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Efficient Techniques for PAPR Reduction in Multicarrier Communication

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ABSTRACT
Orthogonal frequency division multiplexing (OFDM) is an efficient multi-carrier modulation technique for wireless communication. However, one of the main drawbacks in OFDM is high PAPR when non-linear power amplifiers are used. The resultant high peak-to-average power ratio (PAPR) degrades the system performance. The effects include a decrease in the bit error rate (BER), an increase in complexity, or a reduction in the bit rate. The objective of this paper is to describe the PAPR problems in a bid to reduce the peaks in the OFDM signal. In this paper, hybrid techniques for PTS and DCT is used to reduce the PAPR of the OFDM system. Simulations are performed at 64,128,256 and 1024 carriers using MATLAB software.CCDF graphs demonstrate the efficiency of proposed techniques.

Keywords: *OFDM, PAPR, QoS, PTS and SLM.*

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I. INTRODUCTION

OFDM (Orthogonal Frequency Division Multiplex), is multicarrier modulation appropriate composed. The essential concept is to transmit data, high data rate information by splitting the data into various interleaved, parallel bitstreams, and every slice of these bitstreams modulates an independent subcarrier. In this modulation, the channel spectrum is pushing through a number of separated non-selective frequency sub-channels. These sub-channels are used for one transmission link between the transmitter-receiver. OFDM is expeditiously recognized by the use of active signal processing method, fast-Fourier Transform, in the transmitter-receiver. This significantly increases the amount of PAPR in the MIMO-OFDM system compared to earlier FDM-systems. To transmit signal with high PAPR it requires a power amplifier with a very high-power scope. One of the benefits of OFDM is the robustness against the adverse effects of multipath propagation with respect to intersymbol interference It is spectrally active as well because the subcarriers are accumulated maximally adjacent together. OFDM has provided amazing springiness deeming the choice and realization of different modulation alternatives. OFDM requires a completely designed system. For special significances are the design of frequency synchronization and power amplifier back-off in the receiver. As well, the number of subcarriers has to be selected in a suitable way. To that degree, OFDM has been standardized for several applications. Beneath the name, there isdiscrete multitone (DMT) which is the world standard for asymmetric digital subscriber lines (ADSL).As an example of wireless broadcast applications, OFDM has been standardized by the European Digital Audio Broadcasting. A crucial feature of the physical layer is to supply several modulation and coding alternatives. These are both adapt to existing radio link quality and to face the requirements for different physical layer features as defined for the transport channels. BPSK, QPSK, and 16QAM are the corroborative subcarrier modulation schemes. The most serious problem in an OFDM system is transmitting signals with high PAPR it requires high power. To combat this high power is to adapt amplifiers to have large trade-off range however; these types of the amplifier are generally expensive and have low efficiency. On the other side, a certain algorithm was introduced and been proved to have a good performance of high PAPR reduction. Different PAPR Reduction Techniques are Signal Scrambling Techniques and Signal distortion techniques. Signal Scrambling Techniques further classified into Selected Mapping (SLM), Partial Transmit Sequence (PTS), InterleavingTechnique, Tone Reservation (TR) and Tone Injection (TI). Whereas, Signal distortion techniques consists of PeakWindowing, EnvelopScaling, Peak Reduction Carrier and Clipping and Filtering

II. PAPR IN OFDM SIGNAL

Orthogonal frequency division multiplexing (OFDM) is an efficient multi-carrier modulation technique for wireless communication. However, one of the main drawbacks in high PAPR when non-linear power amplifier (PA) is used and large input back off (IBO). The resultant high peak-to-average power ratio (PAPR).The effects include a decrease in the bit error rate (BER), an increase in complexity, or a reduction in the bit rate. The objective of this paper is to describe the PAPR problems in a bid to reduce the peaks in the OFDM signal.

