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ENCHANCE PEAK TO AVERAGE POWER RATIO (PAPR) IN OFDM SYSTEMS USING PARTIAL TRANSMIT SEQUENCE

Ch. Susritha[1], N. BalaSubramanyam[2], T. S. Arulananth[1] and R. Karthik[1]
[1]Department of Electrical and Computer Engineering, MLR Institute of Technology, Hyderabad, India
[2]Department of Electrical and Computer Engineering, Gayatri Vidya Parishad, Vishakhapatnam, India
E-Mail: charugundla.susritha@gmail.com

ABSTRACT
Orthogonal Frequency Division Multiplexing (OFDM) system is preferred in many advanced high data rate wireless communication systems such as Wi-max, WI-FI, Digital Video Broadcasting (DVB), advanced LTE and Hiper-LAN as it is free from multipath fading. Even though this technique is power efficient as well as bandwidth efficient, there are a few drawbacks such as increase in peak power which results in High Peak to Average Power Ratio (PAPR) and Inter Carrier Interference (ICI). High PAPR leads to requirement of power amplifiers with large dynamic range A/D, D/A converters which increases complexity in the system. There are different techniques to reduce PAPR such as clipping & filtering, Partial Transmit Sequence (PTS) and Selective Level Mapping (SLM). In this paper we are implement a distortion less technique is known as Partial Transmits Sequence (PTS) algorithm is analyzed for the reduction of PAPR. In PTS, an input data sequence is partitioned into a number of disjoint sub blocks and each sub block is handled through phase factors. A Low Density Parity Check (LDPC) block code is used for encoding. In this paper, the PAPR values with and without PTS for different modulation techniques are compared.

Keywords: OFDM, PAPR, PTS, phase factors, LDPC, SLM.

INTRODUCTION
Multi carrier modulation or Orthogonal Frequency Division Multiplexing is an attractive technique for wireless communication systems. It is a combination of multiplexing and modulation. Immunity to the Inter Symbol Interference, robustness to the multipath fading are the some of the benefits provided by the OFDM system. These systems have been used in many applications such as Wi-max [1], WI-FI, digital video broadcasting (DVB), ADSL, WLAN and Hiperlan/2.

One of the main drawbacks of OFDM system is increase in peak power which leads to high peak to average power ratio (PAPR).The PAPR of the OFDM signal increases when a number of sub carriers are added in phase. The transmission of an OFDM signal with large peak power requires an amplifier to be linear within wide dynamic range. The nonlinear part of a regular amplifier would give rise to a severe in-band distortion and an undesired out-of-band power of the signal [2].

Several techniques have been proposed for reducing PAPR [3]. Clipping [4], filtering, selective level mapping (SLM) and partial transmit sequence (PTS) are some of the techniques in vogue. Among these clipping and filtering are signal distortion techniques and SLM and PTS methods comes under signal scrambling techniques.

In this paper, Partial Transmit Sequence is considered for reduction of PAPR. In this approach, the whole data block is divided into number of sub blocks. For each block, subcarriers are weighted by a phase factor according to that sub block. Now the PAPR can be reduced by selecting the appropriate phase factor. A low density parity check (LDPC) block code is proposed for encoding and the PAPR values with and without PTS for different modulation techniques are compared. This paper is organized as follows: Section 2 briefly describes peak to average power ratio. The peak power reduction scheme using PTS is reviewed in Section 3. LDPC encoding is discussed in Section 4. Comparisons of different modulation techniques with PTS and without PTS are overviewed in Section 5 and Section 6 concludes this paper.

PEAK TO AVERAGE POWER RATIO (PAPR)
In OFDM, a block of N symbols, where n=0,1,…,N-1,is formed with each symbol modulating one of a set N subcarriers, f_n, n=0,1,…,N-1. The N subcarriers are chosen to be orthogonal that is $f_n = n\,\Delta f$ with $\Delta f = 1/NT$, where T is the original symbol period. The resulting continuous OFDM signal can be expressed as

$$x(t) = \frac{1}{\sqrt{N}} \sum_{n=0}^{N-1} X_k e^{j2\pi n \Delta f t}, 0 \le t \le NT$$

