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A Comparative Analysis of C-PTS, C-SLM and Modified DCT Based OFDM for PAPR Reduction

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ABSTRACT: OFDM is one of the best modulation scheme for the wireless as well as wired communication. It is mostly used for its advantages such as better spectral efficiency, multipath fading , higher data rate and thus good quality of service. However the only major obstruction in its performance is its high peak to power average ratio (PAPR). There have been a lot of research going on for the reduction techniques of PAPR in OFDM system. Although some techniques give a sufficient reduction but then one has to trade off between the computational complexity and also overall efficiency of the system. As high PAPR causes the high power amplifier to perform in its non linear distortion and hence distortion occurs during transmission of data. In this paper a new hybrid technique which is DCT based using PTS and SLM is being proposed in order to reduce the PAPR in the OFDM sytem. Also the results obtained are compared to the PAPR values of conventional PTS , Wavelet based PTS scheme and SLM technique in which the resulted PAPR value of the proposed technique comes around 6.45 dB, which is lesser than the above compared values . The results have been simulated using the MATLAB software.

KEYWORDS: OFDM, ISI, PAPR, SLM, PTS, DCT.

I. INTRODUCTION

OFDM is a very attractive technique used for multi carrier modulation, it means orthogonal frequency division multiplexing. The major reason behind using OFDM on large basis is its high data rate services which it has been made popular among wired as well as wireless communication channels. Also the advantages of OFDM such as high spectral efficiency robustness to the multipath fading and high immunity to ISI (inter symbol interference) and ICI (inter carrier interference) led to the adoption of this OFDM system into fields of communications such as DAB (digital audio broadcasting) and DVB (digital video broadcasting). OFDM is also known as the physical layer for the wireless applications such as wireless LAN, WiMAX, smart grid system and the LTE(long term evolution) etc. However the only major obstruction in its performance is its high peak to power average ratio (PAPR). PAPR is said to be principal difficulty in OFDM as it causes the HPA (high power amplifier) at the transmitter side to operate in its non linear region which causes loss of data or distortion transmission hence it has been a topic of concern thus a lot of research is being made over the PAPR reduction techniques. There has been various techniques brought up such as clipping filtering, PTS , SLM etc. Out of these the PTS scheme is found the best as it gives less probability of data loss . if we use FFT based PTS then in this case the computational complexity increases and also due to the addition of cyclic prefix the spectral efficiency gets affected although it gives better reduction in PAPR. So to encounter the problem of data loss due to spectral efficiency reduction we switch on to a wavelet based PTS scheme which offers better bandwidth efficiency but still the complexity issue remains there. To solve the issue of computational complexity in PTS , DCT (discrete cosine transform) based OFDM will be helpful , the advantage of using DCT matrix before or after IFFT is that autocorrelation coefficients of the input symbols are reduced , the computation gets reduced and ultimately fair low PAPR can be observed. So this brings the need for the design of a new hybrid technique which is DCT based and intends to combine the advantages of PTS and SLM techniques to obtain even better reduction in PAPR. And the results observed will be compared with the PAPR of conventional PTS and that of Wavelet based PTS schemes .

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II. PRIOR WORK DONE

A lot of research has been made in order to solve the issue of PAPR problem in OFDM and many fine methods have been discovered but although the PAPR reduction have been achieved but the problem of overall computational complexity still remains to be solved, which offers the hindrance in the overall functionality of the system . Let us review the techniques proposed in the recent years. In the year 2015, the paper [1] have proposed the wavelet transform method in OFDM system where the FFT/IFFT blocks will be replaced using wavelet transform , the advantages of doing so is the the problem of cyclic prefix insertion is solved, also this technique offers more flexibility and also optimal resolution . here this technique was employed along with PTS and using QPSK modulator and results were found to be much lesser the PTS scheme using IFFT. Later in the same year, the paper [2] has proposed the technique to minimize the gap between the iterative algorithm (I-PTS), and the conventional PTS (C-PTS). This modified flipping algorithm was then compared with original OFDM , PTS and I-flipping and the obtained result offered PAPR reduction with performance /complexity trade off as compared to other techniques. Also paper [3] proposes the method to resolve the complexity issue of SLM by introducing a new phase sequence based on the decimal sequences. This paper provides the study based on the mathematical auto correlation function of Different phase sequence and was found that decimal sequence have less correlation among its elements.