Many methods have been proposed in traditional multi-carrier-based communication to limit the PAPR of the transmitted signals. A clipping and filtering method was introduced and, which iteratively limits the maximum amplitude until its corresponding output is under or equal to a pre-defined PAPR. Selective mapping (SLM), and was used to generate a set of phase sequences, and then each phase sequence is multiplied by the same data sequence to produce their corresponding transmitted sequences, and the one with the lowest PAPR is then chosen for transmission. The partial transmits sequences (PTS) technique was studied, followed by the tone reservation method and tone injection method. The wideband beam pattern formation via iterative techniques (WBFIT) method was introduced for wide-band MIMO radar to directly link the beam pattern to the signals through their Fourier transform.

In the OFDM System Model, it can be noted that the input transmits signals are modulated first using either PSK or QAM i.e. Phase Shift Keying or Quadrature Amplitude Modulation and then undergo IFFT (Inverse Fast Fourier Transform) operation at the transmitter end. The orthogonal sub-carriers are generated at the transmitter part. These transmitted signals can have high peak values in the time domain and these high peak values are referred to as high Peak To Average Power Ratio, in OFDM Systems as compared with Single carrier systems. The high PAPR is a result of the summation of sinc waves and non-constant envelope. The harmful impact of High PAPR is that it reduces the Signal to Quantization Noise Ratio of ADC and DAC's while dropping the performance of power amplifier. Therefore, RF power amplifiers need to be operated in a very large linear region, Else ways the signal peaks will get entered into the non-linear region and will cause distortion. So there are numbers of PAPR reduction techniques. PAPR Reduction Technique efficiency is measured through Cumulative Distribution, i.e. (CDF).

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III. METHODOLOGY

High peak to average power ratio (PAPR) degraded the system performance by increasing the bit error rate (BER) and enhance caused distortion, thus it became necessary to introduce some techniques for minimizing the PAPR.The partial transmit sequence is the one of the most important techniques to average power ratio PAPR in OFDM system. The fundamental idea of the partial transmit sequence algorithm is to split the original OFDM sequence into different subsequences, and for each subsequence, multiple by different weights till an optimum value is selected. The partial transmits sequence (PTS) technique sections an input data block of N symbols into V disjoint sub-blocks as below:

$X = [X^0, X^1, X^2, \ldots X^{v-1}]^{T}$(1)

Where, Xi is the sub-blocks that are consecutively located and also are of equal size. which scrambling is placed to all subcarriers, scrambling (rotating its phase single-handedly) is placed to each sub-block in the PTS technique. Then each partitioned sub-block is multiplied by a corresponding complex phase factor $b^v = e^{j\emptyset v}$, $V = 1, 2, \ldots V$subsequently taking its IFFT to yield

$X = IFFT\,\{\sum_{v-1}^{v} b^v X^v\} = \sum_{v-1}^{v} b^v\ .IFFT\,\{X^v\} = \sum_{v-1}^{v} b^v X^v$(2)

Where $\{X^v\}$ is referred to as a partial transmit sequence (PTS). The phase vector is selected in order to avoid the PAPR can be indicated minimized, which is shown below as:

$[\tilde{b}^1, \ldots \tilde{b}^v] = b^1 b^{v^{\arg\, min}} [n^{max} = 0, 1, \ldots N -$
1 v=1vbvXvn (3)

Then, the identical time-domain signal with the lowest PAPR vector can be extracted as:

$X = \sum_{v=1}^{v} \tilde{b}^v X^v$ (4)

In general, the selection of the phase factors $[b^v]_{v=1}^{v}$ is limited to a set of elements to reduce the search complexity. As the set of allowed phase factors is $b = \{e^{j2\pi/w} | i = 0, 1, \ldots, W - 1\}, W^{v-1}$ sets of phase factors should be searched to find the optimum set of phase vectors. wherefore, the study complexity rises exponentially with the number of sub-blocks. The PTS technique demands V IFFT operations for every single data block and bits of side Information. The PAPR performance of the PTS technique is affected by not only the number of sub blocks, V,and the number of the allowed phase factors, W, but also the sub-block partitioning In point of fact, there are three different sorts of sub-block partitioning schemes: adjacent, interleaved, and pseudo-random. Among these, the pseudo-random one has been known to provide the best performance. Figure1 shows block diagram of partial transmits sequence (PTS) technique for PAPR reduction

