

Performance Improvement of Human Recognition System (WI-VI) Using OFDM

¹Gaurav K. Nanani, ²Kantipudi M V V Prasad
¹PG Research Scholar, ²Assistant Professor
Dept. of Electronics & Communication
R.K.University, Kasturbadham, Rajkot, Gujarat, INDIA

Abstract: In modern wireless world few systems use WI-FI signal to recognize the human behind the wall, not as information carrier signal, namely these systems are Ultra-Wideband System, WI-SEE System, and WI-VI System. Ultra-Wideband system and WI-SEE system have more limitation where WI-VI system found best out of these all three systems. WI-VI system recognizes the moving object which is behind any stationary object up to 8 meters with good accuracy. Many changes can improve the performance of WI-VI system which can increase the efficiency of result and increase the range of the overall system. With this desired goal, first implementation of whole WI-VI system was started, but due to some simulation limitation implementation could not be completed. WI-VI system use OFDM technique, to demonstrate the concept and feasibility of OFDM technology, and investigate how its performance is change by varying some of its major parameter work is done. This objective is met by developing a MATLAB program to simulate OFDM system. From the process of this development, the mechanism of an OFDM system can be studied ; and with completed MATLAB program, the characteristics of an OFDM system can be explored which can improve the performance of WI-VI system.

Keywords: Flesh effect; WI-SEE; WI-VI; OFDM; PAPR; BER; CCDF

I. Introduction

The use of WI-FI signal is not only as an information carrier; these WI-FI signals can be used to track the moving object behind the wall or we can say in a close room. This idea can be used to minimize the casualties in standoff and hostage condition, emergency responder can be used to see through wall, rubber or collapsed structure. Ultra-Wideband system, WI-SEE system and WI-VI system transmits WI-FI signal in the direction of wall, where we want to recognize the moving object or any moving human. Transmission of WI-FI signal in the direction of wall cause two problems (I) Flash effect, (II) magnitude of signal reduced by three to five times after traversing the wall.

Flash effect term refers to “The reflection from the entire stationary object behind the wall rather than just wall”, which is much stronger than the reflection from the object inside the closed room.

II. Human Recognition System

Ultra Wideband system developed by radar community, gives result of moving object detection as just moving blobs on output screen on the basis of arrival time of reflected signal which is transmitted in the direction of wall. This system needs large antenna array, large transmitting power and large bandwidth, due to these draw backs this system is infeasible for entities other than the military application[1].



Fig.1: Ultra Wide-Band System [1]

WI-SEE is a gesture recognition system that utilizes WI-FI signals to recognition of human gesture. This system not requires any sensing device on human body. This system works on Doppler shift principal which gives change in frequency as the targeted object comes near or go away. Problem with this system is that human gesture gives very small frequency change which is very difficult to detect. There may more than one person in home; this situation can affect the system performance. To solve this problem this system use MIMO interfacing of more than one antenna. Accuracy of this system increase with number of antennas means as number of antenna increase within system accuracy of system increases. Major drawback of this system is, system can recognize only 9 gesture of human, other than this 9 gesture WI-SEE system can't work[2].

To overcome the limitation of the ultra wide-band system, and WI-SEE in 2012 an attempt was made to use WI-FI signal to see through wall. The WI-VI system is small in size, use low power, low bandwidth and feasible to non-military entities. This system does not use large antenna array it only require MIMO system of 3 antennas. Problem of flash effect for this system is removed using nulling technique at the receiver side. As this system not use antenna array, this system make use of technique named inverse synthetic aperture radar (ISAR), to recognize the human. ISAR use only single receiver antenna to track the moving object, in this technique moving object or human works as an antenna array. This device can track the human up to range of 8 meters between transmitter and object with 75% accuracy and can't track the human at distance of 9 meters [1]. At output of WI-VI we can achieve only magnitude plot according to the movement of object it doesn't provide the shape of that object. WI-FI signal for WI-VI system is transmitted with OFDM technique, so using efficient OFDM technique with reduced PAPR and better BER we can improve the performance of WI-VI system which is main goal of this research work, related prototype for WI-VI system is developed using USRP N210 radios and algorithm [7] is performed on MATLAB R2012a under Ubuntu.

