ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 8, August 2013

PAPR ANALYSIS OF 8X8 MIMO OFDM AND OFDM SYSTEM

Anurag Sharma[1], Ankush Kansal[2]

Student-ME, Electronics and Communication Department, Thapar University, Patiala, India[1]

Assistant Professor, Electronics and Communication Department, Thapar University, Patiala, India [2]

Abstract: Today we want fast ways of communication, research on even more faster alternatives is going. In present time, 4th generation wireless communication standards is among one of such technologies. The building block of this technology is MIMO-OFDM system. But one of the drawback associated with OFDM is high PAPR. In this paper the PAPR of 8x8 MIMO OFDM system is simulated in Matlab and it is shown that it is better than PAPR of simple OFDM system. PAPR of 8x8 MIMO-OFDM system is reduced further by SLM technique.

Keywords: PAPR, OFDM, MIMO-OFDM, SLM, QPSK, BPSK

I. INTRODUCTION

Until now we all are familiar with 3G technology. But in the present scenarios this is not enough as the ever growing demands of multimedia services, online gaming etc needs higher speed of data. We need more sophisticated technology for higher and faster data transmission and reception. This can be achieved by 4G wireless technology [1]. Antennas can be improved by applying a technique known as MIMO, or multiple-input multiple-output, and the signals can be improved by the modulation technique of OFDM, or orthogonal frequency division multiplexing. This concept, as a whole, is known as MIMO-OFDM, and is used as the basis of the 4G technology.

When a signal propagates through a wireless medium from transmitter to receiver, it is obstructed by certain parameters on its way and the signal travel through a number of different paths known as multipath. While propagating the signal power drops due to path loss and fading. Fading of the signal can be controlled by different diversity techniques. To obtain diversity, the signal is transmitted through multiple independent fading paths e.g. in time, frequency or space and combined constructively at the receiver. Multiple input- multiple-output (MIMO) [2] exploits spatial diversity by having several transmit and receive antennas.

OFDM is multicarrier modulation technique known for its capability to mitigate multipath. In OFDM, a high speed data stream is divided into "N" narrowband data streams and is modulated using subcarriers which are orthogonal to each other and the information is transmitted on each sub carrier. On each subcarrier channel, lower data rate brings longer symbol duration. The symbol duration is made even longer by adding a cyclic prefix to each symbol. As long as the cyclic prefix is longer than the channel delay spread, inter-symbol interference (ISI) free transmission is obtained through OFDM. In OFDM the frequency spacing between sub carriers is selected such that the sub carriers are mathematically orthogonal to each other. The subcarriers in OFDM[3] have the minimum frequency separation required to maintain orthogonality of their corresponding time domain waveforms, still the signal spectra corresponding to the different subcarriers overlap in frequency domain. OFDM is well suited for transmission of high data rate applications in fading channels due to its robustness to inter-symbol interference. IFFT is performed at the transmitter and FFT at the receiver, resulting in conversion of wideband signal affected by frequency selective fading, into "N" narrowband flat fading signals. Therefore, simpler equalizer is required at the receiver. OFDM is used for dedicated short-range communications (DSRC) for road side to vehicle communications and as a backbone for fourth-generation (4G) mobile wireless systems. It is adopted in standards like IEEE802.11a LAN and IEEE802.16a LAN/MAN besides used in IEEE802.20a, a standard in the making for maintaining high-bandwidth connections to users moving at speeds up to 90 km/h. This paper illustrates the PAPR reduction of 8x8 MIMO OFDM system compared to an OFDM system.