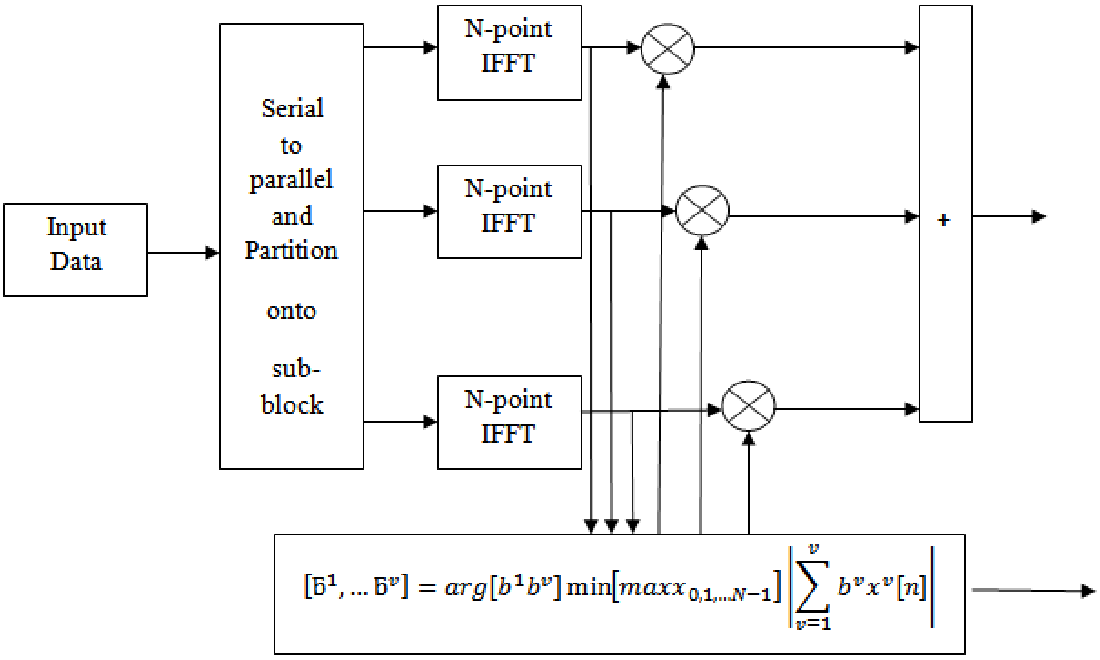

Figure 2: Block diagram of partial transmits sequence (PTS) technique for PAPR reduction

PTS Algorithm

The PTS technique suffers from the complexity of searching for the optimum set of phase vector, especially when the number of sub-block increases In the studies, various schemes have been approached to decrease this complication.For instance, is a suboptimal combination algorithm, which exercises the binary phase factors of {1, -1}.It is summarized as follows:

1. Partition the input data block into V sub-blocks as in Equation (1).
2.Set all the phase factors b^v = 1for v = 1 : V, find PAPR of Equation (2), and set it asPAPR_min.
3. Set v = 2.
4. Find PAPR of Equation with b^v = -1.
5. If PAPR> PAPR min, switch b^v back to 1. Otherwise, update PAPR min=PAPR.
6. If v < V, increment v by one and go back to Step 4. Otherwise, exit this process with the set of optimal phase factors $\tilde{b}$.

IV. RESULTS AND DISCUSSION

In Figure 2 original OFDM signal is having PAPR of 10.9 dB and the PTS reduces the PAPR to 6.5 dB and the combination of PTS and DCT reduced PAPR to 6.4 dB. Thus, there is an overall reduction of 4.5 dB at 64 carriers. In Figure 3 original OFDM signal is having PAPR of 11 dB and the PTS reduces the PAPR to 7.2 dB and the combination of PTS and DCT reduced PAPR to 7 dB. Thus, there is an overall reduction of 3 dB at 128 carriers. In Figure 4 original OFDM signal is having PAPR of 11.4 dB and the PTS reduces the PAPR to 7.6 dB and the combination of PTS and DCT reduced PAPR to 7.5 dB. Thus, there is an overall reduction of 3.9 dB at 256 carriers. In Figure 5 original OFDM signal is having PAPR of 12 dB and the PTS reduces the PAPR to 8.7 dB and the combination of PTS and DCT reduced PAPR to 8.3 dB. Thus, there is an overall reduction of 3.7 dB at 1024 carriers. So it can be observed that if we increase the number of carriers PAPR also increases i.e. PAPR directly depends on number of carriers. Table 1 shows shows the comparison of PAPR at different carriers.