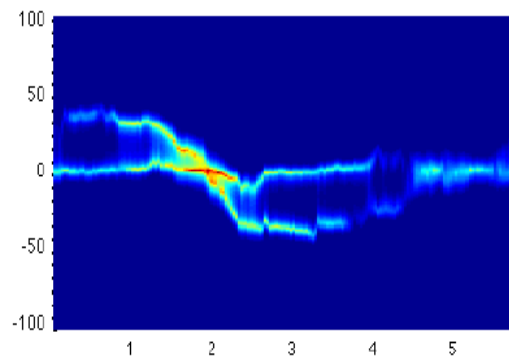


Fig.2: WI-VI system output [1]

III. Implementation

After comparative analysis of all three systems it is clear WI-VI system is best out of three and modification can make WI-VI system more accurate and high performance system [11]. As WI-VI system use OFDM technique to transmit WI-FI signal so this paper present the work to develop OFDM technique with reduced PAPR and better BER can make WI-VI system better.

OFDM signal have a problem of peak to average power ratio (PAPR) which is given as ratio of peak power to the average power of the signal. Due to high PAPR the dynamic range of the power amplifier and digital to analog converter is higher at transmitter and receiver and due to this the overall cost of the system gets increase and efficiency gets decrease. An OFDM signal is a sum of several individual signals modulated over a group of orthogonal subcarriers with equal bandwidths. Therefore, when added up coherently, the OFDM signal has large peak power, while the mean power remains low. PAPR of the transmitted signal can be calculated using equation given below [10].

$$PAPR(x) = 10 \log_{10} \left[\frac{\max |x(n)|^2}{E|x(n)|^2} \right]$$

Now days in modern wireless telecommunication world CCDF measurements is becoming a very accurate tool, CCDF plot offers a complete analysis of signal power peaks. CCDF of a data signal can be calculated with below equation.

$$CDF = \int PDF$$

$$CCDF = [1 - CDF]$$

There are few techniques by which we can reduce PAPR which are Clipping Technique, Subcarrier Phase Adjustment, Linear Combination, Phasing Schemes for PAPR Reduction and Companding Technique. Out of all Companding Technique found easy to implement and have more accurate results then other techniques. In Companding technique the OFDM signal is compressed at the transmitter and expanded at the receiver. Compression improves the quantization resolution of small amplitude signals but reduces the resolution of large signals. This also introduces quantization noise however; the effect of the quantization noise due to reduction in resolution of the peaks is relatively small as the peaks occur less frequently [10]. Whole simulation was performed in MATLAB R2013a under windows seven operating system.

A. Algorithm

The simulated OFDM code is developed according to the below figure-3, with 16 QAM, 32 QAM, and 64 QAM, 256 IFFT points, and PAPR result and BER result are achieved for AWGN channel.

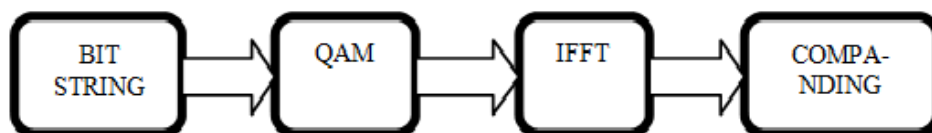


Fig.3: Algorithm for implementation [10]

- First of all $10 * 10^4$ binary data bit string is taken randomly.
- Then 16-QAM is performed on it as shown in block diagram.
- After QAM 256 point IFFT is applied to convert in to time domain, and proper cyclic prefix is applied over the bit stream.
- Then applied companding technique to reduce PAPR of the signal for AWGN channel.
- First three points are repeated in reverse order at the receiver to get original signal back.
- At last for AWGN channel the BER of the signal is also calculated.

IV. Result Analysis

Figure 4 shows the scatter plot of OFDM transmitted signal and Figure 5 shows the scatter plot of OFDM received signal, which says that there is no more noise between transmitted signal and received signal. Figure 6 shows theory plot of PAPR for reference to compare with simulated result of PAPR.

