted pilots at the transmitter are removed then the demodulation is done. Demodulated data is converted to binary form and the de-interleaved and decoded to obtain the original data transmitted.

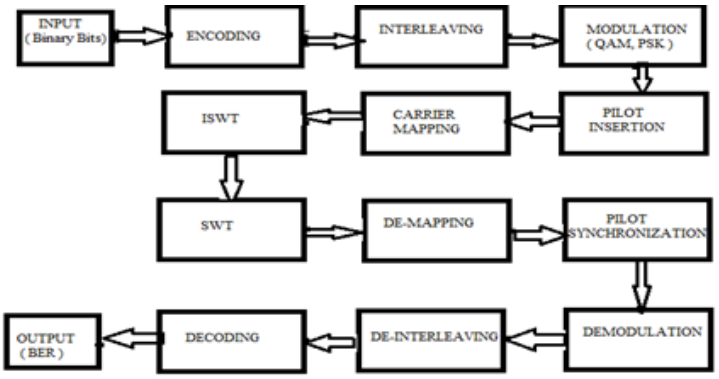

Figure 3. Proposed Block Diagram of SWT Based OFDM

3. Results Analysis and Discussions

BER Performance Evaluation: with the help of simulation software named MATLAB the performance characteristics of SWT based OFDM is obtained for different modulations that are used in LTE. Modulations that could be used for LTE are QPSK, 64 QAM and 128 QAM (Uplink and downlink). QPSK does not provide data at very high speed (Mbps). For the purpose of simulation, signal to noise ratio (SNR) of different values are introduced through SUI channel.

3.1 Existing System

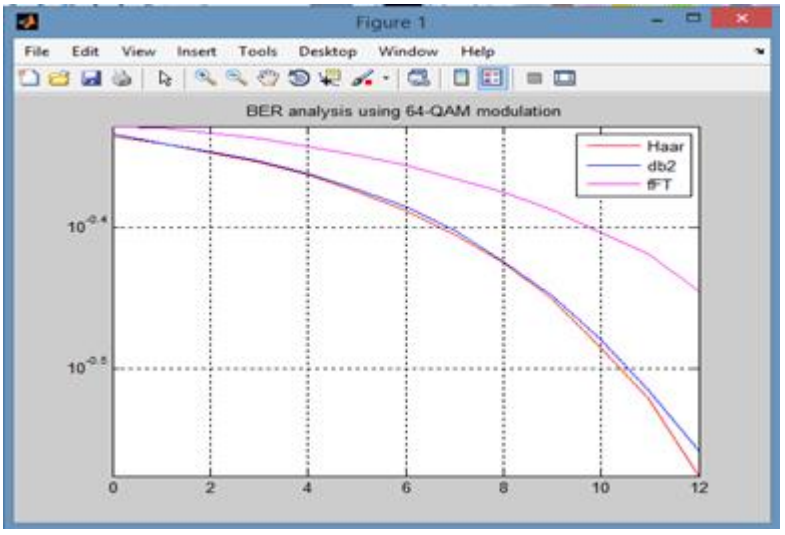

Figure 4. BER Performance of DWT and FFT Based OFDM System Using 64 –QAM

Figure 4 shows the MATLAB simulation output using discrete wavelet transform employing 64 QAM modulation scheme. We tried by replacing DWT with Haar transform and db2 also. We have obtained the simulation results with signal to noise ratio in dB on X-axis and probability of error on Y-axis. The results are
shown on Table 1.

Table 1. Analysis of BER for different SNR values using FFT, DWT.

S.No	Modulation Techniques	Transformation Techniques	SNR	BER
1	QAM-64	FFT	2dB	$0.1472 * 10^{-0.85}$
2	QAM-64	Haar	4dB	$0.04556*10^{-1.34}$
3	QAM-64	db2	4dB	$0.04556*10^{-1.135}$

Table 1 shows the analysis of BER for different SNR values using FFT and DWT. At 4dB the db2 transform with QAM-64 modulation scheme provides less probability of error.

3.2 Proposed System

Data of 9600 bits is sent in the form of 100 symbols, so one symbol is of 96 bits. Averaging for a particular value of SNR for all the symbols is done and BER is obtained and same process is repeated for all the values of SNR and final BERs are obtained Firstly the performance of FFT based OFDM and wavelet based OFDM are obtained for different modulation techniques. Different wavelet types daubechies2 and haar is used in wavelet based OFDM for QPSK, 128-QAM, 64-QAM

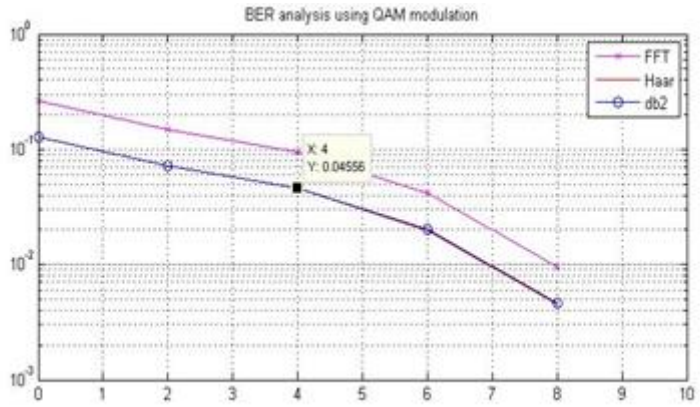

Figure 5. BER Performance of SWT and FFT Based OFDM System Using 64-QAM

Table 2. Analysis of BER for different SNR values using FFT, SWT.

