International Journal of Advanced Technology in Engineering and Science
Vol. No.3, Issue No. 12, December 2015
www.ijates.com
ijates
ISSN 2348 - 7550

A NOVEL TECHNIQUE OF ITERATIVE CLIPPING AND FILTERING METHOD FOR OFDM SYSTEM TO REDUCE PAPR

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ABSTRACT

One of the challenging issues for Orthogonal Frequency Division Multiplexing (OFDM) system is its high peak to average power ratio (PAPR).in this paper, we proposed an iterative clipping and filtering method (ICF) to reduce PAPR. We compared simulation results with selected mapping (SLM) and partial transmit sequence (PTS). Proposed ICF gives better PAPR reduction, less distortion and lower out-of-band radiation than the existing method.

Keywords: Orthogonal Frequency Division Multiplexing (OFDM), Iterative Clipping And Filtering (ICF), Selected Mapping (SLM), Partial Transmit Sequence (PST).

I. INTRODUCTION

Orthogonal Frequency Division Multiplexing (OFDM) is widely used in modern wireless communication systems because of its high spectral efficiency and low susceptibility to multipath effects [1].however one of the major drawback of OFDM is its high peak –to- average power ratio (PAPR), which makes it sensitive to non linear effects of power amplifiers. Hence many PAPR reduction techniques have been proposed in the literature, among all these existing techniques, the iterative clipping and filtering (ICF) procedure may be simplest to approach a specified PAPR threshold in the processed OFDM symbols. However clipping time domain signals causes out of band spectral re-growth and in band distortion[2]. The latter can also degrade bit error performance of the OFDM system. In addition, frequency –domain filtering can reduce the spectral growth, but mat still generate large time –domain peaks. For this reason, the ICF technique requires much iteration to approach a desired PAPR reduction.

In this paper ,we focus the research on clipping and filtering with reduced PAPR , in-band distortion and compared with SLM,PTS schemes .also the simulation results shows the superiority of our algorithm when compared with other schemes.

II. PAPR OF OFDM SIGNALS

In this section, we first review the PAPR problem of OFDM signal then, two previous studied concerning our work, i.e SLM, PTS.

A) Discrete time PAPR:

The PAPR is a measure commonly used to quantify the envelop fluctuations of multicarrier signal. For a discrete time signal x(n), the PAPR is defined as the ratio of the maximum power to the average power[3]:

$$PAPR = \frac{\max\left[\left|x(n)\right|^2\right]}{E\left[\left|x(n)\right|^2\right]} \tag{1}$$

Where $E\left[\left|x(n)\right|^2\right]$ is the average power of the signal x(n). The complex base band OFDM signal for N sub carrier can be represented as

$$s(t) = \frac{1}{\sqrt{N}} \sum_{k=o}^{N-1} X_k e^{j2\pi k\Delta ft} \tag{2}$$

Where X_k is the data symbol carried by the k^{th} subcarrier .according to central limit theorem, when N is large, both the real and imaginary part of s(t) are Gaussian distributed. Therefore the power of OFDM signal is x^2 distributed with two degrees freedom. The cumulative distribution function (CDF) of the signal is[4]:

$$f(z) = 1 - e^{(-z)} \tag{3}$$

If there are N subcarriers in an OFDM system, and all the sampled values are complete independence, the CDF of the system is

$$P(PAPR \le Z) = \left[F(Z)\right]^N = \left(1 - e^{-z}\right)^N \tag{4}$$

So in case of no over sampling, the CCDF which is usually used as an important parameter to describe the PAPR of an OFDM system, is

$$P(PAPR > Z) = 1 - (1 - e^{-z})^N \tag{5}$$

III. B.SLM AND PTS

3.1 Selected Mapping Method (SLM)

SLM was first introduction [4,5] as distortion free PAPR reduction technique. In SLM, D equivalent data sequences are created each by rotating the phases of the original sequence X_k by a distinct sequence $\phi_k^{(d)}$,i.e

