International Journal on Emerging Technologies **5**(2): 27-30(2014)

ISSN No. (Print) : 0975-8364
ISSN No. (Online) : 2249-3255

Reduction of PAPR of OFDM Signal by SLM and Clipping Techniques Using RS Codes

Jitendra Singh Dodiya* and Rahul Sharma**

**PG Student of Digital Communication, PCST Indore, (MP), India*
***Assistant Professor, Department of Electronics & Communication Engineering, PCST Indore, (MP), India*

(Corresponding author: Jitendra Singh Dodiya)
(Received 05 August, 2014 Accepted 13 September, 2014)

ABSTRACT: Multicarrier modulations have become broadened and Orthogonal Frequency Division Multiplexing (OFDM) has been widely implemented in high speed digital modulations. OFDM is a multicarrier transmission technique which divides the available spectrum into many carriers, each one being modulated by a low rate data stream. One major disadvantages of OFDM is that the time domain OFDM signal which is a sum of several sinusoidal leads to high peak to average power ratio (PAPR). Selected Mapping (SLM) and Clipping Technique are the promising PAPR reduction techniques for OFDM. Almost all PAPR reducing techniques degrade the BER Performance. In this paper we used SLM and Clipping techniques with Reed-Solomon Codes to improve BER. A brief comparison of performances of the system with and without the algorithm are also has been done. The code rate used is ½ and the channel considered is AWGN with QAM and BPSK.

Keywords: OFDM, PAPR, CCDF, BER

I. INTRODUCTION

Recently, orthogonal frequency division multiplexing (OFDM) has been regarded and used as one of the core technologies for the communication systems. Especially, OFDM has been adopted for various wireless communication systems such as wireless local area networks (WLANs), wireless metropolitan area networks (WMANs), digital audio broadcasting (DAB), and digital video broadcasting (DVB). OFDM is an attractive technique for achieving high data rate in the wireless communication systems and it is robust to the frequency selective fading channel. However, an OFDM signal can have very high peak-to-average power ratio (PAPR) at the transmitter, which causes the signal distortion such as the in-band distortion and the out-of-band radiation due to the nonlinearity of high power amplifier (HPA), and induces the degradation of bit error rate (BER). Thus, the PAPR reduction is one of the most important research interests for the OFDM systems. If an OFDM system includes N sub-carriers, after IFFT computing, the normalized complex base band symbols are

$$x(t) = \frac{1}{\sqrt{N}} \sum_{K=0}^{N-1} X_k \exp\,(jk\Delta f t)$$

X_k represents the modulated symbols of the k-th sub carrier. Δf is the interval frequency between neighbor channels. For QPSK modulation, Xk = {1,-1, j, -j}. According to the central limit theorem, as long as the number of sub carriers N large enough, you can determine the real and imaginary parts of x(t), which will follow the Gaussian distribution, the zero mean, 0.5 variance (real and imaginary separately parts half of the entire signal). We generally use complementary cumulative distribution function (CCDF) to indicate the PAPR of OFDM symbols, the formula is as follows

$$P\{PAPR > z\} = 1 - P\{PAPR \le z\}$$
$$= 1 - (1 - e^{z})^{N}$$

Therefore, simulation analysis is generally used to measure the CCDF of the OFDM system to value the PAPR distribution.

II. SYSTEM MODEL

In this section, we review the basic of OFDM transmitter and the PAPAR definition. Consider an OFDM consisting of N subcarriers. Let a block of N symbol $X = \{X_k, k = 0,1,...,N-1\}$ is formed with each symbol modulating one of a set of subcarriers $\{f_k, k = 0,1,..., N-1\}$.

The N subcarriers are chosen to be orthogonal, that is, $f_k = k\Delta f$,where $\Delta f = 1/(NT)$ and T is the original symbol period. Therefore, the complex baseband OFDM signal can be written as

$$x(t) = \frac{1}{\sqrt{N}} \sum_{K=0}^{N-1} X_k \exp\,(j2\pi f_k t)\,, 0 \leq t \ \leq NT$$

In general, the PAPR of OFDM signals $x(t)$ is defined as the ratio period between the maximum instantaneous power and its average power during an OFDM symbol

$$\text{PAPR} = \frac{\max_{0 \leq t \leq NT}[|x(t)|^2]}{\frac{1}{N}\int_0^{NT} |x(t)|^2 dt}$$

Reducing the max $x(t)$ is the principle goal of PAPR reduction techniques.