Before in the year 2014, the research paper [4], mentioned about the DCT aided successive addition and subtraction of OFDM symbols in the single OFDM frame, this method's performance was found to be superior than conventional PTS and SLM schemes. Thus it gave the idea to use DCT/ IDCT for more better performance of PAPR reduction than FFT/IFFT. In the year 2013, paper [6] titled presented a simple technique of PAPR reduction by taking the discrete transform of the OFDM signal before passing it on to the IFFT block , and it was found that this technique was beneficial in the case of PAPR reduction. In the same year, in the research paper [7] gives the design of embedding the side information data into WP-OFDM frame and the technique to recover it on the received side which in turn will reduce PAPR and also will help to reduce complexity problem . In year 2012 , paper [8] introduced a modified PTS combined with interleaving scheme to reduce the extra IFFT operations so as to reduce PAPR as well as complexity. In 2011 paper [9] proposed the novel method in PTS technique to halve the computational steps with the help of generating new phase sequence which is based on N-random variable from all possible phase factor. In paper [10], presented a technique which reduced the PAPR using PTS modified by using a scheme to reduce the correlation among the phase vectors thus reduces the computations. Similarly in paper [11], proposed a novel conversion matrices modified SLM scheme to reduce computational complexity in SLM along with PAPR reduction.

III. ANALYSIS OF ABOVE WORK

The analysis of the above referred papers show that continuous research has been made for the reduction of PAPR ratio but at the cost of degradation of either spectral efficiency , increased computational complexity or at the degradation of BER performance. Thus the overall power efficiency of the system gets deducted , resulting in an inefficient communication system. So appropriate methods are needed to be considered which does not hamper the system and thus gives good PAPR system. Also comparison is to be made to find the best solution in accordance with the particular situation.

IV. PROBLEM FORMULATION

- All the more the large variation in signal amplitudes highly affects the HPA efficiency due to their nonlinear characteristic.
- High PAPR results in wide variation of OFDM signal amplitudes which due to non linear characteristics of HPA results in inter-modulation between the different sub carriers and leads to an increase in bit error rat (BER).
- A high dynamic range HPA has poor power efficiency. It has been reported that we can save power by PAPR reduction. This power saving which is achieved in this way has direct relationship with the desired average output power.

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V. PROPOSED WORK

• To perform a comparative analysis of PTS techniques that are FFT based and DWT based with the hybrid scheme of PAPR reduction combining PTS and SLM based on DCT .
• To design a OFDM system with hybrid DCT technique combining PTS and SLM , to obtain a less complex OFDM system with better performance for PAPR reduction without compromising on BER performance

Finally the comparison for the PAPR results of the PTS, SLM and the modified schemes will be made to find out the best solution.

VI. ADVANTAGE of USING IDCT OVER IFFT

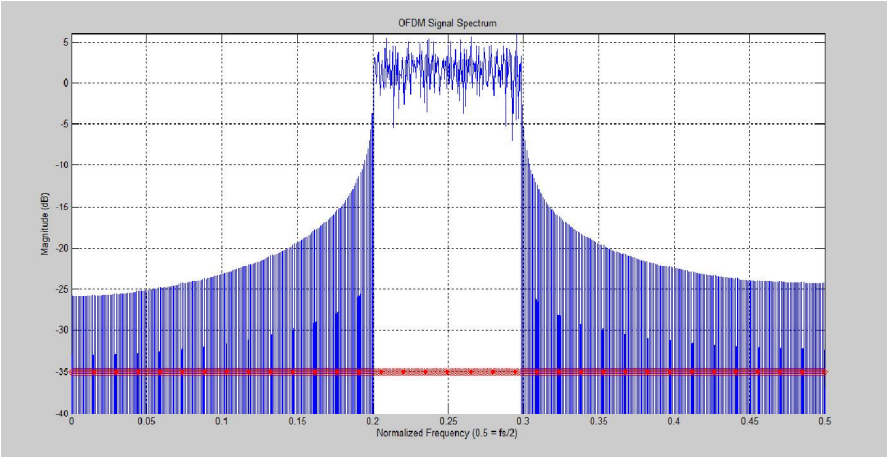

Fig 3: OFDM spectrum using IDCT.

As seen from fig 2 which shows the OFDM spectrum using IFFT, and fig.3 shows the OFDM spectrum using IDCT, on comparing both the figures we can see that the normalized frequency, generated in case of IFFT is more than that generated in case of IDCT Thus more power is required to modulate normalized frequency when IFFT is used, whereas less power is required for modulation when IDCT is used, thus less PAPR can be obtained when IDCT is replaced for IFFT in OFDM .

VII. RESULTS AND DISCUSSIONS

The analysis of the modified DCT based OFDM has been carried out using MATLAB software . The simulation parameters considered are mentioned in the table below:

The complementary cumulative distribution functions (CCDF's) of PAPR are obtained for modified DCT scheme as shown in Fig 4. Whereas Fig.5 shows the comparison of PAPR values between the original OFDM signal where no PAPR reduction technique applied and the other is the result obtained on applying the proposed method. Then the obtained results have been compared with the PTS technique mentioned in reference [2] and the SLM method[3],table 2 shows the comparison . Thus the comparative analysis of all the PAPR values is shown in fig 6, from which we can observe that the proposed modified DCT method shows the best PAPR reduction among the other PTS and SLM methods.