S.No	Modulation Techniques	Transformation Techniques	SNR	BER
1	QAM-64	FFT	6dB	$0.0418*10^{-1.38}$
2	QAM-64	Haar	6dB	$0.01985*10^{-1.7}$
3	QAM-64	db2	6dB	$0.02008*10^{-1.169}$

Table 2 shows the analysis of BER for different SNR values using FFT and SWT. We observed the SNR at different levels on X-axis and probability of error on Y-axis. The db2 transform employing 64-QAM modulation scheme at 6dB provides less probability of error.

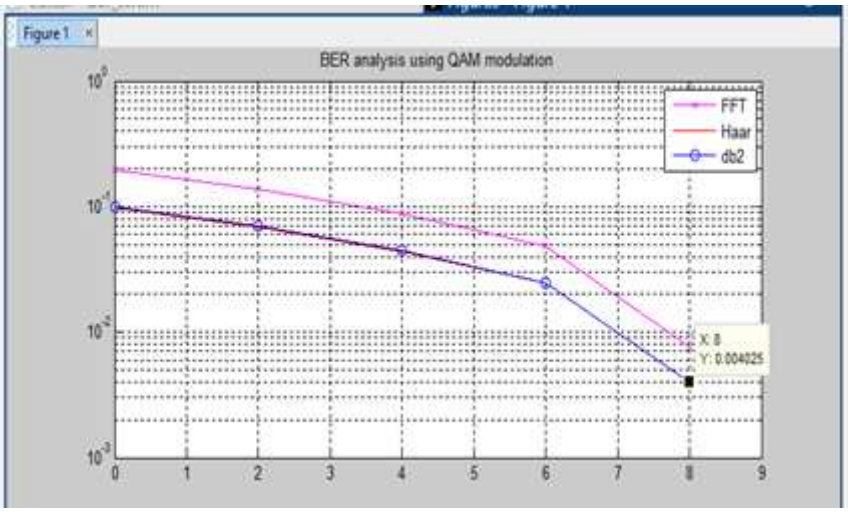

Figure 6. BER Performance of SWT and FFT Based System Using 128-QAM

Table 3. Analysis of BER for different SNR values using FFT, SWT.

S.No	Modulation Techniques	Transformation Techniques	SNR	BER
1	QAM-128	FFT	4dB	$0.0871*10^{-1.06}$
2	QAM-128	HAAR	4dB	$0.04381*10^{-1.34}$
3	QAM-128	db2	4dB	$0.0448*10^{-1.3}$

Here also the table 3 shows the SWT based db2 transform provides less probability of error at 4 dB

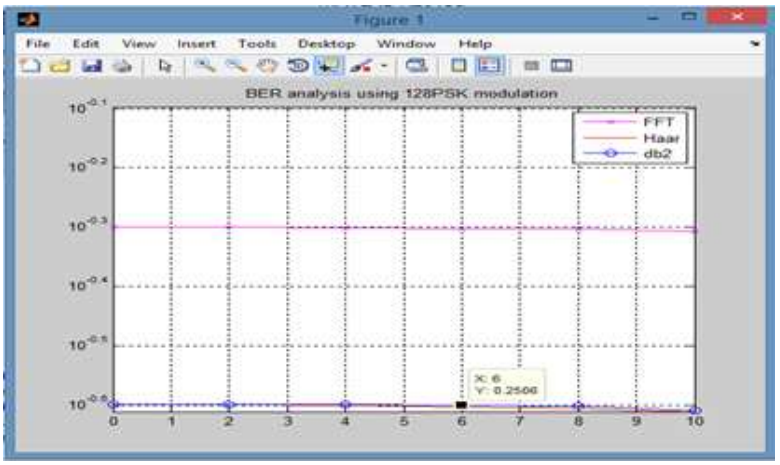

Figure 7. BER Performance of SWT and FFT Based System Using 128-QPS

Table 4. Analysis of BER for different SNR values using FFT, SWT.

S.No	Modulation Techniques	Transformation Techniques	SNR	BER
1	QPSK-128	FFT	4dB	$0.5007 * 10^{-0.3}$
2	QPSK-128	HAAR	4dB	$0.2509 * 10^{-0.6}$
3	QPSK-128	db2	4dB	$0.2517 * 10^{-0.59}$

It is clear that the BER performance of SWT based OFDM is better than the DFT based OFDM. That db2 performs better when QPSK is used. Then when 64-QAM is used db2 and haar have similar performance but far better than FFT where 128-QAM is used haar and db2 performs better than FFT

4. Conclusion

We analyze the performance of wavelet based OFDM system and compare the results with the performance of DFT based OFDM system. Based on the performance curve we noticed that the BER curves obtained from wavelet based OFDM are better than that of DFT based OFDM. We used three modulation techniques which are used in LTE for implementation that are QPSK, 128 QAM and 64 QAM. We have used daubechies2 and haar wavelets, both provide less BER at different intervals of SNR.

5. Acknowledgements

The authors would like to acknowledge the support institute of Aeronautical Engineering management for providing the lab facilities.

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