In the practical system, the OFDM can be implemented by an IFFT. When the continuous time signal $x(t)$ is sampled by Nyquist rate, the discrete time OFDM signal can be written as

$$X_n = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} X_k e^{j2\pi kn/N}, 0 \le n \le N-1$$

When N signals are added with same phase, they produce a peak power that is N times the average power. For an OFDM signal, the PAPR can be defined mathematically as

$$PAPR = \frac{\max[|x_n|^2]}{E[|x_n|^2]}$$

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Where $\max[|x_n|^2]$ represents the maximum power of the signal and $E[|x_n|^2]$ is the average signal power. PAPR reduction may achieved by decreasing the numerator, increasing the denominator. Complementary Cumulative Distribution Function (CCDF) is a method used to characterize the peak power statistics of a digitally modulated signal. CCDF object measures the probability of a signal's instantaneous power to be a specified level above its average power. Mathematically the complementary cumulative distribution function (CCDF) of PAPR of an OFDM signal [3] can be expressed as

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

Here 'Z' denotes threshold value.

LDPC CODES

Error detection and correction is one of the most important tasks in a communication system. In order to achieve reliable communication over noisy channels, with low power consumption, error correcting codes are used. Low density parity check codes are the most recent error correcting codes and are becoming increasingly popular due to their excellent performance. Low Density Parity Check codes [7] are a class of linear binary block codes corresponding to the parity check matrix *H*. Appropriate construction of LDPC codes depend on the corresponding parity check matrix *H*. Parity check matrix $H_{(N-K)\times N}$ consists of zeros and ones, where density of one's is very sparse.

LDPC encoding algorithm

Step1: Take parity check matrix H randomly with dimension (N-K) x N by taking W_r are no. of 1's in each row and W_c are no. of 1's in each column. For the matrix to be low density the two conditions W_c<<N and W_r<<K must be satisfied.

Step2: Convert the parity check matrix into the form $[P^T$: I] by performing t row operations.

Step3: From the H matrix, generator matrix G can be generated in the form of [I: P]

Step4: The codeword C is generated by using C= MG

Where
M = Message vector, G= Generator matrix
H = parity check matrix, C= Codeword

PARTIAL TRANSMIT SEQUENCE

Partial Transmit Sequence (PTS) is a signal scrambling methods of distortion less Communication. The goal of signal scrambling is not to eliminate the peaks, but only to achieve lower probabilistic occurrence of peaks. The block diagram of PTS is shown in below:

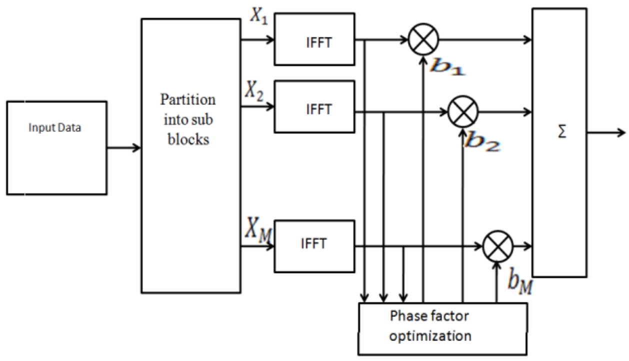

Figure-1. Block diagram of partial transmit sequence approach.

In this approach, the input data block is partitioned into disjoint sub blocks which are combined to minimize the PAPR[5]. First, define the data block as a vector $X=[X_0\ X_1\ \ldots\ X_{N-1}]^T$ [6]. Then partition X into M disjoint sets, represented by the vectors $\{X_{m,}\ m=1,2,\ldots,m\}$. Here we assume that the clusters consist of a contiguous set of subcarriers and are of equal size. Each carrier in the sub block is multiplied with a weighting factor, with

$$\overline{Y} = \sum_{m=1}^{M} b_m X_m$$

The time domain vectors can be composed by the IFFT

$$\overline{y} = IFFT\{\overline{Y}\} = IFFT\left\{\sum_{m=1}^{M} b_m X_m\right\}$$

Finally, the time domain vector with the lowest PAPR is transmitted.