III. SLM TECHNIQUE FOR PAPR REDUCTION

This is described in figure 1. X is the OFDM data block, B(i)'s are the phase vectors. X(i)'s are the modified data blocks in the frequency domain. x(i) are the equivalent time domain blocks.

$$x_{(u)}(t) \ = \ \sum_{k=0}^{k=N-1} X_k B_u k e^{j2\pi k\Delta f t}, 0 \leq t \leq NT$$

where u = 1, 2, . . . , U. and N is both the number of subcarriers and length of **X**. Among the modified data blocks **X**(u), the one with the lowest PAPR is selected for transmission.

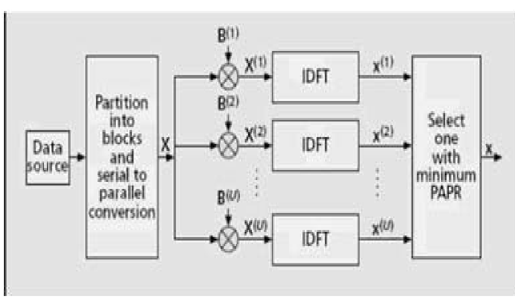

Fig. 1. SLM Block Diagram.

It is well known that SLM is more advantageous than PTS if the amount of side information is limited, but the computational complexity of SLM is larger than that of PTS. In order to improve the PAPR reduction performance of SLM scheme, we have to increase the number of phase sequences.

The computational complexity of SLM scheme linearly increases as the number of phase sequences increases, which

corresponds to the number of IFFTs required to generate the alternative OFDM signals.
Even if the SLM scheme is simple and distortion less, sometimes its computational complexity is burdensome.

IV. CLIPPING TECHNIQUE FOR PAPR REDUCTION

In this approach, we can perform time-domain based clipping or frequency-domain based coding. The simplest approach for PAPR reduction is to deliberately clip the amplitude of the signal to a predefined value before amplification. However, there are several drawbacks of this approach, such as signal distortion and spectral re-growth. Hence simple clipping is not enough, we have to use coding techniques that are applied to OFDM signals in order to find the optimum threshold for every specific signal. However, this technique works well only when the number of subcarriers is small, because at higher subcarriers, the clipping ratio is to be very low which will lead to more distortion. Clipping is the simplest way to reduce the PAPR, but it causes significant distortion of the signal and increases both the out-of-band radiation and the bit error rate (BER).

V. PROPSED SCHEME

In this paper we proposed the modified SLM and Clipping techniques using RS code. Reed Solomon codes are non binary cyclic error correcting codes. They describe a systematic way of building codes that can detect and correct multiple errors. In a block code we have k individual information bits, r individual parity bits and a total of n (=k+r) bits. Rather reed Solomon codes are organized in group of bits. These groups of bits are referred to as symbols. So we can say this code has n number of symbols. This symbol comprises of m number of bits, where
$N = 2^m-1$
These n symbols form a code word. Out of these n symbols k are information symbols where n-k are parity symbols. These codes are used to transfer data between any two medium. There are possibilities that error may occur due to any disturbance in the traverse channel. So we need to have a design tool specified for encoding and then decoding after correcting signals in the receiver side. Reed Solomon codes can be the tool discussed above. The error correcting capability of the code is defined as T,
T= [(n-k)/2]

where [x] represents the greater integer function. The code can correct only half of the number of parity symbols because for every error one parity symbol is used to locate the error and the other is used to correct it. The advantage behind reed Solomon code is that it can correct burst errors. However if erasures are present then only one parity symbol is used to correct error as the location of error is already known. The code rate is defined as R_c, where

R_C=k/n.

VI. SIMMULATION AND RESULT

We have chosen communication toolbox of MATLAB, to do the project simulation. Simulation has been done on MATLAB 7.14.0, following results has been obtain in order to show the performance of Modified Clipping and SLM Techniques, for reduction PAPR of OFDM signals and modified symbols using our proposed method (for 1 and 2 iterations) involving filter optimization. The Figure 2 plots the bit error rate curves of the original signal through an AWGN channel, and it shows that how BER of RS Clipping and RS SLM decrease with increase in SNR (Signal to Noise ratio). The Figure 3 shows that how CCDF of RS Clipping and RS SLM decreases with increase in SNR and it can be seen that both the Clipping and SLM technique can significantly reduce the PAPR.

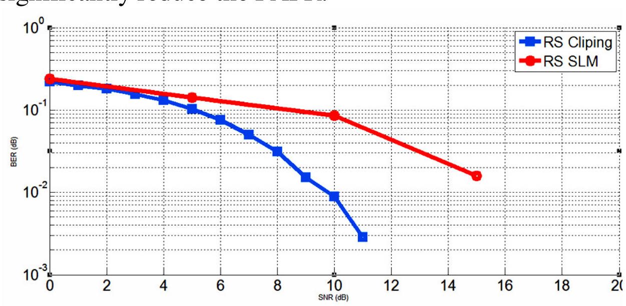

Fig. 2. Comparison Graphs of BER and SNR Using RS Clipping RS SLM.