Table 1: Comparison of PAPR at different carriers

	PAPR (dB)			
	64 Carriers	128 Carriers	256 Carriers	1024 Carriers
Original OFDM Signal	10.9	11	11.4	12
PTS	6.5	7.2	7.6	8.7
PTS+DCT	6.4	7	7.5	8.3

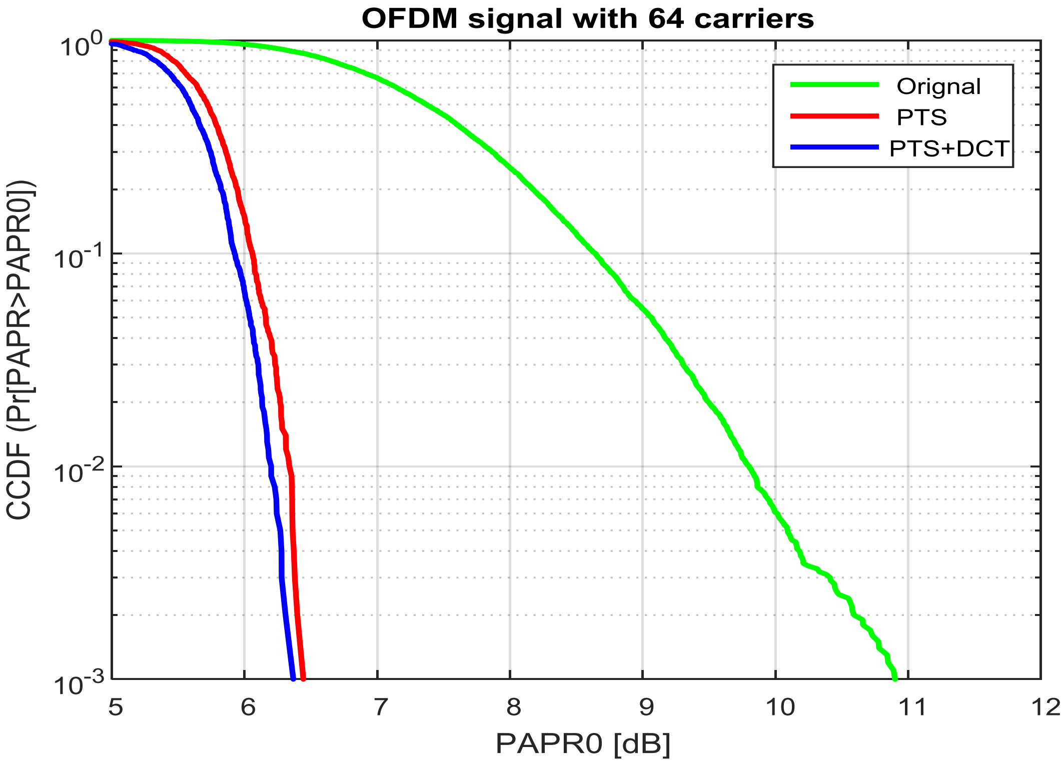

Figure 2 : CCDF plot PAPR reduction at 64 carriers

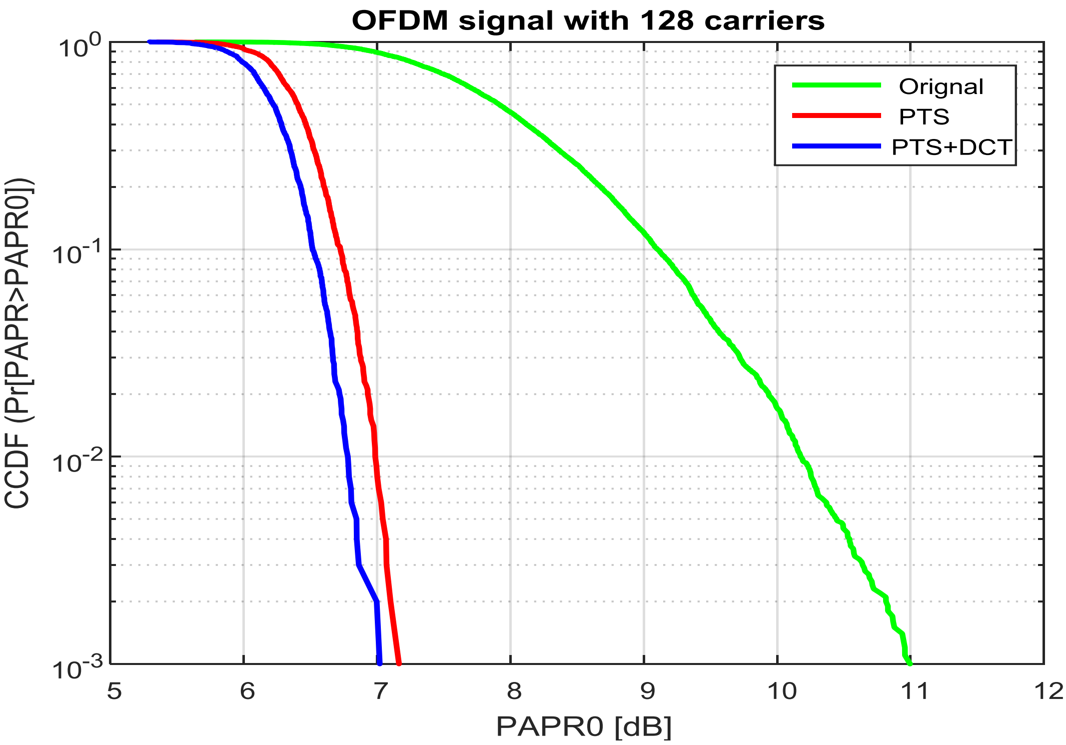

Figure 3: CCDF plot PAPR reduction at 128 carriers