II. MIMO OFDM SYSTEM

As discussed in above about the important properties of MIMO and OFDM system, when we combine both these systems, we get MIMO-OFDM system. The most important

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 8, August 2013

need for a MIMO-OFDM system is that with the development of wireless data and multimedia applications, the demand on transmission rate and QoS assurance of wireless communication system is correspondingly rising which could not be served by MIMO or OFDM systems separately. MIMO-OFDM [4], technique can be used in wireless communication systems to achieve gigabit transmission. It enables high capacities suited for Internet and multimedia services, increases the range and reliability. It also increases diversity gain and enhance system capacity on a time-varying multipath fading channel improving power-spectral efficiency in wireless communication systems besides optimizing the power efficiency. Services like multimedia, very fast broadband etc are also available with 3G but the Qos is not there. The user do not enjoy the kind of services he/she should get because of less speed of communication. This technology guarantees each user's quality of service requirements, including bit-error rate and data rate and as a result ensures fairness to all the active users. It allows transmission over highly frequency-selective channels at a reduced Bit Error Rate with high quality signal.

The increased capacity, coverage and reliability is achievable with the aid of MIMO techniques. As MIMO can be combined with any modulation or multiple access technique, therefore the implementation of combination of MIMO and OFDM is more efficient. OFDM has the property of robustness against multipath delay spread. This is achieved by having a long symbol period, which minimizes the inter-symbol interference [5]. MIMO, can be used either for improving the SNR or data rate. Therefore clubbing of both these techniques result in a new technique which is very helpful when aiming at the design of very high-rate wireless mobile systems.

One of the advantage of this system is reduced BER. The BER of this system is quite less as compared to an OFDM system. By saying higher data rate, we mean more number of bits per unit time. For a fixed value of

SNR we can achieve less bit error rate, so we can say that we have an improvement in SNR or we can say that we have less error probability of bits resulting in higher data rate. As we go on increasing the number of antennas on transmitter and receiver side, the BER is further reduced because of diversity. In this paper an 8x8 MIMO-OFDM system is used.

III. PEAK TO AVERAGE POWER RATIO(PAPR)

In section II, we discussed some of the advantages of OFDM which makes it a strong contender for MIMO-OFDM systems. But OFDM has a disadvantage also which is PAPR(peak to average power ratio). PAPR is the ratio between the maximum power and the average power of the complex pass band signal s_n,

$$PAPR = \frac{P_{peak}}{P_{avg}} = 10log\frac{max[|s_n|^2]}{E[|s_n|^2]} \qquad (1)$$

where, P_{peak} is the peak output power, P_{avg} is the average output power, $E[.]$ denotes the expected value, s_n represents the transmitted OFDM signals which are obtained by taking IFFT operation on modulated input symbols S_K. s_n can be expressed as

$$s_n = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} S_k\, W_N^{nk} \qquad (2)$$

The PAPR [6] puts a stringent requirement on the power amplifier and reduces the efficiency in the sense that a higher input backoff factor is needed before the peaks in the signal experience significant distortion due to power amplifier nonlinearity.

A. PAPR REDUCTION BY SLM

This drawback can be reduced using few techniques. SLM (Selected Mapping) technique is one of them. In this paper SLM is used to counter PAPR. SLM comes under the category of symbol scrambling technique. The basic idea of symbol scrambling is that for each OFDM symbol, the input sequence is scrambled by a certain number of scrambling sequence, and the output signal is transmitted with the smallest PAPR. The transmitter selects one favorable transmit signal from a set of sufficiently different signals which all represent the same information. SLM [7] generates "N" transmit sequences $t_\mu^{(n)}$, representing the same information for each OFDM symbol and then selects the lowest PAPR in time-domain of "N" sequences to transmit. The "N" distinct vectors are then defined as $V^{(n)} = [V_1^{(n)}, \dots, V_M^{(n)}]$, $V_L^{(n)} = e^{j\phi_L^{(n)}}$where $\phi_L^{(n)} \epsilon\ [0,2\pi]$, L = 1: M(number of subcarriers), n=1:N. Each OFDM frame is multiplied carrier wise with "N" vectors: $T_\mu^{(n)}[L] = T_\mu[L].e^{j\phi_L^{(n)}}$, L=1: M and n=1: N

.