$$X_k^{(d)} = X_k e^{j\phi_k^{(d)}} \tag{6}$$

This is used to create

$$x_n^{(d)} = IFFT\left\{X_k^{(d)}\right\} \tag{7}$$

Where $d = \{0,1,..............,D-1\}$. A total of D length N-IFFT are performed, From these D candidates, the transmitter selects the lowest PAPR sequence $x_n^{(d)}$, for transmission where

$$\bar{d} = avg \min_{0 \le d \le D-1} PAPR\left[x_n^{(d)}\right] \tag{8}$$

It is assumed that the table of D length, N-phase sequences $\phi_k^{(d)}$ have the transmitter and the receiver .however ,inorder to recover the original data sequence X_k ,the receiver must compute $\bar{d}$ to distinguish $\bar{d}$ from the D possibilities, $\log_2(D)$ are needed.

3.2 Partial Transmit Sequence (PTS)

In a PTS system, $\{X_k\}_{k=0}^{N-1}$ is partitioned into V non overlapping subblocks $\{X_{V_v}\}_{v=0}^{V-1}$ which indicates in the sets $\{V_v\}_{v=0}^{V-1}$ that is [6]

$$\bigcup_{v=0}^{V-1} V_v = \{0,1,............., N-1\} \tag{9}$$

And

$$\sum_{v=0}^{V-1} X_{V_v} = X_k, \forall k \in [0,1,.................., N-1] \tag{10}$$

To generate D PTS signal representations, each of the subblocks is scaled by a complex constant $e^{j\phi_v^{(d)}}$ and added together so that

$$x_n^{(d)} = IFFT\left\{\sum_{v=0}^{v-1} e^{j\theta_v^{(d)}} X_{V_v}\right\} \sum_{v=0}^{v-1} e^{j\theta_v^{(d)}} IFFT\left[X_{V_v}\right] \tag{11}$$

Where $d \in (0,1,......., D-1)$ .finally ,the transmitted signal $x_n^{(\bar{d})}$ is chosen according to (8) similar to SLM method. Therefore, there are two important issues should be solved in PST: High computational complexity for searching the optimal phase factor and the overhead of the optimal phase factor as side information needed to be transmitted to receiver for the correct decoding of the transmitted bit sequence.

IV. PROPOSED ICF

Figure 1 shows the basic block diagram of proposed ICF PAPR reduction scheme. It modifies each OFDM symbol one at a time. In the first iteration ($m = 1$), switch K1 is set to 1 and the new OFDM symbol enters the ICF block. Then, both K1 and K2 are set to 2 and clipping and filtering is iteratively performed. In the M-th (final) iteration, the switches are returned to position 1 and thus the output c is produced[2].

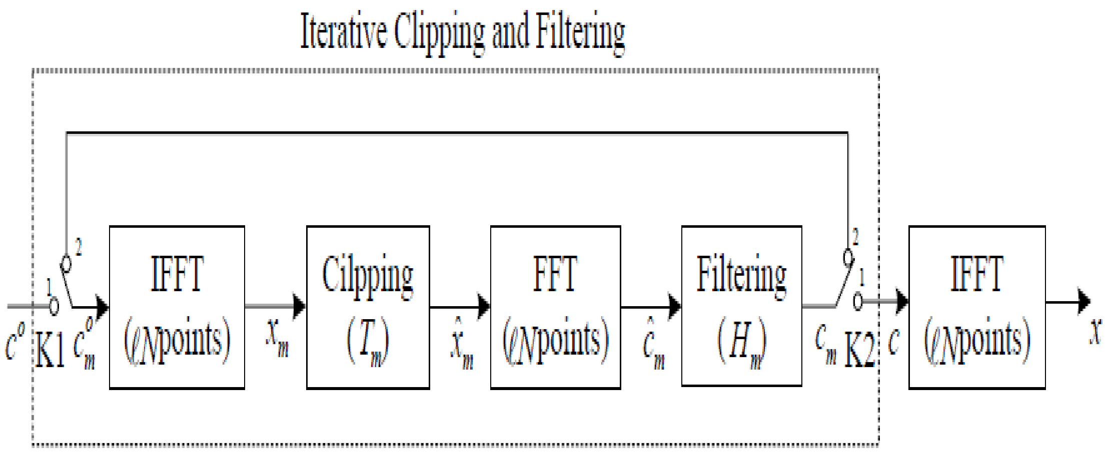

Figure1: Iterative Clipping and Filtering Scheme.