RESULTS AND DISCUSSIONS

In this section we will discuss the PAPR performance by PTS algorithm and other conventional methods of OFDM signal. CCDF is employed to describe the performance of PAPR. An OFDM system is modulated with different modulation techniques such as BPSK, QPSK, and 8-PSK is used for simulation. The PAPR values of different modulation techniques with and without PTS are an evaluated and shown in Table-1 and Table-2 and simulation results are shown in Figure-2, Figure-3 and Figure-4.

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Table-1. PAPR values without PTS technique.

Message stream	BPSK	QPSK	8-PSK
000000	10.7918	7.7815	6.026
000010	7.27	5.2288	2.1319
111111	7.7815	6.3682	3.9794
111100	3.9586	2.8119	1.9444
000001	4.7712	2.8119	1.8453

Table-2. PAPR values with PTS technique.

Message stream	BPSK	QPSK	8PSK
000000	5.4894	4.7712	3.0103
000010	4.5046	3.2623	1.4913
111111	4.5046	3.3539	1.793
111100	2.2185	1.2494	0.9727
000001	3.2689	2.2185	1.2268

Figure-2 Contains the CCDF curves of convectional OFDM signal and PTS signal.

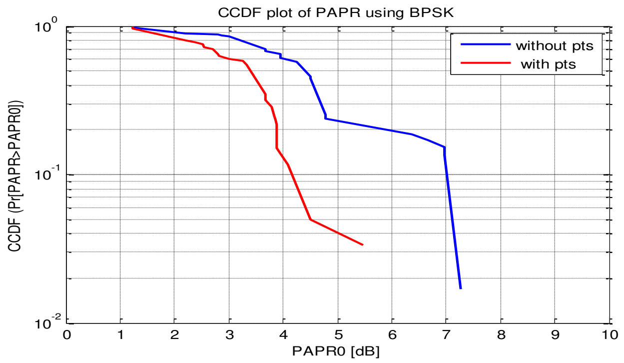

Figure-2. CCDF of PAPR without PTS and with PTS.

The CCDF plot of different modulation techniques with PTS approach as shown in Figure-3.

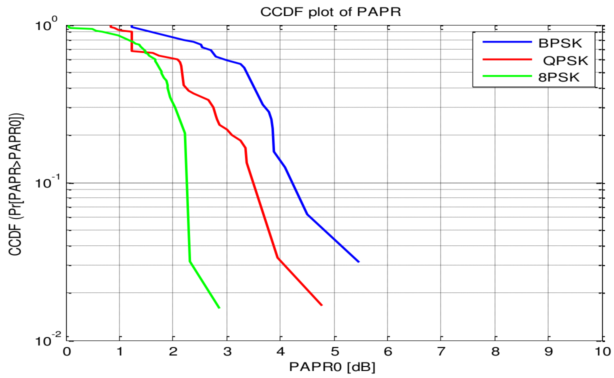

Figure-3. Comparison of PAPR reduction performances with BPSK, QPSK, and 8-PSK modulation schemes.

The PAPR comparisons of PTS algorithm with different sub blocks shown in Figure-4.

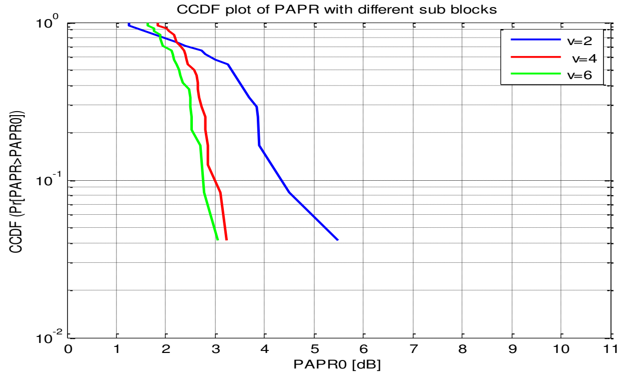

Figure-4. Comparison of PAPR reduction performances with different sub blocks.

CONCLUSIONS

This paper describes an efficient method of distortion less PAPR reduction PTS scheme along with LDPC encoding. The PAPR performance of OFDM for different modulation techniques with and without PTS is compared. PTS scheme can work with different sub blocks. The PAPR reduction performances with different sub blocks are compared. It is observed that the improvement in PAPR is different for different modulation techniques and best improvement in PAPR is obtained in 8-PSK scheme and also better PAPR obtained with increase in number of sub blocks.

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