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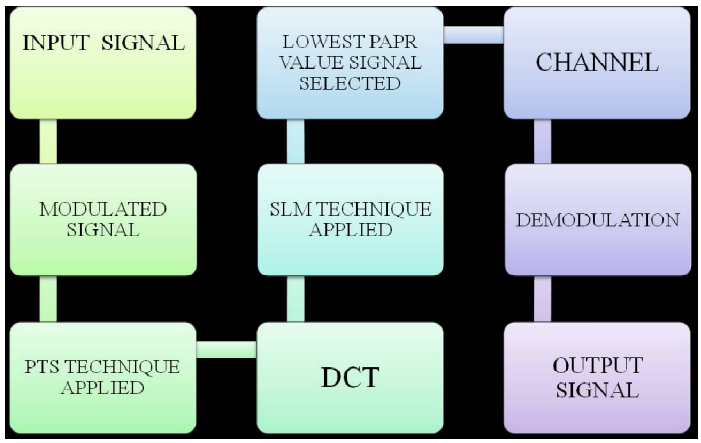

Fig 4: PAPR value using PTS+DCT+SLM

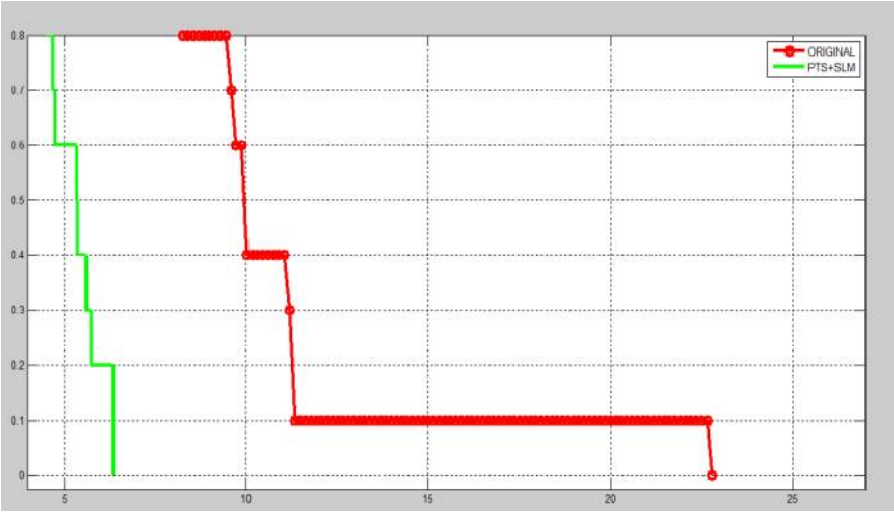

Fig 5: Original Signal vs Modified DCT based OFDM

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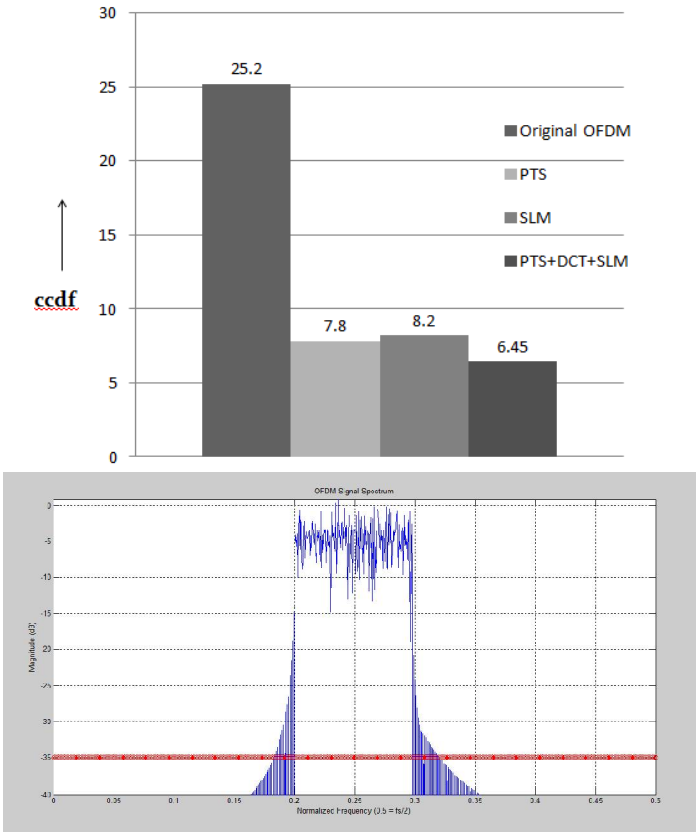

Fig 6: Comparative analysis

VIII. CONCLUSION

This paper proposed a modified DCT based method for PAPR reduction in OFDM system . The significance of this technique is that it combines the best methods of PTS and SLM Via DCT transform matrix block , this block helps in reducing the correlation factors and thus reducing the complexity of the system resulting in reduction of PAPR . Hence this will in turn be beneficial to improve BER performance of the OFDM system and hence the system will become more efficient.

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