More specifically, the clipping procedure is performed by

$$\hat{x}_m(k) = \begin{cases} T_m e^{j\theta_m(k)}, & |x_m(k)| > T_m \\ x_m(k), & |x_m(k)| \le T_m \end{cases} \tag{12}$$

Where $1 \le k \le \ell N$, (k) represents the phase of (k), and Tm is the clipping level in the m-th iteration. The clipping in the m-th iteration[7,8]. The clipping level is recalculated in each iteration according to a constant value called the clipping ratio (CR). In the proposed ICF method, the filtering step is based on a rectangular window with frequency response defined by

$$H_m(i) = \begin{cases} 1, & 1 \le i \le N \\ 0, & N+1 \le i \le \ell N \end{cases} \tag{13}$$

The above filtering step simply removes the out-of-band spectral re growth without considering the effect on the time domain peak after the IFFT operation. As a result, it tends to cause sizable time-domain peaks, requiring clipping and filtering to be repeated many iterations before achieving the desired PAPR.

V. RESULTS AND DISCUSSION

In attempt to compare the performance of the original and proposed algorithms, we consider an OFDM system with 256 subcarriers and QPSK modulation. Our proposed ICF will be compared f with the SLM and PTS techniques.

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ISSN 2348 - 7550

Simulation parameters	Type/value
Number of subcarriers(N)	256
Number of selections	4
Oversampling factor(L)	2
Modulation Scheme	QPSK
Phase factor	[1, -1]

Table1. Simulation Parameters

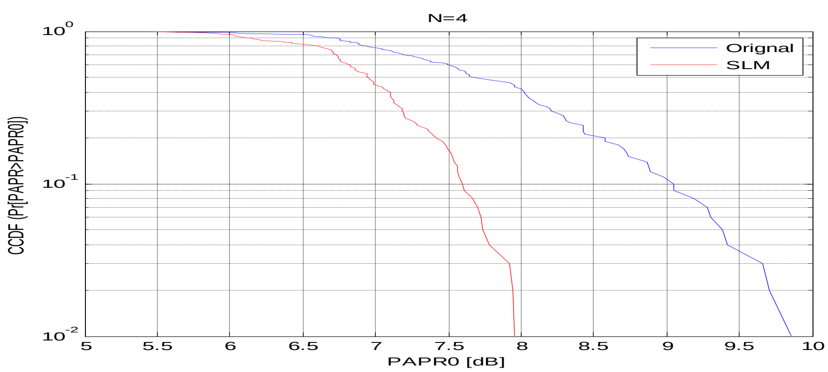

Figure2: PAPR reduction performance of original and SLM

Figure 2 show the PAPR reduction performance of selected mapping method for256 sub carriers. Here compared original OFDM PAPR with SLM, it shows that SLM gives better performance.