Table-1. Comparison of PAPR reduction

CCDF	PAPR Reduction in dB			
	Theory	16-QAM	32-QAM	64-QAM
10^{-2}	10.5 dB	9.5 dB	9.2 dB	9.2 dB
10^{-1}	10 dB	8.15 dB	8.25 dB	8.25 dB

Table-1 shows that compare to theory value the PAPR is reduced using 16-QAM, 32-QAM, and 64-QAM. We can see that there is no more change between the result of 32-QAM and 64-QAM. This table shows that peak power at CCDF= 10^{-2} is reduced by 1 dB with 16-QAM and reduced by 1.3 dB with 32-QAM and 64-QAM.

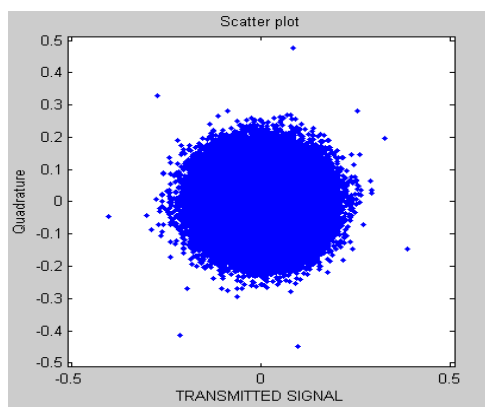


Fig.4: Scatter plot of transmitted signal, 16-QAM

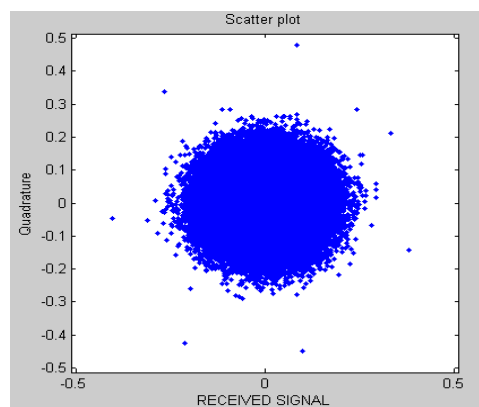


Fig.5: Scatter plot of received signal, 16-QAM

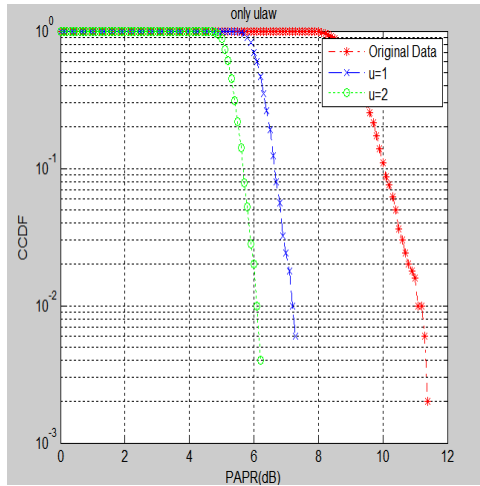


Fig.6: Theory PAPR [10]