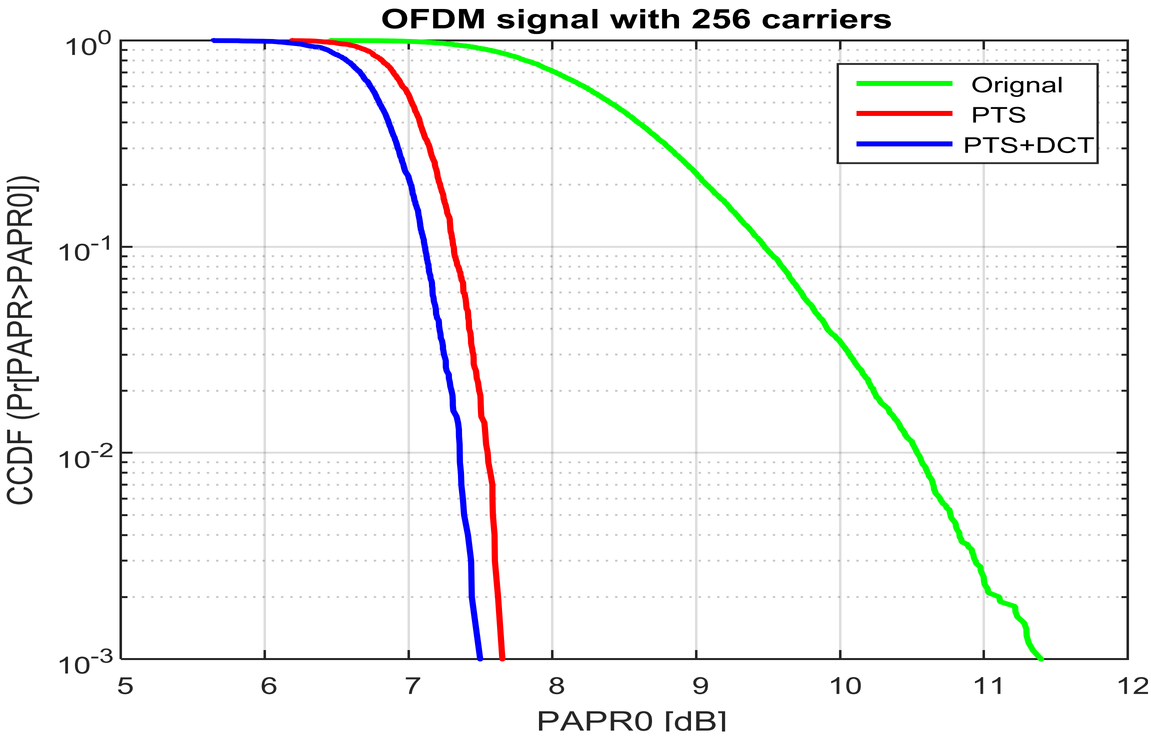

Figure 4 : CCDF plot PAPR reduction at 256 carriers

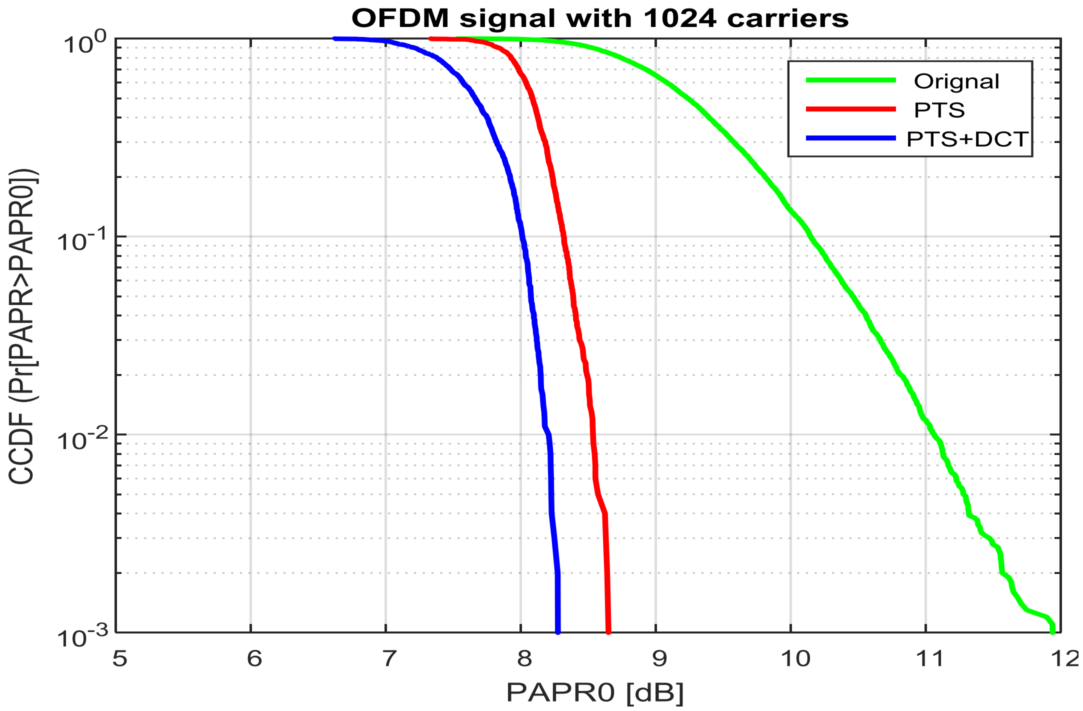

Figure 5 : CCDF plot PAPR reduction at 1024 carriers

V. CONCLUSION

In this paper we have investigated the PAPR problem in the OFDM system, especially in the downlink. A new hybrid technique of partial transmit sequence and DCT are used to reduce the PAPR at different carriers. Moreover, different carriers are used to the dependency of PAPR on the number of subcarriers. It can be concluded that PAPR increases with the number of carriers and shows the significant decrement using the proposed techniques.

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