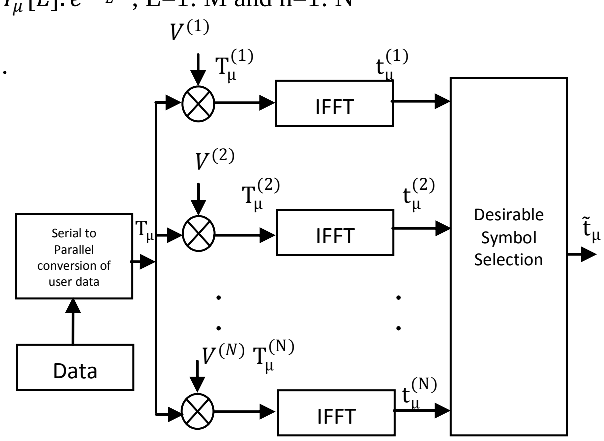

Fig. 1. Block diagram of Selected Mapping Technique [8]

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 8, August 2013

IV. SIMULATION RESULTS

(i)

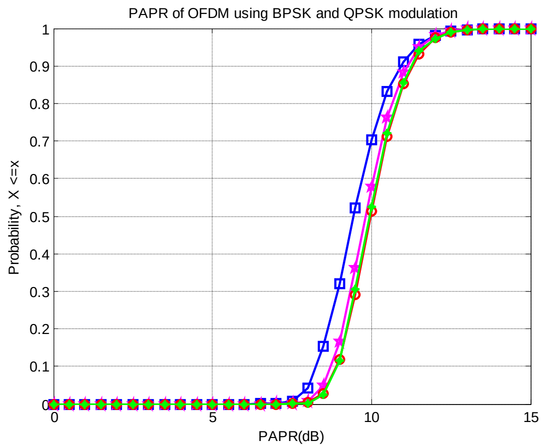

Figure 2. PAPR of OFDM using BPSK and QPSK modulation

Fig 2. shows the Matlab simulation, PAPR v/s CCDF graph of a simple OFDM system employing BPSK and QPSK modulation techniques. From this graph it is observed that the PAPR is greater than 12dB. PAPR value for this system is quite large. OFDM signal consists of a lot of independent modulated subcarriers, which creates the problem of PAPR. It is impossible to send this high peak amplitude signals to the transmitter without reducing peaks. So we have to reduce high peak amplitude of the signals before transmitting.

(ii)

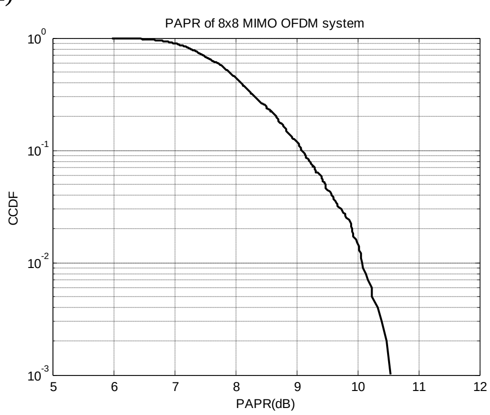

Figure 3. PAPR of 8x8 MIMO OFDM system

Fig 3 shows that using 8x8 MIMO OFDM the PAPR is 10.5 dB using QPSK modulation technique. This is 2 dB less than the PAPR of simple OFDM system as shown in fig2. This is the effect of MIMO-OFDM system. It is observed that in case of 8x8 MIMO OFDM system the effect of PAPR is also less as compared to a simple OFDM system. Now by using SLM, PAPR is further reduced which is shown in Fig 4.