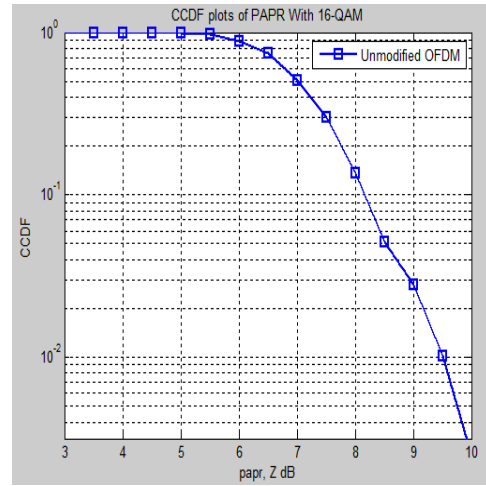


Fig.7: PAPR with 16-QAM

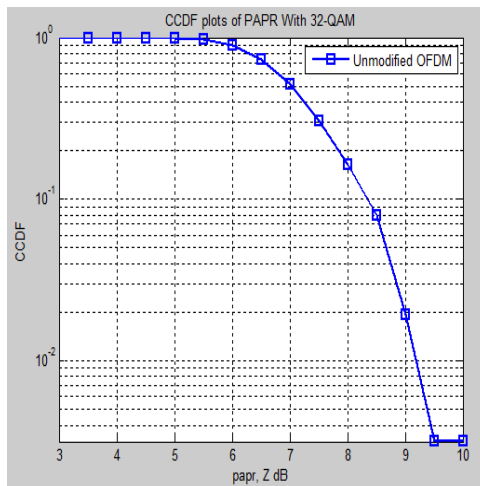


Fig.8: PAPR with 32-QAM

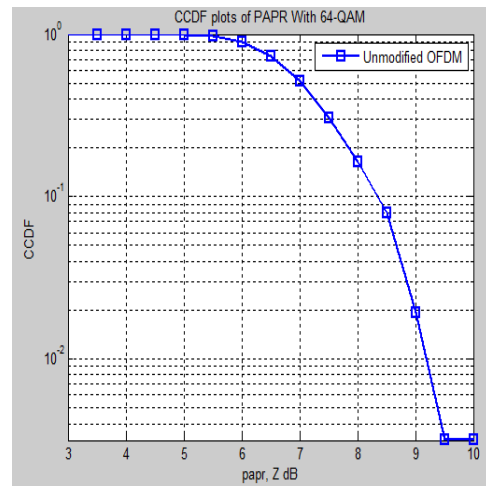


Fig.9: PAPR with 64-QAM

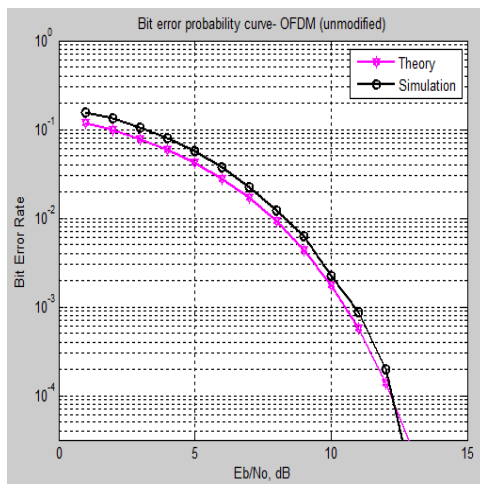


Fig.10: BER with 16-QAM for AWGN channel

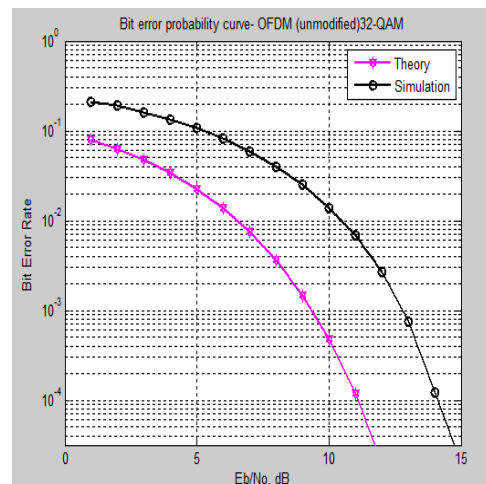


Fig.11: BER with 32-QAM for AWGN channel

Figure 10 and Figure 11 shows BER of the system for 16-QAM and 32-QAM. From the result it can be said that 16-QAM gives result closer to the theory value where with 32-QAM has large variation between theory and simulated result means 16-QAM gives better result than 32-QAM but for more long bit stream 32-QAM will give more accurate result.

V. Conclusion and Future Scope

With the proper survey it is found that WI-VI system is best system to recognize moving object behind the wall, and many improvements can make this system more accurate and better. From the work done to improve the performance of WI-VI system it can be concluded that the accurate OFDM modulation with reduced PAPR and better BER can improve the overall performance of the WI-VI system, also with reduced PAPR the power consumption by D/A converter and power amplifiers is very less and component cost for both is also less, which makes whole system cost effective. So with this OFDM modulation which gives reduced PAPR and better BER, the performance and accuracy of WI-VI system can be improved.

As discussed WI-VI system gives only magnitude plot according to the movement of any object which is behind the wall, so rather than just achieving the magnitude plot we can have proper shape of that moving object with advance algorithms and efficient techniques.

VI. References

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VII. Acknowledgments

I am very much thankful to Mr. *K M V V Prasad* for success full completion of this research work. I acknowledge my friends for their kind support. I am thankful to all persons who directly or indirectly helped me for this work. I also thankful to the department of Electronics and Communication at R.K. University, Rajkot for their support in my research work.