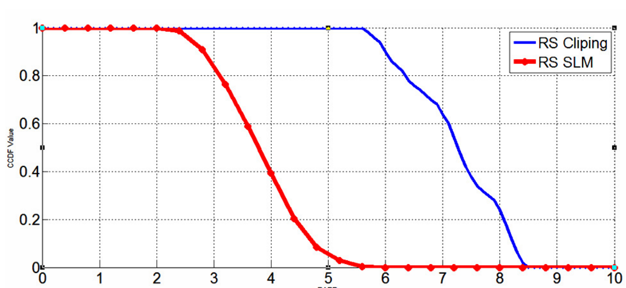

Fig. 3. Comparison Graphs of CCDF and PAPR Using RS Clipping and RS SLM.

Comparing the BER curves of our method with those of the Clipping and SLM technique with RS coding, it is observed that the signal to noise ratio (SNR) of SLM and Clipping is having same performance up to SNR 4 dB, after 4 clipping is better than SLM.

VII. CONCLUSION

This paper proposes a optimization technique to dynamically Reduce the PAPR of OFDM signal using Clipping and SLM methods using Reed Solomon Code. It has been observed that this method has better PAPR and computational complexity reduction performances without the degradation of the BER. These results will help to design an efficient PAPR reduction in OFDM and will increase the efficiency of utilization of spectrum and provide large economic and social benefits.

REFERENCES

[1] Xiaodong Zhu, Wensheng Pan, Hong Li, and Youxi Tang, "Simplified Approach to Optimized Iterative Clipping and Filtering for PAPR Reduction of OFDM Signals", *IEEE Transactions on Communications*, Vol. **61**, No. 5, May 2013.

[2] Mohit Chandwani, Arjun Singhal, Naga VishnuKanth and Vijaykumar Chakka, "A Low Complexity SLM Technique for PAPR reduction in OFDM using Riemann Sequence and Thresholding of Power Amplifier", Indicon 2009, 18-20 Dec, 2009. Reference Subject to Publication by IEEE Explore.

[3]. Guangliang Ren, Hui Zhang, and Yilin Chang, "A Complementary Clipping Transform Technique for the Reduction of Peak-to-Average Power Ratio of OFDM System", *IEEE Transactions on Consumer Electronics*, Vol. **49**, No. 4, November 2003.

[4]. N.R. Raajan, S. Prabha, and D. Meenakshi," Improved Performance in OFDM Systems by PAPR Reduction Techniques" *International Conference on Computer Communication and Informatics*, Jan. 04 - 06, 2013.

[5]. Y.C. Wang and Z.Q. Luo, "Optimized Iterative Clipping and Filtering for PAPR Reduction of OFDM Signals", *IEEE Transactions on communications*, Vol. **59**, No. 1, January 2011.

[6]. Luqing Wang and Chintha Tellambura, "Analysis of Clipping Noise and Tone-Reservation Algorithms for Peak Reduction in OFDM Systems", *IEEE Transactions on vehicular Technology*, Vol. **57**, No. 3, May 2008.

[7]. W. Aziz, E. Ahmed, G. Abbas, S. Saleem and Q. Islam, "PAPR Reduction in OFDM using Clipping and Filtering", *World Applied Sciences Journal,* **18**, 1495-1500, 2012.

[8]. P. Foomooljareon and W.A.C. Fernand, “PAPR Reduction in OFDM System”, *Thamm. J. Sc.T ech.*,Vol. **7**, No. 3, September-December 2002.

[9]. Seok-Joong Heo, Hyung-Suk Noh, Jong-Seon No and Dong-Joon Shin, “A Modified SLM Scheme with Low omplexity For PAPR Reduction of OFDM Systems”, *18th Annual IEEE International Symposium on Personal, Indoor and Mobile Radio Communications*, 2007.

[10]. Md. Ibrahim Abdullah, Md. Zulfiker Mahmud, Md. Shamim Hossain, and Md. Nurul Islam, “Comparative Study of PAPR Reduction Techniques in OFDM”, *ARPN Journal of Systems and Software*, Vol. **1**, No. 8, November 2011.

[11]. N.R. Raajan, S. Prabha, and D. Meenakshi,” Improved Performance in OFDM Systems By PAPR Reduction Techniques” *International Conference on Computer Communication and Informatics,* Jan. 04 - 06, 2013.