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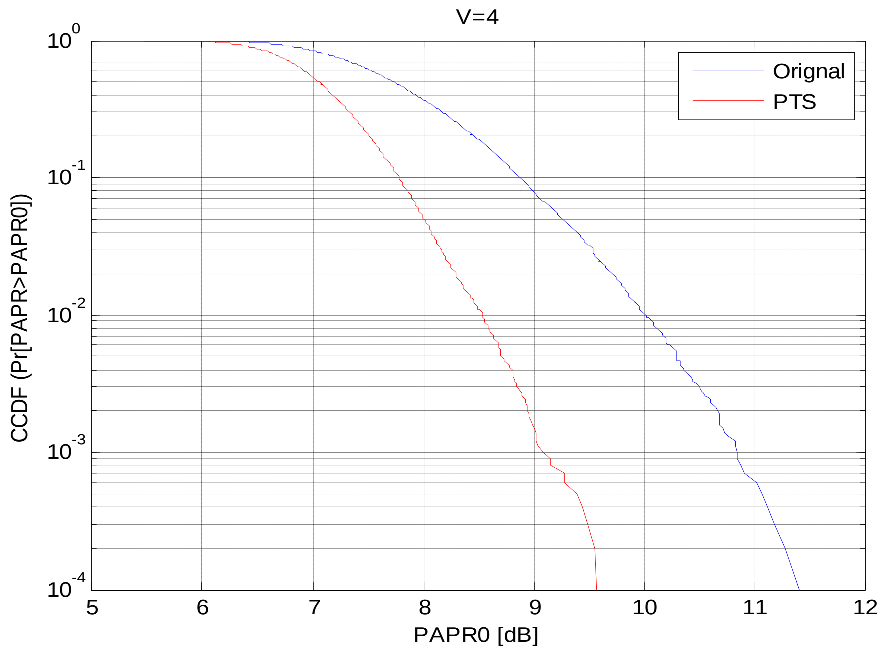

Figure3: PAPR reduction performance of original and PTS

Figure 3 show the PAPR CCDF curves for the signal processed by using the original and partial transmit sequence techniques .here we compared both the previous technique at 10^{-2}, the performance of the PTS is worse compared to SLM about1.3 dB for equal number of selections ,further these results is compared with propose ICF.

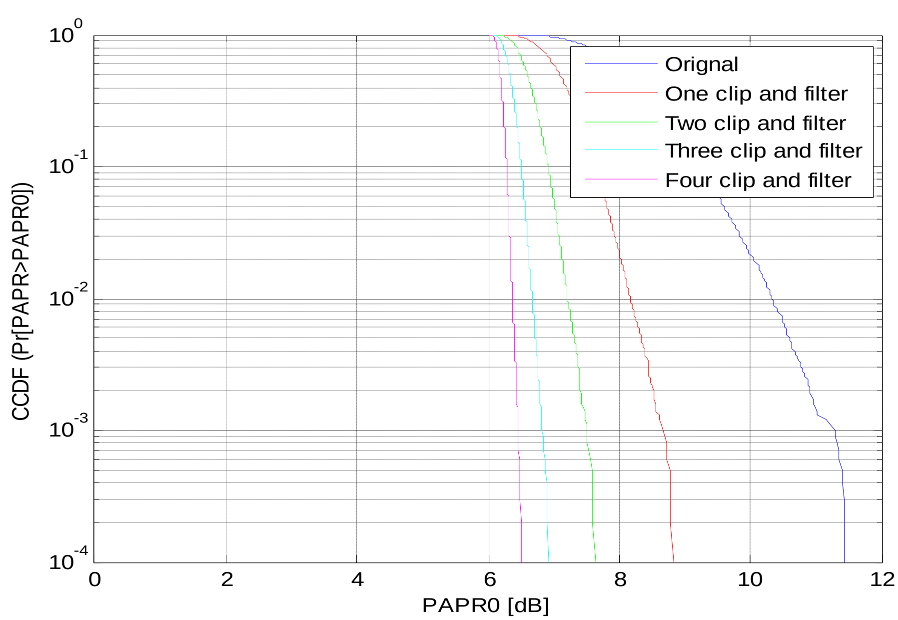

Figure4: PAPR reduction performance of original and Proposed ICF.

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Figure4 the PAPR reduction performance of original and Proposed ICF. We compared PAPR at 10^{-2} there is reduction in it's, on an average 1.45db and the proposed ICF gives better performance compared with conventional techniques.

VI. CONCLUSION

Multicarrier transmission is a very attractive technique for high-speed transmission over a dispersive communication channel. The PAPR problem is one of the important issues to be addressed in developing multicarrier transmission systems. In this paper we proposed ICF technique, the simulation results are compared with ICF, which give better performance than SLM, and PTS techniques.

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