(iii)

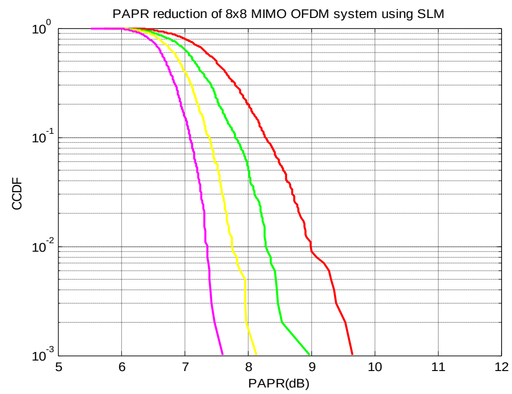

Figure 4. PAPR reduction of 8x8 MIMO OFDM system using SLM

From Fig 4, it is observed that by using SLM, PAPR is reduced effectively. Lowest value of 7.5 dB is achieved. Here four curves show the PAPR values with different roll off factors. We conclude that as the roll off factor is increased the PAPR starts reducing. With a beta value of 1.0 the PAPR is reduced to a value 7.5 dB. So there is an improvement of 3 dB in PAPR compared to 8x8 MIMO OFDM system without SLM. It is also observed that compared to an OFDM system the PAPR of 8x8 MIMO OFDM system using SLM is reduced by approximately 5dB.The red curve shows PAPR with beta=0.2, green curve shows PAPR with beta=0.4, yellow with beta= 0.8 and pink with beta =1.0

V. CONCLUSION

PAPR of 8x8 MIMO-OFDM system and simple OFDM system is compared. It is shown that PAPR of high antenna configuration employing 8 antennas at the transmitter and receiver in MIMO-OFDM system is better than the PAPR of an OFDM system. Further, by using Selected Mapping technique for PAPR reduction, PAPR value is reduced upto a lower value of 3 dB compared to 8x8 MIMO OFDM system without using SLM technique for PAPR reduction. It is also concluded that higher antenna configuration MIMO OFDM system is better in BER as well as PAPR than an OFDM system. The PAPR of the 8x8 MIMO OFDM system is reduced by 5 dB by using SLM compared to an OFDM system without using SLM.

REFERENCES

[1] B. Krenik, “4G wireless technology: When will it happen? What does it offer?,”, *IEEE Asian Solid-State Circuits Conference*, pp.141-144, 2008.

[2] P. Soma ; D.S Baum; V. Erceg; R. Krishnamoorthy; A.J. Paulraj, “Analysis and modeling of multiple-input multiple-output (MIMO) radio channel based on outdoor measurements conducted at 2.5 GHz for

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 8, August 2013

fixed BWA applications,"*IEEE International Conference on Communications*, vol.1, pp.272-276, 2002.
[3] W. Kabir , "Orthogonal Frequency Division Multiplexing (OFDM)," *Microwave Conference*, pp.178-184, 2008.
[4] G.L Stuber; J.R Barry; S.W McLaughlin; Ye Li; M.A Ingram; T.G Pratt, "Broadband MIMO-OFDM wireless communications," *Proceedings of the IEEE* , vol.92, no.2, pp.271-294, 2004.
[5] Liu Zujun; Wang Jieling; Tian Hongxin; Kechu Yi, "Reducing specific inter-symbol interference of constant envelope OFDM system through optimizing zero-padding pattern,"*IEEE International Conference on Signal Processing, Communications and Computing*, pp.1-4, 2011.
[6] Tao Jiang; Yiyan Wu, "An Overview: Peak-to-Average Power Ratio Reduction Techniques for OFDM Signals," *IEEE Transactions on Broadcasting*, vol.54, no.2, pp.257-268, 2008.
[7] Gwo-Ruey Lee; Chia-Hsin Cheng; Ho-Lung Hung, "Selected mapping applied scheme for PAPR reduction in OFDM communication systems,", *2010 Sixth International Conference on Networked Computing and Advanced Information Management (NCM)* , pp.752-755, 2010.
[8] MIMO-OFDM Wireless Communications with MATLAB by Yong Soo Cho, Jaekwon Kim, Won Young Yang, Chung G. Kang.

BIBLIOGRAPHY

Anurag Sharma is presently pursuing ME in Electronics and Communication Engineering from Thapar University, Patiala. His research interests include 4G systems, MIMO-OFDM systems and Mobile Communication.

Ankush Kansal is currently serving as Assistant Professor in Electronics and Communication Department, Thapar University, Patiala. His research interests include Wireless and Mobile Communication.